Development of Facility Management Assessment Tool for Public Office Buildings: In the Context of Hawassa City (Sidama Region, Ethiopia)

Tigilu Eshetu Nare

A Thesis Submitted to the Department of Civil Engineering

School of Civil Engineering and Architecture

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

Office of Graduate Studies

Adama Science and Technology University

July, 2023

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DECLARATION

I hereby declare that this Master Thesis entitled “Development of Facility Management Assessment Tool for Public Office Buildings: In the context of Hawassa City (Sidama Region, Ethiopia)” 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.

Tigilu Eshetu Nare	_____	_____
Name of the Student	Signature	Date

RECOMMENDATION

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "Development of Facility Management Assessment Tool for Public Office Buildings: In the context of Hawassa City (Sidama Region, Ethiopia)" prepared under my guidance by Tigilu Eshetu Nare submitted in partial fulfilment of the requirements for the degree of Masters of Science in Civil Engineering (Specialization in Construction Engineering and Management). Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

Lemma Beressa, Ph.D.	_____	_____
Major advisor	Signature	Date

APPROVAL SHEET

I, the advisor of the thesis entitled "Development of Facility Management Assessment Tool for Public Office Buildings: In the context of Hawassa City (Sidama Region, Ethiopia)"and developed by Tigilu Eshetu Nare, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Lemma Beressa, Ph.D.	_____	_____
Major Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Tigilu Eshetu Nare have read and evaluated the thesis entitled "Development of Facility Management Assessment Tool for Public Office Buildings: In the context of Hawassa City (Sidama Region, Ethiopia)" and examined the candidate during open defence. This is, therefore, to certify that the thesis is accepted for partial fulfilment of the requirement of the degree of Masters of Civil Engineering Specialization in Construction Engineering and Management).

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AHP	Analytical Hierarchical Process
BIFM	British Institute of Facility Management
BIM	Building Information Model
BOMA	Building Owners and Managers Association.
BPRT:	Building Performance Risk Rating Tool
BREEAM	Building Research Establishment Environmental Assessment Method
CAGR	Compound Annual Growth Rate
EBCS	Ethiopian Building Code Standard
EILIBCI:	Evaluation on intelligence level of the building complex in an ICT
Ethio-SBAT	Ethiopian Sustainable Building Assessment Tool
FM	Facility Management
FMAA	Facility Management Association in Australia
FMAT	Facility Management Assessment Tool
GIS	Geographic Information System
HCM	Hawassa city municipality
HCA	Hawassa City Administration
HKIFM	Hong Kong Institute of Facility Management
ICT	Information Communication Technology
IFMA	International Facility Management Association
IoT	Internet of Thing
ISBRS:	Iran Sustainable Building Rating System
ISO	International Standard Organization
JFMP	Japan Facility Management Process
KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design

OSHA	Occupational Safety and Health Administration.
PMI	Project Management Institute
RICS	Royal Institution of Chartered Surveyors
SAFMA:	South Africa Facility Management Association
SFM	Sustainable Facility Management
SNRSUDCB	Sidama National Region State Urban Development and Construction Bureau
UK	United Kingdom
USA	United State of America
VAT	Value Added Tax

ABSTRACT

Facility management involves the daily operations that are essential for maintaining a physical environment that aligns with an organization's requirements and main functions. This amplifies the importance of facility management in enhancing organizational performance on a global scale. One of the key indicator for effective facility management existence is the facility management assessment tool, which is used to evaluate and control the performance of facility management. Unfortunately, there is a lack of this tool in Hawassa City, including Ethiopia as a whole. And this made it difficult to know the performance of facility management, especially in public office buildings of Hawassa city. Thus, the objective of this study was to develop a facility management assessment tool for public office buildings in the context of Hawassa City, which would be used in the operation phase. The study used both secondary and primary data sources; secondary data from the existing literature review, and primary data obtained from purposively selected respondents by using closed-ended questionnaires, open-ended questionnaires, and focus group discussions. The data was analyzed by using item content validity index, analytical hierarchy process, descriptive analysis and inferential analysis as per data type and specific objective of the study with the help of Microsoft Excel version 2016 and a Statistical Package for Social Science Software version 2023. The literature review identified 81 indicators related to facility management across nine categories. These indicators were further evaluated for their content validity using the item content validity index analysis. After the analysis, 67 indicators remained, categorized into eight different groups. The results of the content validity study were then compared through survey questionnaires based on the analytical hierarchical process. Based on the data analysis, financial, functional, learning, and management categories were identified as the most three critical categories for the facility management performance evaluation. From sub-indicators, leadership skills of the top management, energy efficiency, and understanding of Ethiopian law related to facility management were identified as the top three critical indicators for the facility management performance assessment. On top of prioritization, evaluation, and status award points were suggested. Accordingly, a score of ≤ 20 indicates poor performance, 21-40 indicates low performance, 41–60 indicates medium or good performance, 61-80 indicates very good performance and 81–100 indicates excellent performance of facility management. By using the result of the prioritization and evaluation range, the facility management practice was evaluated. And as per the result, the socio-cultural, financial, and human resource management practices were found in a medium or good performance. Whereas, technical category service was found in the lowest range than others, and overall facility management performance of the public office building in Hawassa city resulted in low performance. Finally, based on the result of overall data analysis, a conceptual framework has been developed which can be applied to facility management in the public office building of Hawassa city, which can improve the existing facility management practice.

Keywords: Facility Management, Performance, Tool, Public Office Building

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The construction industry plays a significant role in human life, with the building or housing sector being particularly important. Housing is a fundamental requirement for human beings and has a significant impact on community efficiency, social welfare, and overall health within the environment (Ebenehi et al., 2018). Merely constructing a building is not enough to create a suitable environment for individuals; it also requires proper facility management. Facility management plays a crucial role in enhancing a suitable environment that supports the primary objectives of an organization (Barrett and Baldry, 2003).

The implementation of facility management practices varies from country to country due to the need for compatibility with end users' interests (Shin et al., 2018). Moreover, cultural differences, climate conditions, geography, and economic status among countries further contribute to variations in facility management approaches. Developed countries such as the USA, UK, Japan, Hong Kong, and others have established facility management institutions and rapidly adopted facility management services, including property management and facility management companies (Sari, 2018). This highlights the attention given to facility management in developed countries.

However, in Ethiopia, facility management practices are still in the early stages. Studies conducted by Bekele (2022) in Addis Ababa, Nibret (2015) in the Amhara region, Sahelu (2015) in Addis Ababa, and Seyoum (2017) in Oromia Cooperative Bank S.C. in different districts indicate a lack of quality facility services in Ethiopia. This deficiency has led to user complaints, decreased employee productivity, and a lack of building functionality. Several factors contribute to poor facility management in Ethiopia, including the absence of common standards or guidelines, inadequate use of ICT applications and defect detection systems (Bekele, 2022). Nibret (2015) also identified poor planning, building operation and maintenance policies, insufficient building records, lack of specific facility organizations or associations, and inadequate training for building management staff as contributing factors to poor facility management.

In Hawassa city, the demand for facility management is rapidly growing due to the increase in employees and customers in public office buildings since the establishment of the Sidama

region. However, there is a lack of established evaluation criteria specifically tailored to the context of public office buildings, which are crucial for promoting effective facility management. On the another hand, office buildings have unique requirements that distinguish them from residential or other buildings. The first one is, office building users expect a high level of reliability and performance from the facilities to enhance productivity, along with complex operations and maintenance needs (Shin et al., 2018). The second one is, office buildings have distinct designs and layouts as they serve as workspaces and accommodate various administrative, informational, and knowledge processing activities such as supervision, decision-making, and communication (Chinemenma et al., 2021). Therefore, it is important to develop a suitable performance evaluation tool that specifically addresses the needs of office buildings in Hawassa city (Sidama region, Ethiopia). As a result, this study seeks to develop the local facility management assessment tool for public office buildings in the context of Hawassa (Sidama region, Ethiopia), which is supported by ISO (2018), and IFMA (2017) using a subjective weighting system and develop a conceptual framework of facility management after assessing current practice in the city.

1.2 Statement of the Problem

The absence of a facility management assessment tool in Ethiopia has contributed to inadequate facility management practices (Bekele, 2022; Sahelu, 2015; Nibret, 2015). This highlights the impact of the facility management assessment tool on facility management performance and the implications of its absence in various cities within Ethiopia.

In Hawassa city, the growing number of public office employees and customers, particularly since Sidama became one of the regions in Ethiopia, has led to an increased demand for facility management. However, public office buildings in the city lack well-designed criteria for assessing facility management performance. This has resulted in challenges in monitoring, evaluating, and controlling facility management performance, which are crucial for ensuring employee and customer satisfaction. While ISO-41001 (2018) and IFMA (2017) recommend the development of local evaluation criteria, there exists a significant gap between these recommendations and the actual implementation on the ground. In conclusion, the aforementioned statement emphasizes the importance of establishing facility management evaluation criteria specifically for public office buildings in the city and existing problem regarding with this.

1.3 Objective of the Study

1.3.1 General Objective of the Study

The general objective of the study was to develop the facility management assessment tool for the public office building in the context of Hawassa city (Sidama Region, Ethiopia)

1.3.2 Specific Objectives of the Study

The study has the following specific objectives: -

- To prioritize the relevant variables of facility management in the context of Hawassa City for public office buildings
- To identify suitable ranking system for facility management performance evaluation
- To develop facility management assessment tool for public office buildings
- To evaluate the current practices of public office building facility management by using developed tool
- To develop a conceptual framework that ensures public office building facility management performance.

1.4 Significance of the Study

The involvement of facility management in the building sector is increasing rapidly across the world. However, the practice of facility management in Ethiopia is found in the infant stage, and little research has been conducted on the field of facility management. One of the major factor that affected the performance of the facility management is the lack of a local proper facility management assessment tool, according to previous studies in different cities in Ethiopia. In Hawassa city also, due to lack of this tool, facility managers or building administrators have been facing several problems regarding with provision of the proper facility services to users and makes dissatisfaction among users in office buildings. Therefore, the proper facility management assessment for public office buildings is was important. This study has developed a significant facility management assessment tool for public office buildings in the context of Hawassa city, assessed the current status, and provided a conceptual framework. Due to the development of the new tool and conceptual framework, it is expected that it contributes to the existing knowledge on building facility management in Ethiopia (Hawassa), an area where little research has been conducted previously. And also majorly, it helps the facility manager in building facility management

processes in Hawassa City. Further, for future research, it will help as a reference and give the initiation for further research.

1.5 Scope of the Study

Facility management is a wide concept and involves in the different stages of the building lifecycle. This study extended to develop the facility management assessment tool which is used with the incorporation of the post-occupancy evaluation method during the operation phase of the public office building, assess the current status and development of a conceptual framework of facility management. The study has bounded in both location and types of the building addressed. The study was bounded in Hawassa city in location, while in the types of building, public office buildings were addressed which owned by the government, and between G+1 and G+4 in height/story. Based on data obtained from the Hawassa city municipality in 2023, the city is divided into eight zones, each zone has specific regulations regarding the height of buildings that can be constructed. Among these zones, six of them (accounting for 75% of the total) allow for the construction of buildings with a maximum height of G+4 (See Appendix - I). That is why, this study focuses specifically on buildings with a height restriction of G+4 or lower.

1.6 Limitation of the Study

The study has two limitations. The first limitation was, while distributing the questionnaires to the participants, a verbal explanation was provided in person regarding the study, variables, and instructions on how to fill them out, especially in comparison based survey. Nevertheless, a few respondents could not receive this opportunity due to time constraints on their work. This have some effect on the data collected from them, as certain variables may require additional clarification and understanding. The second limitation was due to shortage of the time; top level management were not included during the assessment of the current facility management practice.

CHAPTER TWO

LITERATURE REVIEW

To develop a better understanding of the research objective, a comprehensive literature review has been conducted as per the general and specific objectives of the study. The literature review structure consists definition and concept of facility management, building facility management, facility management and life cycle of building, facility management in the office building, performance evaluation and measurement of building facility management, building performance rating system, facility management practices in a different country, features of future facility management, a summary of literature review, and Research gap.

2.1 Definition and Concept of Facility Management

The modern background of facility management started in the 1980s. Starting from this time, a new and more incorporative type of management has been developed mainly focusing on the facility (Isa et al., 2016). And over the last three-decade facility management has been established as a profession with several worldwide professional bodies supporting and accepting a significant number of facilities management practitioners. The understanding of facilities management is varied as different professions interpreted it differently. However, despite its diversity in theory and practice, facilities management retains essential cores that maintain its identity that differentiate it from other professions (Rozilah, 2011); it is a dynamic field (Rimbalová and Vilčeková, 2013).

The term and concept of facility management is a wide concept and has no unique definition (Maliene et al., 2008). This is because of variations of the bottom line of the organization as well as countries' conditions as discussed in the above statements. On top of that, the formulation of an FM definition predominantly relies on the variety of themes and the interests of individuals and organizations in the business environment (Payne, 2000), and from the organization's point of view, the emergence of the definition of FM depends on the setting of the environment (Owen, 1994, as cited in Tucker & Masuri, 2016).

For this reason, several facility management professional institutes and authors provided various definitions of facility management. To gain a better understanding about general facility management, the comprehensive definition of facility management is presented in table 2.1 from different sources.

Table 2.1 Definition of facility management

Source	Definition
Dilanthi et al. (2000)	FM as "creating an environment that is conducive to carrying out the organization's primary operations, taking an integrated view of the services infrastructure and using this to deliver customer satisfaction and value for money through support for enhancement of the core business.
RICS (2014)	Facility management is the total management of all services that support the core business of the organization using best business practices to reduce a company's operating cost and at the same time increase productivity.
SAFMA (2012)	FM is the enabler of Sustainable enterprise performance through the whole-life management of productive workplaces and effective business support services
HKIFM (2010)	Facility Management is the process by which an organization integrates its people, work process and physical assets to serve its strategic objectives. As a discipline, facility management is the science and art of managing this integrative process from operational strategic to strategic levels for promoting the competitiveness of organizations (Hong Kong Institute of Facilities Management)
JFMP (2010)	It is a comprehensive management approach for the optimization of the ownership, utilization, operation, and maintenance of the business 'real properties (land, buildings, structures, equipment, etc.) and maintain them in optimal conditions (minimum costs and maximum effects), so that they could contribute to the overall management of the business.

MRI (2022)	Facilities Management is a profession that refers to the integration of physical infrastructures (like technology) and the employees who maintain the safety, security, and efficiency of these systems.
Barrett and Baldry (2003)	FM is an integration approach to maintaining, improving and adapting the buildings of an organisation in order to create an environment that strongly supports the primary objectives of that organisation"
ISO (2018)	Facility management (FM) integrates multiple disciplines to an influence on the efficiency and productivity of economies of societies, communities and organizations, as well as the manner in which individuals interact with the built environment
BIFM (2014)	"Facilities management is the integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of its primary activities"

The above-mentioned definition of facility management indicates that facility management provides the necessary supporting management function to the success of the organization's goal by giving guidance between physical work and people. And it requires multi–professional approach to integrate place, people process, and adapted technology for the execution of facility management. For this study, a comprehensive definition of facility management which expresses the workplace and people, the definition of building facility management by Barrett & Baldry (2003) used, stated as "building facility management is a management system used to operate and maintain the buildings of an institution to create an environment that strongly supports the primary objectives of that institution".

2.2 Building Facility Management

Building Facilities Management is a complex field that ensures the effective operation of a structure throughout its lifespan. In recent decades, Facility Management (FM) has experienced significant growth due to increasing performance demands from users and owners (Lavy & Shohet, 2009)**,** as well as the construction of more high-rise buildings. Consequently, the maintenance of buildings has become crucial for their overall performance. This transformation has led to the establishment of FM as a well-defined research and professional discipline (Shohet, 2006). Additionally, facility management

within buildings has emerged to prioritize user satisfaction and overall building performance. Building facility management has its own set of objectives. According to Atkin and Brook (2009, as cited in Olaniyi, 2017) these objectives encompass both broad and specific goals. The overarching aim of building facility management is to ensure the provision of attractive buildings with well-functioning components and systems. This involves proper operation, maintenance, and creating a conducive environment for quality instruction and learning. Furthermore, specific objectives include identifying and addressing facility deficiencies and need through periodic system reviews, maintaining clean and safe buildings, managing facilities to minimize conflicts and retrofit costs, and securing sufficient funding and resources for future maintenance requirements.

2.3 Facility Management and Life Cycle of Building

In a building, facility management involves in at least all life cycles of building. According to literature by Cotts et al. (1999), there are four major phases in which facility management is involved in the building lifecycle. Those are the planning phase, possession phase, tasks and maintenance phase, and delivery phase.

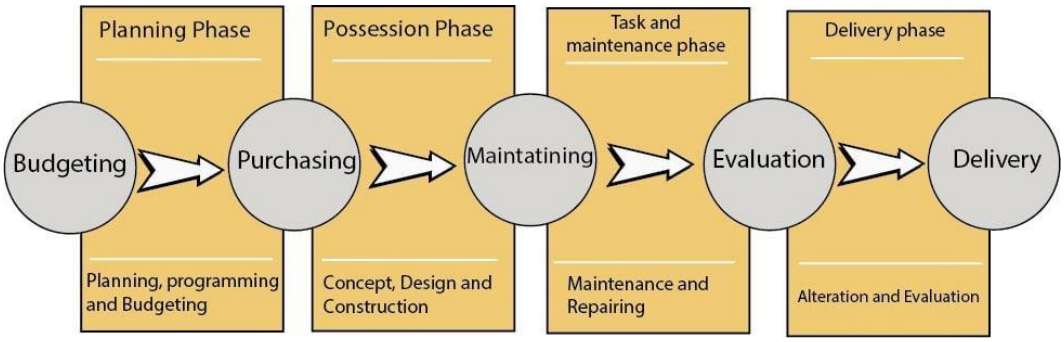

Figure 2.1 Lifecycle of facility management (Cotts et al., 1999)

2.3.1 Planning Phase

During this phase, the Facility Management (FM) team carries out strategic planning to define important company objectives and establish guidelines for future plans. One aspect of this planning is short-term planning, which involves addressing the facility requirements for the building. Short-term planning includes space planning, which considers various needs such as building space and personnel space. This type of planning is intricate because it takes into account the overall growth of the industry, the company's expansion plans, and how the organization assigns space for specific employees. The layout of the area also considers movable items like furniture. At this stage, an initial master plan of the site is analysed, which

includes the current and proposed plans, the building's current condition, operational and maintenance costs, as well as expenses associated with repairs and alterations(Cotts et al., 1999; Hou et al., 2014).

During the conceptual planning stage, the primary objectives of the proposed structure are clearly stated, along with the necessary resources and features. Functional requirements, such as specific goals to be achieved, the services required for construction, the overall organizational structure and staffing, proposed policies, and operational procedures, are all thoroughly discussed and analysed (Cotts et al., 1999). The FM team also focuses on assessing the expenses associated with the overall plan allocation.

2.3.2 Acquisition Phase

During this stage, various decisions related to the acquisition, such as leasing or purchasing the building, are made (Volk et al., 2014). The choice between buying or renting the facility depends on the business's budget, investment policies, cash flow management, and overall objectives. The acquisition and design phase provides essential information for the design process, converting the customer's construction requirements into a viable solution. It also involves confirming the scope, overall budget, and time frame of the project. At the design stage, the necessary work is standardized, and precise drawings are created. Additionally, the documentation phase focuses on analysing the specific Facility Management (FM) needs and other required documents for the contractors involved in the construction process. During the acquisition and design process, the construction needs and their associated costs are determined and finalized (Volk et al., 2014; Cotts et al., 1999).

2.3.3 Tasks and Maintenance Phase

The tasks and maintenance phase is responsible for preparing the building for client occupancy and ensuring their satisfaction. During this stage, both interior and exterior modifications can be made to meet the customer's requirements. Moreover, existing structures are utilized to optimize their functionality once again. This phase encompasses various mechanical-based functions such as monitoring energy consumption, managing hazardous waste, tracking changes, implementing recycling practices, conducting maintenance activities, and ensuring security (Cotts et al., 1999).

According to Puķīte & Geipele (2017), maintenance monitoring is a vital component of this phase as it involves the necessary actions to preserve the integrity of the existing construction and its supporting materials. This management process primarily entails inspection and

checks, which can be performed regularly or on an as-needed basis. The facility management's maintenance team is responsible for tasks like tightening fixed screws and bolts, lubricating essential equipment for smooth operation, conducting painting and cleaning activities, and replacing any damaged components. By addressing these issues, the FM team can effectively prevent unexpected equipment shutdowns and ensure the proper functioning of the facility.

2.2.4 Delivery Phase

The delivery phase, which concludes the Facility Management process, is described by FM managers do a last inspection of the building when it is nearing completion to ensure that it meets the needs of the user or the client (Cotts et al., 1999).

In addition to this, the function of facility management is influenced by the size and objectives of the organization. Barrett & Baldry (2003) identified four main structures and their respective sub-functions within facility management. The first function is facility planning, which involves strategic space planning, establishing corporate planning standards and guidelines, assessing user needs, monitoring space utilization, and defining performance metrics. The second function is real estate and building construction, which encompasses activities such as designing and managing new building construction, acquiring and disposing of properties, negotiating and overseeing leases, providing advice on property investment, and controlling the capital budget. The third function of facility management is building operation and maintenance, which aligns with the tasks and maintenance phases discussed earlier. Finally, the fourth function is general/office services, which includes managing and providing support services, overseeing office purchasing (such as stationery and equipment), coordinating non-building contract services (such as catering and travel arrangements), ensuring housekeeping standards, and maintaining health and safety measures.

Furthermore, during the operational stage of a building, facility management is responsible for managing the built assets and providing necessary services for the organization and user satisfaction (Lavy et al., 2010). Proper maintenance of these assets is essential throughout their life cycle (Fakhrudin et al., 2011, as cited in Olaniyi & Smith, 2015). To ensure effective building operations, facility managers have several responsibilities. According to Fennimore (2014, as cited in Olaniyi and Smith, 2015), they are accountable for creating a comfortable, healthy, safe, and productive environment for building occupants by overseeing

a skilled workforce. Similarly, facility managers play a role in maintaining excellent indoor air quality, which includes proper maintenance of Heating, Ventilating, and Air Conditioning (HVAC) systems and addressing any issues related to air infiltration and energy efficiency (Shah, 2007).

In terms of management and performance evaluation, facility managers bear significant responsibilities during the operational stage of the building. They are involved in managing and controlling maintenance strategies and costs, overseeing operating activities and costs, collecting and analysing facility management data for improvement, ensuring the desired level of service is met, and ensuring facility availability (El-Haram and Agapiou, 2002, as cited in Olaniyi and Smith,2015). Additionally, they monitor and enhance the delivery of required service levels, and comply with government regulations regarding environmental, health, and security standards (Olaniyi & Smith, 2015).

2.4 Facility Management in Office Building

Among several types of buildings, the office building is one. An office building is a built structure that serves as a work place and accommodates the administrative, information, and knowledge-processing activities of an organization such as supervising, directing, decision-making, communication, and filling (Chinemenma et al., 2021). The characteristics of the office building office require effective facility management and its facility management need should be identified application of effective facility management help in enhancing the productivity of an employee in an office building by providing reliable and better performed (Shin et al., 2018).

Facility management in the office building requires the effective implementation of the full package of facility management. one of the key facility management factors is human resource management (IFMA, 2020). In nature, the management of human resources requires a clear strong relationship among the stakeholders. Moreover, facility management of office buildings facility management requires a series of procedures to implement good facilities in the organization. Before this, the office building stakeholder should be identified. Major office building stakeholders are the facility manager, landlord, and tenant (Shin et al., 2017, as cited in Shin et al., 2018). The facilities manager provides FM services to the landlord and tenants and is paid a service fee according to the FM service agreement. The tenant uses the office building and runs the enterprise based on the space and services provided by the office building and facility manager. The tenant also pays rent to the landlord

in accordance with the lease agreement. The landlord earns profits from both rental income and capital gain. The relationship between the stakeholders who participated in office building facility management is presented in next figure 2.2.

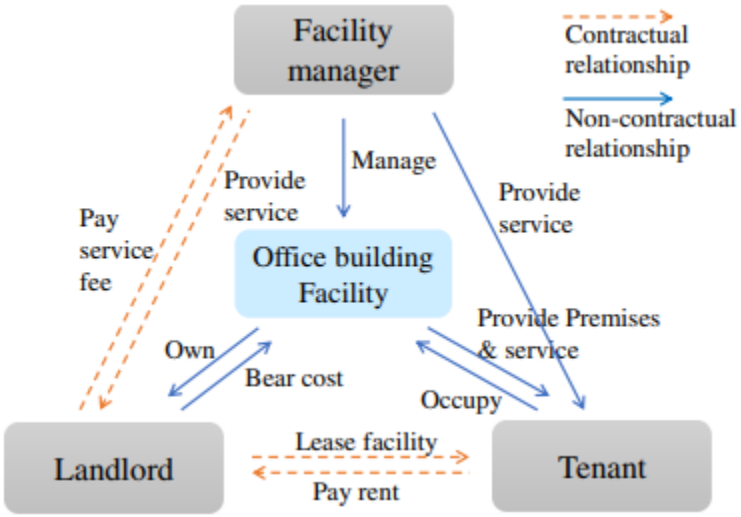

Figure 2.2 Facility management stakeholders and their relationship (Shin et al., 2017 as cited in Shin et al., 2018)

The role and responsibility of stakeholders in office building facility management should be also identified to address effective facility management. Table 2.2 Presented the office building facility management stakeholders' role and responsibility.

Table 2.2 FM stakeholders and their roles and responsibility (Shin et al., 2018).

Stakeholders	Roles	Responsibility
Landlord	Owner of the facility	To own facility
	Lessor by the lease agreement	To lease
	Client by FM service agreement	To order service and pay service free
Tenant	Occupant of facility	To occupy facility
	Lessee by the lease agreement	To pay rent
	No contractual relationship with FM	_____
Facility manager	Contractor by FM service agreement	To provide FM service and get a service fee
	No contractual relationship with tenant	

The stakeholders and their contractual relations have a great effect on the performance of facility management.

Moreover, various literature reviews outline the stakeholders involved in facility management. According to the ISO (2018), the stakeholders of facility management include the client, architect, contractor, consultant, and facility manager. Additionally, the IWFM (2020), identifies stakeholders such as staff, product suppliers, service providers, building occupants, senior managers, investors, neighbours, and regulatory bodies in the field of facility management. GCS (2011, as cited in Olaniyi, 2017) also asserts that facility management stakeholders encompass the client, architect, contractor, consultant, and facility manager.

On top of that, to say the facility management is effective, the performance measurement of facility management should be identified.

The next section presents the performance measurements of facility management.

2.5 Performance Measurement of Building Facility Management

The evaluation of facility management for buildings and infrastructure plays a significant role in determining the overall success of an organization. The assessment of building performance is crucial for developing strategies and making informed decisions(Lavy et al., 2014). The field of facility management has been gradually gaining importance within the property and construction industry (Awang et al., 2014). According to Hodges (2005, as cited in Olaniyi, 2017), facility managers hold a unique position that allows them to oversee the entire process and have a significant influence on the entire life cycle of a facility. When the facility management position is well-maintained, it not only reduces costs but also improves productivity, revenue generation, and the organization's image. Evaluating facility management, directly and indirectly, benefits the organization in various ways.

It is recommended that the performance assessment of facilities is important to continuously improve and maintain their performance, along with receiving regular feedback from stakeholders (Cohen et al., 2001 as cited in Lavy et al., 2014). Several references discuss the advantages of performance evaluation. Bordas et al. (2001, as cited in Chinemenma et al., 2021) state that evaluating the performance of building equipment helps identify shortcomings and find easier ways to accomplish tasks with minimal effort. Signs of poor building performance may indicate that the manager is overwhelmed with building support requirements or reveal the presence of faulty support systems. Augenbroe and Park (2005, as cited in Chinemenma et al., 2021), argue that performance evaluation helps bridge the gap between building users' expectations and the quality of service provided by practitioners,

resulting in increased customer satisfaction and more user-friendly buildings. Additionally, Nelson (2006) suggests that performance measurement demonstrates the value of facility management to organizations and enables practitioners to take on strategic roles within their organizations. By using appropriate measurement tools aligned with the organization's bottom line, facility management performance can be effectively evaluated, leading to better monitoring, control, and improved industry performance overall.

There are numerous facility management measurement tools. In table 2.3. the comprehensive summary of facility measurement tool types, definitions, and purposes is presented to gain a better understanding.

Table 2.3 performance measurement tools and their purpose (Pärn et al., 2017)

Performance measurement tools	Definitions and attributes
Post-occupancy Evaluation	The evaluation of a building's performance in use by auditing client satisfaction. Implemented at the concluding stage of the design process, this can identify potential system inefficiencies and improve design and procurement for future projects.
Business excellence model (BEM)	Represents a conceptual framework to measure business performance, using processes based on cause and effect. More widely accepted and more effective than other types of performance measurement tool.
Capability maturity model (CMM)	A process maturity framework of five maturity levels (the structural components that comprise the CMM Software), based upon a software development evaluation methodology that has been introduced to other disciplines.
Balanced scorecard (BSC)	A semi-standard structured report used by managers to monitor staff activities and any consequences arising from these actions It may include additional perspectives such as service, physical, financial, community, environmental, and utilization.
BIFM measurement protocol	Measures the effectiveness of facility management operation in terms of cost and attempts to measure value for money. Aims to resolve the problems resulting from the amorphous range of services covered by FM and represents a first step in the development of standardised facilities management performance measurement.
Hierarchical system of performance indicators	Key performance indicators (KPIs) that have intrinsic mutual relationships/dependencies with other KPIs that are linked through a hierarchal structure.

Benchmarking and cost of operation	Benchmarking reflects the ethos of promoting continuous improvement, determined from both within and outside the organisation. It is the associated tool used to achieve critical success factors such as operational service efficiency.
Key performance indicators (KPIs)	A performance measure of the success of an organisation or activity in which it engages; performance indicators are seen to deliver a service and are used to select providers of FM; KPIs seek to benchmark industry performance with a view to improving it; results show that there is a relationship between types of maintenance strategy implemented and end user satisfaction. Widely used performance measurement tool in FM.
Input versus output based performance measurement	Seeks to develop standardised performance metrics.
Service balanced scorecard (SBS)	A method for measuring facility performance that encompasses financial and non-financial indicators.

As presented in table 2.3, different performance measurement tools were discussed, and key performance indicators were concluded as widely applicable tools for facility management. For this study also, a hierarchical system of performance indicators in the form of key performance indicators was selected.

Various professional institutions for facility management have been established, such as ISO, IFMA in the USA, JFMA in Japan, BFMA in the UK, FMAA in Australia, SAFMA in South Africa, and others, to achieve effective facility management. These institutions and several authors propose key performance indicators for facility management. However, there are differences in contents and indicators among them due to, every country having its own culture, type of organization, and leadership, leading to different levels of facility management at different stages of development (Lindholm, 2005, as cited in Lavy et al., 2014). In addition, there are variations in benchmarks, services scope, and complexity of performance measurement (Amos et al., 2019, cited in Amos et al., 2020). According to Amaratunga et al. (2001, as cited in Lavy et al., 2014), KPIs provide the freedom to select performance metrics based on the scope of the study or user needs. The evaluation process of performance assessment using KPIs starts with the selection of measurable and quantifiable indicators based on the study's scopes, types of users, nature of the organization, performance assessment focus, current trends, and demand. Furthermore, the KPI approach to performance assessment is comprehensive and provides users with the flexibility to select the metric of their choice (Lavy et al., 2014).

Additionally, numerous pieces of literature discuss the advantages of the uses of performance indicators. Performance indicators provide timely feedback on the current state of a building's facilities. They play a crucial role in assessing organizational growth, understanding the condition of facilities, and developing plans to achieve key performance indicators (Labardges, as cited in Lavy et al., 2010). The KPI approach in performance assessment also allows for comparisons within and across organizations (Ho et al., 2000, as cited in Lavy et al., 2014). Badawy et al. (2016), further emphasize the importance of KPIs in demonstrating the structure and activities of facility management organizations and measuring progress towards established goals.

Furthermore, it is important to not only provide a list of KPIs but also to limit them to ensure everyone's attention is focused on achieving the same objectives (Rimbalová & Vilčeková, 2013). The selection of KPIs should also consider the audience or stakeholders and their alignment with the organization's mission (Voordt & Jensen, 2018). Not using KPIs can be disadvantageous for an organization as it may lead to resource constraints and higher costs when relying solely on traditional peer reviews (Vyas and hozain, 2014, as cited in Amos et al., 2020).

Moreover, key performance indicators (KPIs) are widely used in performance measurement to evaluate the success of an organization or activity. They are used to assess service delivery and select FM providers, benchmark industry performance, and improve it. Research indicates a correlation between the types of maintenance strategies implemented and end-user satisfaction and KPIs are a widely utilized performance measurement tool in facility management (Pärn et al., 2017).

2.6 Key Performance Indicators from Existing Facility Management Tools

Different facility management institutions provide the various variables which used for evaluation of facility management performance. Like ISO (41001-2018), BIFM, FMAA, RICS, IFMA, HKIFM, and others.

In next table 2.4 Numerous performance indicators of facility management of buildings are extracted from different sources and presented.

Table 2.4 Facility management indicators

	Facility management indicators	Reference
S. no	Financial category indicators	
1	Building maintenance cost	Kim et al. (2018), Lavy et al. (2010), Rimbalová & Vilčeková (2013), Lavy, et al.(2014)
2	Utility cost	Kim et al. (2018), Lavy et al. (2010)
3	Operating cost	Kim et al. (2018), Lavy et al. (2010), Raavi (2015), Lavy, et al.(2014)
4	Custodial and janitorial cost	Kim et al. (2018), Lavy et al. (2010), Rimbalová & Vilčeková (2013)
5	Deferred maintenance & differed maintenance backlog	Kim et al. (2018), Lavy et al. (2010)
6	Capital cost	Kim et al. (2018), Lavy et al. (2010), IFMA (2020)
7	Capital renewal cost	Kim et al. (2018), Lavy et al. (2010)
8	Churn cost	Kim et al. (2018), Lavy et al. (2010)
9	Proportion of facility management budget	Amos et al. (2020)
10	Facility condition assessment cost	Kim et al. (2018), Lavy et al. (2010)
11	Occupancy cost	Kim et al. (2018), Lavy et al. (2010)
12	Financial management (procurement and contract management)	Kim et al. (2018), Azasu et al. (2018),IFMA (2010, as cited in Awang et al., 2014), IFMA (2020), ISO (2018), IFMA (2020), ISO (2018), Roper & Payant (2014), shin et al.(2017, as cited in Shin et al., 2018)
13	Time value of the money	Amos et al. (2020), Lavy et al. (2010), Chinemenma et al. (2021)

14	Cost feasibility, review, analyse and report	Roper & Payant (2014), shin et al.(2017, as cited in Shin et al., 2018)
S. no	Technical category indicators	
1	Scheduled maintenance of building elements	Kim et al. (2018), Azasu et al. (2018),, IFMA (2010, as cited in Awang et al., 2014),7, IFMA (2020), ISO (2018), ,Raavi (2015), Lepkova & Uselis (2013), Jayasena et al. (2020), Lavy, et al.(2014) OSHA (as cited in Mahabir & Punb,2022)
2	Physical detection of building	Lavy et al. (2010), Chinemenma et al. (2021**),** Lepkova & Uselis (2013)
3	Repair, renovation and refurbishment (rehabilitation)	Rimbalová & Vilčeková (2013), IFMA (2010, as cited in Awang et al., 2014), IFMA (2020),11-15,18-20,22, Lavy, et al.(2014),
4	Measurement of building elements if needed	Lepkova & Uselis (2013)
5	ICT application	Kim et al. (2018), IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), ISO (2018),20-22,25
6	Understanding of building design	IFMA (2020), ISO (2018), BIFM (2010)
S. no	Human resource management category	
1	Background of the facility manager	Azasu et al. (2018), Rimbalová & Vilčeková (2013), IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021), BIFM (2010), FMAA (2010), RICS, HKIFM (2010), Shin et al. (2018) , Raavi (2015), Lepkova & Uselis (2013)
2	Train the facility manager and user	Azasu et al. (2018), Rimbalová & Vilčeková (2013), Chinemenma et al. (2021), Raavi (2015)Shin et al. (2018), Lepkova & Uselis (2013), shin et al.(2017, as cited in Shin et al., 2018)

3	Improve the skill of facility manager and evaluate	Kim et al. (2018), ISO (2018), Jayasena et al. (2020)
4	Effective communication between the stakeholders in organization	Kim et al. (2018),4, IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021), IFMA (2020),9, ISO (2018), Raavi (2015), Lepkova & Uselis (2013), Lavy, et al.(2014)
5	Cooperation with real supplier/contractor/FM specialist	IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), ISO (2018), Raavi (2015), Lepkova & Uselis (2013), Atkin and Brooks (2005, as cited in Awang et al., 2014), Omar et al (2016)
6	Time management of the facility employee	Kim et al. (2018), IFMA (2010, as cited in Awang et al., 2014), Lepkova & Uselis (2013)
7	Leadership skill of top manager	Azasu et al. (2018), PMI (as cited in Mahabir & Punb, 2022), ISO (2018), OSHA (as cited in Mahabir & Punb,2022)
8	Team management	IFMA (2020), Lepkova & Uselis (2013)
S. no	Environmental category indicators	
1	Energy efficiency	Kim et al. (2018),3,5, IFMA (2010, as cited in Awang et al., 2014), IFMA (2020),11-14,16,18,19, Lepkova & Uselis (2013),22,26,34
2	Water consumption management	Kim et al. (2018),3, IFMA (2010, as cited in Awang et al., 2014), IFMA (2020), Shin et al. (2018), Jayasena et al. (2020)
3	Waste management and discharge	Kim et al. (2018),3, IFMA (2020), HKIFM (2010), Jayasena et al. (2020), EBCS-12 (2014).
4	Material consumption for maintenance	Lavy et al. (2010), IFMA (2020), Raavi (2015)
5	Environmental impact assessment	Rimbalová & Vilčeková (2013), Jayasena et al. (2020)
6	Planning & sustainable development (ecology)	Azasu et al. (2018), Lepkova & Uselis (2013), Jayasena et al. (2020)

S. no	Functional category indicator	
1	Building services like (drainage, piping, sanitary..)	IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021),11-13, Payne (2000), Markus & Cameron (2002), National research council (as cited in Awang et al., 2014), 35=EBCS-12 (2014).
2	Landscaping /ground	IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021), EBCS-12 (2014).
3	Space utilization	Kim et al. (2018),3,4, Chinemenma et al. (2021), IFMA (2020),, Lavy, et al.(2014).
4	Cleanliness	IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021), Lepkova & Uselis (2013), Lavy, et al.(2014).
5	Health, safety, security, privacy, and fire protection	Kim et al. (2018), IFMA (2010, as cited in Awang et al., 2014), Chinemenma et al. (2021),11,13-16,18,19, Lavy, et al.(2014).
6	Monitor and record facility condition (condition index)	Kim et al. (2018), ISO (2018), Shin et al. (2018), Dasandara et al. (2022)
7	Manage inventory and spare parts	Lavy, et al.(2014), shin et al.(2017, as cited in Shin et al., 2018)
8	Emergency exit	Dasandara et al. (2022), EBCS-12 (2014).
9	Heating, ventilation, noise, artificial and natural light	IFMA (2010, as cited in Awang et al., 2014),21, Lavy, et al.(2014), EBCS-12 (2014).
10	Mechanical and electrical services	Lavy et al. (2010), shin et al.(2017, as cited in Shin et al., 2018)
11	Ancillary services (mail, housing)	IFMA (2010, as cited in Awang et al., 2014)
12	Insurance of property	Lepkova & Uselis (2013)

13	One window services	Lepkova & Uselis (2013)
14	Furniture, fixtures and equipment	Kim et al. (2018), IFMA (2020), HKIFM (2010), Roper & Payant (2014)
15	Accessibility for aged and disabled persons (including ramp, lift..)	Kim et al. (2018),3, Lavy, et al.(2014), Roper & Payant (2014),
16	Productivity	Lavy et al. (2010), Lavy, et al.(2014)
17	Signal and waiting room	Lavy, et al.(2014), Sanni-Anibire et al. (2016), EBCS-12 (2014).
18	Relax area	Lavy, et al.(2014), Sanni-Anibire et al. (2016)
19	Transport accessibility and parking area	Lavy et al. (2010), Lavy, et al.(2014), Dasandara et al. (2022), EBCS-12 (2014).
S. no	User's perception/survey based	
1	Customer satisfaction with the services	Kim et al. (2018),3-6, PMI (as cited in Mahabir & Punb, 2022),19, Lavy, et al.(2014),24,34
2	Complaints on the facility services	IFMA (2010, as cited in Awang et al., 2014), Shin et al. (2018), shin et al.(2017, as cited in Shin et al., 2018)
3	Occupant turn rate	Lavy et al. (2010), Rimbalová & Vilčeková (2013)
4	Public image on facility condition	Lavy, et al.(2014)
S. no	Socio-behavioural indicator	
1	Appearance/view out	Lavy et al. (2010), IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), Lavy, et al.(2014), Sanni-Anibire et al. (2016)
2	Aesthetic value	IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), Lepkova & Uselis (2013),25
3	Feeling of equality	IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), Lavy, et al.(2014), OSHA (as cited in Mahabir & Punb,2022)

4	Additional contribution for society	IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), OSHA (as cited in Mahabir & Punb,2022)
5	Integration with the urban	IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), Lavy, et al.(2014), OSHA (as cited in Mahabir & Punb,2022)
6	Location of the building	Lavy et al. (2010), IFMA (2020), PMI (as cited in Mahabir & Punb, 2022), Sanni-Anibire et al. (2016)
S. no	Performance based category indicators	
1	Scope of monitory	ISO (2018)
2	Monitoring means and methods	ISO (2018)
3	Evaluation of the performance	IFMA (2010, as cited in Awang et al., 2014),7, ISO (2018)
4	Documentation of the result	Kim et al. (2018), IFMA (2020), Shin et al. (2018)
5	Strategic audit and top management review	IFMA (2010, as cited in Awang et al., 2014), IFMA (2020), ISO (2018), RICS (as cited in Awang et al., 2014)
6	Corrective measure (proactive action)	ISO (2018)
7	Gap analysis on facility management	ISO (2018)
8	Continually improvement	ISO (2018), National research council (as cited in Awang et al., 2014)
S. no	Learning and management category indicator	
1	Learning and management	Lavy et al. (2010), IFMA (2010, as cited in Awang et al., 2014), IFMA (2020),15,18, Lavy, et al.(2014)
2	Managing the change	IFMA (2010, as cited in Wang et al., 2014), Chinemenma et al. (2021), IFMA (2020),12, Markus & Cameron (2002), Van Den (2006, as cited in Awang et al., 2014)

3	Real estate management	Lavy et al. (2010),4, IFMA (2020), Raavi (2015), Lavy, et al.(2014)
4	Understanding facility management professional practices	APPA (2010, as cited in Awang et al., 2014), Payne (2000), National research council (as cited in Awang et al., 2014)
5	Understanding organizational structure and strategy	PMI (as cited in Mahabir & Punb, 2022), ISO (2018),National research council (as cited in Awang et al., 2014),
6	Develop a facility management strategy (plan) in line with organization structure	Kim et al. (2018),4,6, IFMA (2020), ISO (2018), Markus & Cameron (2002), Clark& Hinxman (1999, as cited in Awang et al., 2014)
7	Risk management (Assessment, control, mitigation and emergency preparedness)	Azasu et al. (2018), IFMA (2010, as cited in Awang et al., 2014), IFMA (2020),10-12,14,17-19,21,26,28
8	Evidence-based decision making	IFMA (2010, as cited in Awang et al., 2014), IFMA (2020)
9	Understanding international facility management requirement laws and criteria	Azasu et al. (2018), ISO (2018), Jayasena et al. (2020)
10	Rate of the response by the concerned body	Chinemenma et al. (2021), Lavy, et al.(2014), Dasandara et al. (2022)
11	Consultancy services	Azasu et al. (2018), RICS (as cited in Awang et al., 2014)
12	Roles, responsibility, and authority management	PMI (as cited in Mahabir & Punb, 2022), ISO (2018), OSHA (as cited in Mahabir & Punb,2022)

As presented in above Table 2.4, various facility management indicators were presented. Among them, the learning and management category, functional indicators category, and environmental category indicators were more cited in the literature review. Moreover, based on countries and institution background, the above indicators are used for evaluation facility management mostly through post-occupancy evaluation with a prepared scale of evaluation. A post-occupancy assessment is a measurement tool used to measure or assess a building occupant's perspectives and requirements for an occupied building (Darkwa, 2006; FFC, 2011, as cited in Aliyu et al., 2016; Wahab & Kamaruzzaman, 2011). In post-occupancy assessment systems, data collection methods are questionnaires, walk-through observations, activity and behaviour mapping, interviews, focus groups, visual selection, and perception (Preiser and Vischer, 2004; Van der Voordt and van Wegen, 2005, as cited in Aliyu et al., 2016).

In the next section, building performance evaluation scales are presented.

2.7 Building Performance Rating System

To evaluate the performance of the building, evaluation scales are being used across the world. However, the range of evaluation and award system nominations is not the same across the globe. in the following Table 2.6 different rating scale and award system are presented, which was extracted from the literature review.

Table 2.5 Building performance rating system

S.no	Name of institution/author	Award scale/score	Reference
1	Ethio-SBAT	<40 points, Certified with not green 40-59 points, Green 60-79 points, Very green, and ≥ 80 points, Extremely green	Anshebo et al.(2022)
2	BPRT	20-30 points/score, Poor 31-40 points/score, Low 41-59 points/score, Medium 60-79 points/score, Good 80-100 points/score, Excellent	Khalil et al. (2016)
3	SABA	<50 point, not green 50-79 point, green 80-100, very green	Ali & Al Nsairat (2009)

4	ISBRS	40-49 points, certified, 50-59 points, silver rank, 60-79 points, gold rank ≥ 80 points, sustainable building rate	Niksefat & Taghizade (2018)
5	Mohammad Fathian (2006) (EILIBCI)	<40 points, weak 40-70 points, medium 70-90 points, good >90 points, superlative	Fathian & Akhavan (2006)
6	BREEAM	<10 point, Unclassified, ≥10 to <25 point, Acceptable ≥25 to <40 point, Pass ≥40 to <55 point, Good ≥55 to <70 point, Very good ≥70 to <85 point, Excellent ≥85 point, outstanding	Shahrokhi et al. (2016)
7	BOMA	Up to 59 points, certified 60-69 points, Bronze 70-79 points, Silver 80-89 points, Gold 90-100 points, Platinum	Shahrokhi et al.(2016)
8	LEED	≥ 40 points, certified ≥ 50 points, silver ≥ 60 points, Gold ≥ 80 Points Platinum	Doan et al.(2017)

Famous internationally acceptable manuals like BREEAM, LEED, and BOMA were included in Table 2.5. On top of that, Ethio-SBAT was also presented, which was a newly proposed rating system for Ethiopian sustainable building performance assessment. From Table 2.5, three were internationally acceptable manuals, and the remaining were research articles.

In the next section, features of facility management practice in different country contexts are presented and discussed.

2.8 Facility Management Practice in Some World Countries

Facility management practices vary across the world due to different backgrounds. This section discusses facility management practices in various countries. The history of facility management began in the United States in the 1950s and 1960s, and it fully developed in the 1970s. In Europe, facility management services started and were used in the 1980s (Jensen ,

2012, as cited in Sari, 2018). The United Kingdom was the first country to adopt these practices, followed by Germany and France (Ancarani & Capaldo, 2005). Currently, the United Kingdom, the United States, Nordic European countries, and the Netherlands are the leaders in international facility management development (Jensen, 2012, as cited in Sari, 2018). In contrast, Italy faces delays in implementing facility management due to its economic structure (Ancarani & Capaldo, 2005).

In Australia, the development of the Facility Management Association of Australia (FMAA) in 2000, indicates the presence of facility management services in Australasian countries, despite a lack of publication. In the United States and Europe, facility management is widely used by both property developers and facility management companies, highlighting the prevalence of these practices in those regions. The rapid growth and implementation of facility management reflect the increased awareness of the importance of the physical environment to organizations (Jensen, 2009). The International Facility Management Association (IFMA) has played a vital role in the rapid development of facility management in the USA and Europe, particularly in transitioning from traditional maintenance systems to proactive maintenance (Sari, 2018). However, there are significant challenges associated with this transition. The first challenge is acquiring the necessary skills and technological advancements to shift from reactive maintenance to proactive maintenance (Jensen, 2009). The second challenge is the presence of disorganized databases from building design to construction, which hampers the implementation of proactive maintenance(Liu & Issa, 2013). To address these challenges, Building Information Modelling (BIM) software has been developed and used to bridge the gap between facility management professionals and designers. Nonetheless, research indicates that there still exists a knowledge and technology gap between professionals in Nordic Europe and the USA (Jensen, 2009; Liu & Issa, 2013).

Nowadays, Digitalization particularly through BIM implementation, has become the main technology driving facility management worldwide (Wong et al., 2018). In Europe, there is an additional challenge related to the provision of quality facility management, even when equipped with ISO standards (Lepkova and Uselis, 2013, as cited in Sari, 2018). Moreover, the description of some other countries' FM practice description presented in Table 2.6.

Table 2.6 Description of some countries' FM practice (Maliene et al., 2008)

Country	FM description
Finland	• FM market is very young, local company used to purchase service from external suppliers, in many case the transaction of total FM have been concluded with the largest supplier of FM services
Norway	• FM market is the least developed among the Scandinavian countries • Different models of FM organisation are almost unknown • Norway has its official national standard
Sweden	• FM market is the second largest after the Danish one according to the level of its development • Many globally known companies did not enter the Finnish and Norwegian markets but merged with Swedish companies.
Denmark	• Danish FM is the most advanced in comparison with other Northern European countries • The Danish FM has a renowned background and is very similar to the American NT management style rather than to the UK's one • The contractors of property management in Denmark occupy almost 50% of the total management markets • Denmark is the only state in the entire European Union where the companies rendering FM services do not pay the VAT while the service providers, who render different kinds of services other than FM ones, must pay the VAT
Spain	• FM was officially chartered in Spain in 1998 with the foundation of Sefm (Spanish Facility Management Association) • FM is recognized in the market today, but the concept is still far from clear.
Hungary	• At the beginning of the 1990s, foreign office building investors (mainly from Austria and France) organized the first FM knowledge transfer to manage Hungarian buildings. • It was the presumption to found the first Hungarian facility management association in 1991 • Mainly Hungarian FM market is focused on service provision.

Denmark's facility management practice is most advanced compared with other Europe countries as presented in Table 2.6. the second most advanced facility management

development owner is Sweden. In contrast, Norway is the owner of the least facility management service.

In Asian countries, facility management practices are relatively young compared to the USA and Europe (Elyna Myeda & Pitt, 2014). Asia can be divided into two categories: developed countries like Japan, Hong Kong, and Singapore, where facility management has rapidly developed, and developing countries like Malaysia and Thailand, where it is still in its early stages (Sari, 2018). The challenges in these developing countries include low awareness about the importance of facility management, reliance on reactive maintenance, lack of facility standards, and insufficient financial support (Mustapa et al., 2009, as cited in Sari, 2018). Hong Kong, in particular, has been at the forefront of facility management performance since 1994, making it a gateway for other Asian countries.

2.9 Facility Management Practice in Africa

Facility management practices vary across the world, and relatively few studies have been conducted to examine the context of facility management in African countries when compared with developed continents. The majority of these studies focus on Nigeria, South Africa, and Egypt. Facility management in Africa emerged in the 1990s and is considered relatively new compared to other regions (Sari, 2018). Among African countries, South Africa has taken different approaches to lead the adoption and implementation of facility management. This includes formal education, the presence of multinational corporations, universities offering facility management programs, and a professional association dedicated to facility management. As a result, South Africa has attracted many students interested in learning about facility management (Roper & Borello, 2013; Roper & Payant, 2014). In addition to South Africa, Nigeria, and Egypt have also developed comprehensive facility services providers, as well as smaller competitive companies specializing in specific facility services (Roper & Borello, 2013). On the other hand, Uganda lacks a comprehensive package for facility management and does not have a well-defined professional framework (Natukunda et al., 2013).

From the context of Nigeria, according to the literature by Ogunyooye (2012, as cited in Roper & Borello, 2013), the Nigerian government supports facility management by establishing the Public Works Bureau, which is responsible for maintaining the state's infrastructure. They create a conducive environment for potential investors through relevant legislation concerning the built environment. To expedite the development of facility

management in African countries, they are adopting a rapid maintenance culture, employing skilled personnel, utilizing advanced technologies, and establishing robust infrastructures. This offers them the opportunity to bypass older technologies and start with the latest versions, often at lower costs than more developed countries incurred for their initial investments (Roper & Borello, 2013). In the Nigerian context, facility management is a relatively new profession (Oladokun, 2011), mainly because it was previously dominated by real estate management alone (Roper & Borello, 2013). Additionally, the expertise of professionals plays a significant role in impeding the rapid progress of facility management in Nigeria. Oladokun (2011), suggests that facility management is still in its infancy stage in Nigeria, largely due to the dominance of younger professionals. This study highlights the need for effective nurturing to allow facility management to mature, similar to developed countries such as the USA and UK. In Nigeria, facility management procurement in public buildings plays a role in decision-making. The top three factors identified for outsourcing FM services include cost reduction, lack of improved standards, and improved responsiveness (Momoh et al., 2021). Nigerian industry facility managers face both internal and external challenges. Internal challenges can be controlled and managed by facility managers, while external challenges are beyond their control. Both types of challenges can be attributed to a lack of commitment to facility maintenance management for existing facilities and inadequate management of government-funded resources (Bako, 2020). Similarly, facility managers in South Africa face several challenges, including limited availability of funds, occupants' limited knowledge of FM, absence of policy guidance for FM practice, deteriorating facilities, and challenges related to design concepts and scope, all of which affect effective facility management in public buildings (Mewomo et al., 2022). However, South Africa has a professional association called the South Africa Facility Management Association. Furthermore, higher learning institutions in the Eastern Cape region of South Africa also require improvements in facility management practices due to the low stage of facility maintenance management, which leads to employee dissatisfaction (Ntshebe et al., 2022). Another study by Chikafalimani et al. (2021), examined facility management practices at public universities in Nigeria, Africa. The study revealed that facility management practices at public universities in Africa are in poor condition, primarily due to overcrowding, limited skills and capabilities of facility management departments, and a lack of financial resources. Previous studies generally describe the overall stage of facility management practice in Africa as being in its infancy. However, there are opportunities for

the future development of facility management practices in Africa, including Ethiopia, encompassing both hard and soft facility management aspects (Mondor, 2022).

According to the Mondor (2022) report, the facility management market in Africa is projected to experience a compound annual growth rate (CAGR) of 7.63% from 2022 to 2027. The report highlights that extreme climate conditions play a vital role in the need for both hard and soft facility management in Africa, alongside the increasing demand for space management, cleaning, disinfection, and various ongoing infrastructural projects. Furthermore, the growing construction activity in Africa significantly contributes to the growth of the facility management sector in the region. Specifically, a 7.7% CAGR growth is expected for hard facility management in Africa over the next five years (2023-2028).

The Mondor report identifies certain countries as indicators of the growth of facility management in Africa. For instance, the economic development of countries like Nigeria has positively influenced the market, with a shift towards outsourcing FM services rather than relying on in-house services. The report predicts that favourable government support, through financial aid and policy changes, for large-scale infrastructural development will drive the demand for FM services. However, the high unemployment rate in the region is identified as a significant challenge due to the lack of skills, which hampers the growth of the facility management market.

South Africa is highlighted as the most developed market among other African nations in the Mondor report, primarily due to a more favourable business environment and the presence of major hard facility management companies. The private and public infrastructure sector plays a crucial role in South Africa's facility management market, driven by rapid infrastructure growth and the increasing demand for hotels, shops, malls, and office complexes. The report supports this growth by stating a projected CAGR of 5.6% for the South African facility management market from 2022 to 2027.

In summary, the anticipated growth of facility management in Africa faces significant challenges. One major obstacle is the lack of skilled professionals due to high unemployment rates and increasing hiring costs (Mondor, 2022). Additionally, there are notable disparities and challenges in terms of service quality, standards, and financial support compared to other continents like Europe and the USA (Sari, 2018).

2.10 Facility Management Practices in Ethiopia

Limited research has been conducted in Ethiopia regarding facility management, which stands in contrast to the extensive studies conducted in developed countries like the USA and Europe over an extended period. Among the few studies conducted in Ethiopia, Nibret's study (2015) focused on identifying gaps in international facility management practices, assessing problems related to building a facility management practice, and suggesting ways to improve existing issues based on research findings. Another study by Bekele (2022) also concentrated on facility management with objectives such as evaluating the current practice in Addis Ababa, assessing applicable activities or tasks for facility or property managers in the Ethiopian context, and determining the need for facility managers in the construction industry. Both studies concluded that facility management practice in Ethiopia is considered poor or at an early stage of development (Bekele, 2022; Nibret, 2015).

The main reasons for this poor facility management are the lack of a comprehensive package of services. only a few services have been considered like security, cleaning, and maintenance as well as widely accepted standards (Bekele, 2022). Other contributing factors identified in Nibret's study (2015), include inadequate planning, building operation, and maintenance policies, a lack of detailed building records, the absence of specific organizations or associations, insufficient training for building management staff, and a shortage of facility management experts.

Sahelu (2015)'s, which focused on facility management practices in public hospitals in Addis Ababa, also revealed poor facility management. The study attributed this to factors such as the experience of maintenance staff, lack of maintenance formats and policies, and delays in maintenance. Similarly, Seyoum (2017) examined facility management practices in the Cooperative Bank of Oromia and found deficiencies in preventive maintenance, procurement, and ICT application (database).

In contrast, the latest report by Mondor (2022) argues that facility management practice in Ethiopia, particularly for critical end users such as banking, commercial, and industrial sectors, offers a potential market for outsourced facilities management. However, it should be noted that Mondor's report does not encompass all areas of facility management applications.

Overall, based on the aforementioned studies conducted by various researchers in Ethiopia, facility management practice is considered poor from different perspectives. The main

contributing factors identified are the lack of proper policies, guidelines, and performance measurement frameworks. Therefore, there is a need for the development of comprehensive policies and guidelines specific to the local context to improve facility management practices

2.11 Features of Future Facility Management

This section examines the future features of facility management based on literature studies. Facility management encompasses a wide range of topics and requires addressing unanswered questions. Several studies have emphasized the growing importance of sustainability and digitization in the future of facility management. According to Opoku & Lee (2022), sustainability and digitization have been significant forces shaping facility management since the 1970s. Atkin & Bildsten (2017) also confirmed the importance of these issues. Similarly, Mari & Poggesi (2014) also agreed on the significance of sustainability in facility management.

From a digitization perspective, the development of facility management operations is characterized by incremental changes, occasionally disrupted by less frequent disruptive shifts. These disruptive changes, which have a more fundamental impact, occur over the medium to long term. The introduction of artificial intelligence (AI) is the most anticipated disruptive shift in facility management in the near future (Christensen et al., 2006, as cited in Geerdink, 2020; Atkin and Bildsten, 2017). Artificial intelligence is expected to significantly transform innovative FM technology. Building Information Modelling (BIM) is another recurring theme in facility management, assisting professionals in managing and maintaining buildings (Atkin and Bildsten, 2017). The literature on Wong et al. (2018), also highlights the role of BIM as a key technology in building facility management. However, there are unanswered questions regarding BIM that require further research, such as data interoperability, improved data capturing technologies for 'as-is' BIM models, and the enhancement of BIM open standards and data specifications. The implementation of additional technologies like GIS and IoT in facility management is also not fully satisfactory, representing additional features of future facility management (Wong et al., 2018).

Another important development is the concept of "soft landings," which aims to bridge the gap between predicted and actual facility performance. It focuses on improving operational readiness and sustained performance during facility start-up. However, the execution of the soft landings philosophy remains a challenge that needs to be addressed in the future (Atkin and Bildsten, 2017).

In terms of sustainability, it is essential to consider the environmental, social, and economic aspects of facility management. Consumer attention to sustainability can significantly impact performance assessment in facility management, and the relationship between sustainability and technology is crucial for success (Atkin and Bildsten, 2017; Opoku & Lee, 2022). The FM industry is urged to develop solutions that reduce the negative environmental impact of buildings, considering the challenges posed by climate change and the need for energy efficiency. Updating and greening existing building stock is crucial, as the operation phase of buildings accounts for 80% of their impact on climate change (Buser et al., 2018, as cited in Opoku and Lee, 2022).

From total consumption, the built environment alone accounts for more than 33% of energy use, 40% of materials use, and produces 40 – 50% of greenhouse gas emissions globally. The SFM of existing building stock and infrastructure is essential in achieving the global agenda towards sustainability due to the volume of existing building stock (Nielsen et al., 2009; Rabede and Ozumba, 2021, as cited in Opoku & Lee, 2022). Therefore, sustainability is considered as mandatory issue in facility management, this is because, SFM can help in addressing some of the global challenges such as climate adaptation, energy efficiency, and sustainable development developing innovative solutions for organizations and society (Nielsen et al., 2016; Opoku & Lee, 2022).

Overall, sustainability and digitization are key focus areas for future facility management. The integration of artificial intelligence, the use of BIM, and the implementation of soft landings and sustainable practices will play a crucial role in shaping the future of facility management.

2.12 Summary of the Literature Review

The overall summary of the literature review was summarized in this section. In the housing construction industry, facility management has a significant role, especially, in the context of office buildings. Facility management in office building enhances a good workplace and increase the productivity of the employee. On top of that, effective facility management shows the performance of the building as per the required aspects. The term facility management has no single definition across the globe, because of the difference in the bottom line of organizations or countries' culture. From this point, different countries' organizations or institutions or authors defined facility management in different ways. However, the

overall definition of facility management from various literature shows the integration of people, work process, and physical asset.

Another main issue extracted from the literature review is the necessity of evaluation of facility management performance. Among the other facility management performance evaluation tool, the key performance indicator was summarized as the most widely applicable tool in facility management. In the context of countries' requirements and culture, key facility management indicators were defined and the evaluation scale was determined. In last, in the context of countries/continents' performance, the USA and Europe are summarized as the most widely facility management implemented continent. In contrast to this, in Asia and Africa, the facility management practice is found in the infant stage. From African countries, only South Africa and Nigeria adopted facility management practices in more. While Ethiopia the practice of facility management is found in the infant stage. Moreover, the feature of future facility management is more concentrated in the concept of sustainability and digitalization.

2.13 Research Gap

The prevalence of performance assessment systems or tools in the organization is essential for the existence of facility management. The choice of assessment tool depends on the organization's or country's culture and objectives. Therefore, it is important to develop a local facility management assessment tool ISO (2018) under clause 9, IFMA (2017) under the performance and quality section; Rimbalová & Vilčeková (2013). However, in the context of Ethiopia, there is no facility management assessment tool, and only a limited number of studies have been conducted in the country. Moreover, Ethiopian researchers have primarily focused on assessing facility management practices. For example, Seyoum (2017) assessed facility management practices in the Cooperative Bank of Oromia, Sahelu (2015) examined building maintenance management practices in public hospitals in Addis Ababa, Nibret (2015) studied building facility management practices in higher education institutions in the Amhara region, and Bekele (2022) investigated facility management practices in selected public and private buildings in Addis Ababa. Finally, a clear research gap was found regards with lack of facility management assessment tools in Ethiopia as well as in Hawassa City.

In the next chapter, the research methodology of the study has been presented.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the overall research methodology employed to achieve indicated research objectives. The outline contains study area, overall research design, research type, target population, sources of data, sampling method, data collection techniques, data collection, data analysis, data presentation and ethics consideration.

3.2 Study Area

The research was conducted in Hawassa City, which is situated at the shores of Lake Hawassa in the Great Rift Valley. Hawassa City is positioned approximately 278.465 km south of Addis Ababa and is situated along the Trans-African Highway 4. The city's geographic coordinates are 7°3′N 38°28′E, and it has an elevation of 1708 meters above sea level. Hawassa City comprises eight sub-city administrations and a total of thirty-two kebeles (HCA, 2018).

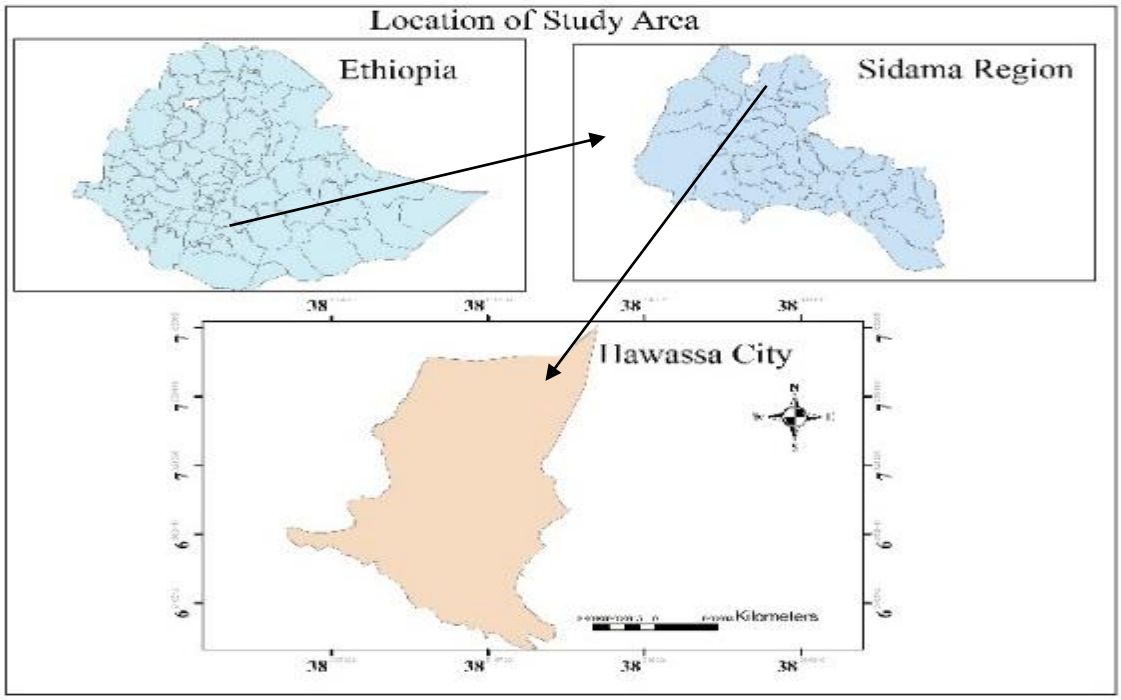

Figure 3.1 Location of the study area (HCA, 2018)

3.3 Overall Research Design

The overall applied steps of the research have been summarized and presented in following Figure 3.2.

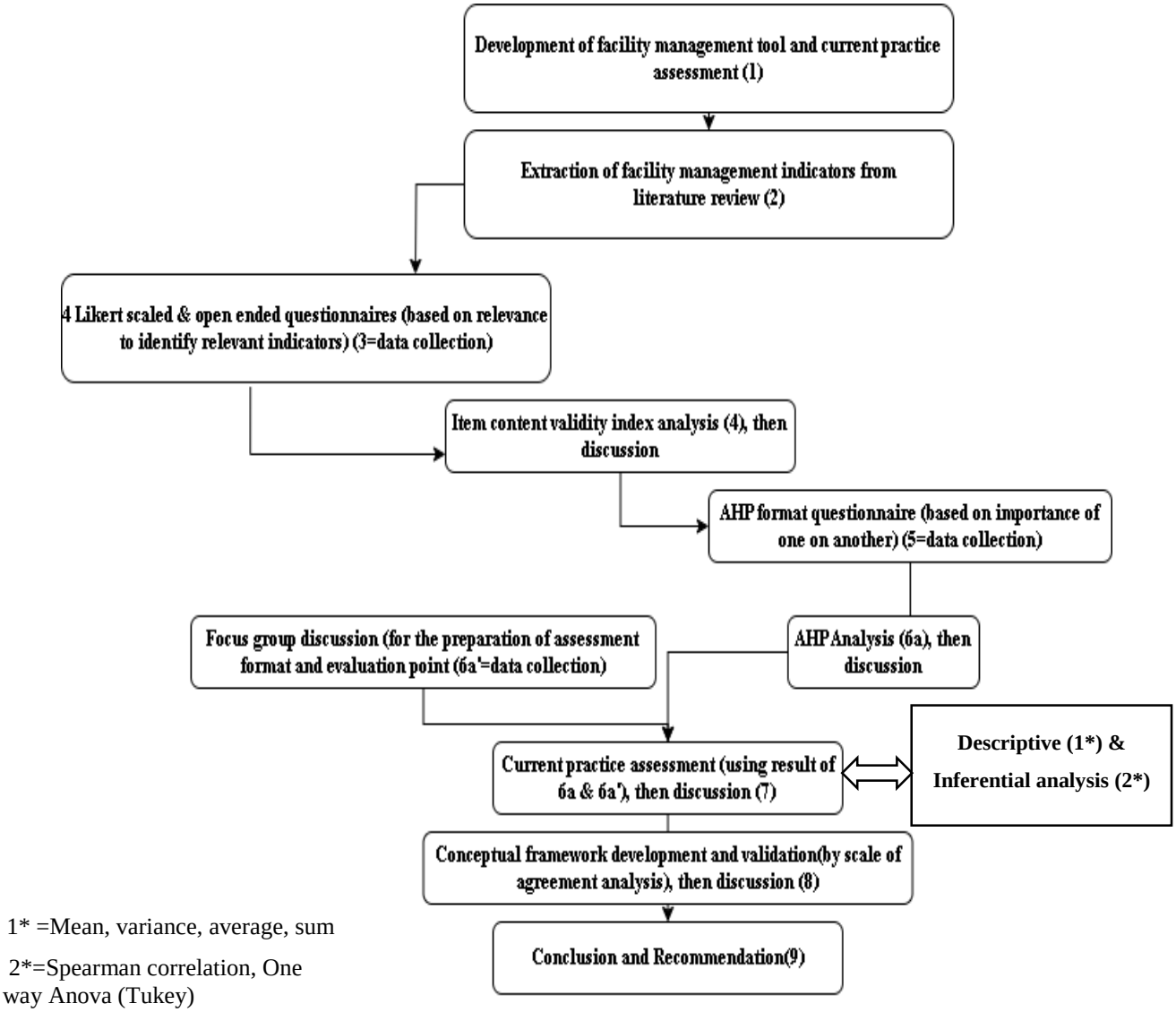

Figure 3.2 Research design flow chart

3.4 Research Type

The study employed mixed type of the research which encompasses the explorative and descriptive research type.

Explorative Research was employed particularly to explore the new facility management

variables which used for the evaluation of facility management in context of the Hawassa city.

Descriptive Research was employed to describe the current status of facility management in public office building.

3.5 Target Population

The target population or research population is defined as the collection of individuals or objects that have the same bindings characteristics or traits, according to Kumar (2010). In the line of this study, the target population is defined as the set of entities from which the research sample is drawn. The target population of this study was public office buildings (i.e. between G+1 and G+4), which owned by Government.

3.6 Sources of Data

For this study, both secondary and primary data sources were utilized. primary data was collected from various facility management field professionals and respondents from public office buildings. Their opinions were sought regarding the necessary objectives.

On the other hand, Secondary sources, specifically a literature review, were employed to extract facility management variables, primarily focusing on objective one.

3.7 Sampling Method

3.7.1 Sampling of Target population

Census sampling techniques was the sampling techniques which was employed to in this research for target population. This to mean, in the city there were twenty buildings (G+4=5, G+3=3, G+2=9, G+1=3). All buildings were taken as the sample of the population due to the small size of the population.

3.7.2 Sampling of the Respondents

The study employed purposive sampling as the sampling technique for respondents sampling. This approach was chosen to select the appropriate participants for the study. There were three main reasons for opting for purposive sampling in this research. Firstly, in the context of Ethiopia, including Hawassa, there is a shortage of professionals in the field of facility management. Secondly, for content validity of the study, a limited number of respondents (6-10), who were senior experts in the field were recommended, following the approach suggested by (Yusoff, 2019). The third reason was that comparison-based surveys

involved the use of AHP analysis, which is not practical for a large-scale questionnaire survey as it may lead to arbitrary responses and a higher degree of inconsistency (Wong and Li, 2007, as cited in Jayasena et al., 2020). In contrast, the AHP method is more suitable when a small number of representatives are involved (Duke & Aull-Hyde, 2002).

Additionally, for framework validation and preparation of the facility management assessment format and evaluation range, a small number of experts (6-12) were recommended and utilized, especially for focus group discussion (Van Eeuwijk & Angehrn, 2017). In this scenario, the selection of respondents was based on their knowledge, and the ability to provide high-quality and valuable information is advisable, following the guidance of Denscombe (2017). The respondents were chosen from both private and government higher academic institutions found in Hawassa city, building consultants, building coordinators from the Hawassa city municipality and the Sidama national regional state urban development and Construction Bureau, and facility and purchasing managers with relevant experience. The filtration of respondents was based on the possession of a minimum bachelor's degree and a minimum of five years of experience for a content validity study, two years of experience for AHP analysis, and ten years of experience for the validation of the framework, and for preparation of assessment format and evaluation range, both ten years and the five-year experience was used. For evaluation of the current practice facility management in the city, respondents were purposively selected who works in the organizations, and the respondent's background was presented in section 4.1.

The number of respondents versus their job titles is presented in Table 3.1.

Table 3.1 Number of the participant and their job title

Objective	Number of participants	Description
Content Validity	Eight	Two from academic, two from facility manager, two from building coordinators (one from HCM and one from SNRSUDCB), and two from building consultants (architects)
AHP data collection	Forty - nine	49 respondents participated. 10 from academics, 14 from facility managers and purchasing officers, 6 from

		building coordinators (3 from HCM & 3 SNRSUDCB), and 19 from consultants (11 architects and 8 others)
FM format & evaluation range	Seven	On top of the frame validation participants, 5-year experienced participants were included. 1 Facility manager, and 1 architect (from consultant)
FW validation	Five	Two from academics, one from the facility manager, one from the building coordinator (from HCM), and one from the architect (consultant)

Note: FW stands for Framework

3.8 Data Collection Instruments and Methods

The data collection methods used for this study were both qualitative and quantitative in the form of open-ended and close-ended questionnaires and focus group discussion.

3.8.1 Focus Group Discussion

This method was used for the selection of facility management evaluation rate and preparation of format. The focus group discussion was conducted on following activities:

- Discussion on the existing evaluation system (See section 2.7, Table 2.5)
- Collect new evaluation system, if any
- Choose either existing system or newly added
- Discussion on chosen evaluation system
- Approve the chosen system after final discussion on it.

3.8.2 Questionnaires

Questionnaire mainly used in refining/content validity/ the relevant variables, prioritization and weighting, assessment of current facility management practice, and validation of conceptual framework.

The questionnaire contained two major parts. The first part was prepared to capture the demographic profile of respondents, and the second part was prepared to elicit the expert's or respondent's opinion on provided section.

Questionnaire for Content Validity/Refining Relevant Facility Management Variables

To address the extraction and validation of facility management variables, a content validation study was used. Following the work of (Yusoff, 2019; Bark, 1990, as cited in Amos et al., 2020), the expert's judgment on validation was asked based on the degree of relevance, clarity, representativeness, and practicality of the indicators of facility management in open-ended and close-ended questionnaire format. The close-ended questionnaire was four Likert scaled. Where 1 = item is not relevant, 2 = item is somewhat relevant, 3 = quite relevant, and 4 = highly relevant. The open-ended questionnaire was used under close-ended questions to collect comments and additional items.

Questionnaire for Prioritization and Weighting of Facility Management Variables

For the comparison-based survey/prioritization and weighting/, a closed-ended questionnaire was used in the form of AHP format, following Saaty (2008). For easy reference, Saaty's numeric scale was revised (See Table 3.2). Scale 1=Equally and remained the same, 3 = Moderate importance and changed to 2, 5 = Strong importance and changed to 3, 7 = Very strong and changed to 4, and 9 = Extreme importance and changed to 5. Note that: the intermediate values in Saaty's table 3.2, which are 2,4,6, and 8 changed to 1.5,2.5,3.5, and 4.5. and the reciprocals rule remained the same. The same approach was used in the study by Anshebo et al. (2022).

Table 3.2 Pairwise comparison numerical scale

Intensity of importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Moderate importance	Experience and judgment moderately favour one activity over another
3	Essential or Strong importance	Experience and judgment strongly favour one activity over another
4	Very strong importance	An activity is strongly favoured and its dominance demonstrated in practice
5	Extreme importance	An activity is extremely favoured and its dominance demonstrated in practice
1.5,2.5,3.5, 4.5	Intermediate values between the two adjacent judgments	

Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.

Source: Modified from Saaty (2008) by researcher

Questionnaire for Current Facility Management Practice Assessment

For the assessment of the current facility management practice, the output of focus group discussion was used in form 5-point evaluation. The points were designed as:

< = 0.2 refers poor performance, 0.4 refers low performance, 0.6 medium/good performance, 0.8 refers very good performance and 1 refer excellent performance.

Questionnaire for Framework Validation

7 Likert scale questionnaire was used to validate the framework as used in Raouf & Al - Ghamdi (2023) and Shin et al. (2018).

Table 3.3 Likert Scale of the Framework validation questionnaire

Scale	1	2	3	4	5	6	7
Refer	Entirely disagree	Mostly disagree	Somewhat disagree	Neutral	Somewhat agree	Mostly agree	Entirely agree

On top of that, an open space for comments was provided.

3.9 Data Analysis Methods

For all objectives, different data analysis techniques were used. For the content validity study/refining facility management/, the item content validity index was used. For weighting and prioritization, the AHP analysis method was used. For framework validation, the scale of agreement analysis was used. and for the assessment of current practices of facility management, descriptive and inferential analyses were used. For the data analysis, SPSS (Statistical Package for social science) Version 23, and Microsoft Excel Version 2016 were used.

Data Analysis for Content Validity/Refining Facility Management Variables

For the content validity study/refining variables, according to Yusoff (2019) and Polit & Beck (2006), before calculating the content validity index, the steps of preparing the content validation form, selecting a review panel of experts, conducting content validation, and Providing score on each item should be carried out. After collecting the responses from selected experts, the rate 1 and 2 were recorded as 0, and the rate 3 and 4 were recorded as

1. This 1 counted as the number of agreements. CVI is calculated in terms of the item in the following equations.

Experts in agreement = Sum of the relevant rating provided by all experts for each item

Content validity index in terms of the item (I-CVI) $= \frac{expert\ in\ agreemnt}{number\ of\ expert}$

In conclusion, for the validation, 0.83 minimum average I-CVI was used, which is recommended by Lynn (1986, as cited in Yusoff, 2019) and Polit & Beck (2006). The computation of the I - CVI was carried out after the second round of validation by experts in this study.

Data Analysis for Prioritization and Weighting

To address the prioritization and weighting of the variables, the analytical hierarchy process (AHP) analysis method was used. The full analysis of AHP follows the following major steps, according to Wong & Li, 2008 and CEPAS (2021, as cited in Anshebo et al., 2022). Defining problems, development of hierarchy, pairwise comparison, normalization or driving relative weight, checking consistency, and synthesizing the results.

i. Defining the Problem

It is the first step in AHP analysis. The ultimate goal of decision-making is brought hierarchically into a scene of the related decision elements. In the AHP model method, the problem modelling as well as pairwise comparison concerning its structure can be represented by the hierarchical structure of AHP (Saaty & Vargas, 2012).

ii. Development of Hierarchy

Hierarchical construction is top to down process and it contains several categories and sub-criteria's each category. There is no standardized model to develop a hierarchical structure. This study comprises eight categories and 67 sub-criteria in three levels. Level one is the proposed facility management assessment tool (FMAT), level two is eight categories and level three is sub-criteria under each category (refer to figure 4.7). The elements of hierarchical levels are controlled in such a way that they are on the same scale and magnitude and they must be associated with other relevant factors of structure, according to Waris et al.(2019).

iii. Pairwise Comparison Matrix

Pair-wise comparison is used for the prioritization of both categories as well as a criterion and distinguishes more important factors from less important factors (Wong and Li, 2007, as cited in Anshebo et al., 2022). The numerical scale for pairwise comparison is 1 to 5 as indicated in section 3.3 (Data collection method), Table 3.2. For a pairwise comparison matrix, it's vital to note that the matrix's diagonal values are all 1, indicating that the weight of criteria about itself is always 1. Average of the ratings given by the respondents from pair-wise comparison given for each category and criteria used for further analysis.

iv. Normalization or Driving Criteria Weight

From this step, the criteria weight for each category as well as a criterion is determined. Normalization of the result of the pairwise matrix has to be done for categories according to their contribution to the expected goal while criterion to its contribution to its categories. According to Ahmed et al. (2017, as cited in Anshebo et al., 2022) and Temiz & Calis (2017), the normalization process follows three steps.

a. The value in each column of the pairwise matrix is summed as

$$C_{ij} = \sum_{i=1}^{n} c_{ij}$$

b. Each element in the matrix is divided by its column total to generate a normalized pairwise matrix Xij represented as

$$Xij = \left(\frac{Cij}{\sum Cij}\right)\begin{Bmatrix} W11 & W12 & W13 \\ W21 & W22 & W23 \\ W31 & W32 & W33 \end{Bmatrix}$$

c. The sum of the normalized column of the matrix is divided by the number of criteria used (n) to generate a weighted matrix (priority vector), Wij which is represented as

$$W_{ij} = \frac{\sum_{i=1}^{n} w_{ij}}{n}\begin{Bmatrix} W11 \\ W21 \\ W31 \end{Bmatrix}.$$

v. Consistency Checking

The accuracy and consistency of a survey are significant aspects of research, referring to the validity and reliability of data. For AHP analysis consistency or validation can be checked

by consistency index (CI) and consistency ratio (CR) (Saaty, 2005;Goepel, 2015). Consistency checking in the study was used to guarantee that original preference ratings were consistent, and a consistency ratio was generated and its value checked. The acceptable consistency ratio range should be less than or equal to 10% 0r 0.1 (Saaty, 2005;Deng, 2014). If the CR value is greater than 0.1, the pairwise comparison must be revised.

As suggested by Hazem et al. (2020) and Goepel (2015), the following steps were carried out to calculate the consistency ratio:

Step 1: The first column's each value from the pairwise table was multiplied by the criteria weight of the first item; the same was done to the remained columns

Step 2: Values across rows were summed to get a vector of values called "Weighted Sum".

Step 3: The Weighted Sums of every element were divided using each equivalent prioritized criterion to get a Weighted Sum value/ Criteria Weight

Step 4: The average of the values in Weighted Sum/Weight was calculated and expressed as λ_max

Step 5: Finally, CI calculated from the following equations

Consistency index(CI)

CI = $\frac{\lambda max - n}{n-1}$, where n is the number of items (criteria) being compared.

λ_max is the average of WSV/CW

Consistency ratio (CR)

$CR = \frac{CI}{RI}$, where

CI is the consistency index,

RI is the random inconsistency index obtained from a randomly generated pairwise comparison, which is presented in Table 3.4. Finally, CR should be less than or equal to 0.1, to say consistent, valid, and reliable.

Table 3.4 Random consistency index values (Taherdoost, 2017)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.52	1.54	1.56	1.58	1.59

Data Analysis for Current Facility Management Practice

For the assessment of current practice, both descriptive and inferential data analyses were carried out. For descriptive analysis, mean score analysis with average mean, and standard deviation were carried out, while for inferential analysis, correlation analysis (i.e. spearman correlation test) and one-way ANOVA (Post hock test, Tukey) was carried out under the condition of 95% confidence level

Data Analysis for Framework Validation

Finally, based on the findings of the study, literature review, and researcher's walkthrough observation, the conceptual framework of facility management has been developed. The drawn framework was validated by following the work of Raouf & Al-Ghamdi (2023) and Shin et al. (2018). The reliability of the survey results for a small number of experts can be evaluated through the level of agreement of the responses (Lee, 2001, as cited in Shin et al, 2018). The level of agreement is calculated according to following equation.

$$\text{Agreement} = 1 - \frac{\text{Q3}-\text{Q1}}{\text{Mdn}}$$

Where Q3 and Q1 are the third and first quartile, respectively, and Mdn is the median of the data set. A degree close to 1 indicates that the answers to the question are valid.

3.10 Data Presentation

The analysed data was presented in form of the Table and Figure.

3.11 Validity and Reliability of the Study

The validity and reliability of the study are critical issues in enhancing the problem solver study. validity is defined as the capacity of the scale or instrument to measure the intended measurement, as stated by Zikmund (2003). For this study, face-to-face content validity was carried out after extracting the indicators of the facility from the literature review (see section 4.2) and the scale of agreement analysis used for the framework validation. while the reliability of the study can be defined as the internal consistency of the study, this means it reflects the extent to which items within the instrument measure various aspects of the same characteristics or construct. Cronbach's alpha is used as the instrument to check internal consistency. Thus Cronbach's alpha was used to check the reliability of the assessment questionnaires in this study. for AHP validity and reliability consistency, a ratio has been used. In the following Table, 3.5 Internal consistency (Cronbach's alpha) is presented.

Table 3.5 Cronbach's alpha

Category	Cronbach's Alpha	N of items
Financial	0.895	10
Environmental	0.840	6
Technical	0.888	6
Human resource management	0.823	6
Functional	0.872	14
Performance-based	0.892	7
Socio-Cultural	0.825	8
Learning and management	0.854	10

The minimum acceptable value of Cronbach's is 0.7. All category of the study was greater than the minimum value, so it can be concluded as the questionnaire of the study was reliable.

3.12 Ethical Consideration

The study has been conducted by considering ASTU (2021) post-graduate studies guidelines. The following major ethical principles were taken into account.

Table 3.6 Principles of Ethical issue

Ethical principles	Description
Honesty	The researcher communicates and reports data and findings honestly.
Objectivity	Bias was avoided in data analysis, data interpretation, and data presentation.
Integrity	The researcher acts with sincerity while performing the research to ensure consistency of thinking and activity.
Carefulness	The researcher attempted to prevent casual mistakes and neglect.
Openness	Regarding the study, the researcher is open to criticism and new ideas, has a high regard for intellectual property, and respects patents, copyrights, and other kinds of intellectual property.
Confidentiality	The researcher keeps confidential conversations private.
Social responsibility	Through study, the researcher strives to promote social good and avoid or reduce social damage.

CHAPTER FOUR

RESULT AND DISCUSSION

In this chapter response rates, respondents' backgrounds, major findings, and discussion have been presented.

4.1 Response Rate and Respondents Background

4.1.1 Response Rate of Questionnaires

The response rate is useful in determining the effectiveness of the questionnaires returned in the survey. The response rates of this study were calculated after surveying questionnaires. For content validity and framework validation, the response rate is 100%. While for the AHP questionnaire/Prioritization, and current practice assessment the response rate was computed and presented in Table 4.1.

Table 4.1 Response rate

Response Rate on the AHP format/prioritization				
	Frequency	Percentage		
Distributed	49	100%		
Responded	43	88%		
uncompleted	2	4%		
Net	41	84%		
Response Rate on the Current practice assessment				
	G+1	G+2	G+3	G+4
Distributed	14(100%)	32(100%)	16(100%)	24(100%)
Responded	11(79%)	29(91%)	12(75%)	21(88%)
uncompleted	1(7%)	3(9%)	0(0%)	1(4%)
Net	10(71%)	26(81%)	12(75%)	20(83%)

Total 49 questionnaires were distributed and 43 (88%) were returned in AHP format questionnaire. Besides, 2 (4%) were uncompleted questionnaires and for further analysis, a net 41 (84%) questionnaires were used. While for current practice assessment the questionnaires were distributed in groups. For G+1 respondents, 14 questionnaires distributed then net 10 (71%) questionnaires used for analysis, For G+2 respondents, 32 questionnaires distributed then net 26 (81%) questionnaires used for analysis, For G+3 respondents, 16 questionnaires distributed then net 12 (75%) questionnaires used for analysis, For G+4 respondents, 24 questionnaires distributed then net 20(83%) questionnaires used for analysis.

In the next section, the demography of the respondents has been presented.

4.1.2 Demography of Respondents

The demography of respondents was categorized with respect to objectives.

The respondent's minimum education level was bachelor degree in all specific objectives. From experience year category, minimum experience year of respondents on content validity/refining facility management variables/ and focus group was 5 years, 2 years was for prioritization, 10 years was framework validation. In next, the group demography of the respondents has been presented who participated in current facility management practice assessment.

Table 4.2 Respondents background on current practice assessment

	G+1		G+2		G+3		G+4	
Demography Category	F	%ge	F	%ge	F	%ge	F	%ge
Experience Year								
1-5	5	50%	7	27%	3	25%	6	30%
5-10	2	20%	13	50%	5	42%	7	35%
10-15	3	30%	4	15%	4	33%	4	20%
>15	-	-	2	8%	-	-	3	15%
Total	10	100%	26	100%	12	1000%	20	100%
Sex								
Male	7	70%	19	73%	9	75%	18	90%
Female	3	30%	5	19%	3	25%	2	10%
Education Level								
BSc	6	60%	17	65%	10	83%	13	65%
MSc	4	40%	9	35%	2	17%	7	35%

F stands for frequency, %ge stands for percentage

Most of the participants have the experience year between 5 and 10 years. From sex category, most of them were male. From education background of the respondent, more number lies in first degree/BSc. Out of four groups more number of participants were selected from G+2 buildings.

4.2 Prioritization of the Facility Management Variables

4.2.1 Refining/Identifying the Relevant Facility Management Variables

As presented in chapter three sub-section 3.8, Four Likert scale questionnaires were distributed to eight senior experts. The analysis followed a series of steps.

Step 1: four scaled Likert answers rearranged as, 1 and 2 were recorded as 0; 3 and 4 were recorded as 1.

Step 2. 1 is represented as agreement while 0 is not.

Step 3. Sum up all 1 of the indicator, represent as experts in agreement

For example: from the financial category, the number of experts in agreement for building maintenance cost was 8 out of 8 experts, which means all experts agreed on the indicator.

Step 4: item content validity index (I-CVI) calculation

For the same example used in step 3, (I-CVI) = $\frac{\text{Expert in agreement}}{\text{Number of Experts}} = \frac{8}{8} = 1$

Step 5: Validation

For eight experts, the minimum validation point of I-CVI is 0.83. According to this, the building maintenance cost was validated, hence its I - CVI was 1, which was greater than the minimum acceptable I-CVI. For all categories, the same procedures were followed. The financial category presented in Table 4.3

Table 4.3 Financial category validation

Financial indicators			
S.no	Tested items	I-CVI	Validation
1	Building maintenance cost	1	validated
2	Utility cost	1	validated
3	Operating cost	1	validated
4	Custodial and janitorial cost	1	validated
5	Deferred maintenance & differed maintenance backlog	0.88	validated
6	Capital cost	1	validated
7	Capital renewal cost	0.88	validated
8	Churn cost and rate	0.63	excluded
9	Proportion of facility management budget	0.5	excluded

10	Facility condition assessment cost	1	validated
11	Occupancy cost	1	validated
12	Financial management (procurement and contract management	1	validated
13	Time value of the money	1	validated
14	Cost feasibility, review, analyse and report	1	validated

Note: Ex stands for Experts

As presented in above table 4.1, churn cost and rate is excluded, because, it doesn't meet the minimum required I-CVI value which is 0.83 for 8 experts. On top of that, the comments of each category also should be taken into account in the content validity study. The following comments were given by experts for Financial category indicators for better improvement (Note that: the comments were validated by all experts in the second round of validation). Facility condition assessment cost and deferred maintenance & differed maintenance backlog suggested to be merged and get a new name or modified**.** Likewise, cost feasibility, review analysis, and the report suggested to merged into financial management. considering all comments of experts, Facility condition assessment cost and deferred maintenance & differed maintenance backlog merged and named Facility condition survey cost or budget. And, cost feasibility, review analysis, and report merged into financial management.

The same procedure and analysis used for all other types of the category and items are presented in next Table 4.4.

Table 4.4 Validations of remained category's indicators

S.no	Environmental indicator		
1	Energy efficiency	1.00	Validated
2	Water consumption management	0.88	Validated
3	Waste management and discharge	0.88	Validated
4	Material consumption for maintenance (including quality)	1	Validated
5	Environmental impact assessment	1	Validated
6	Ecologic value	1	Validated

S.no	Technical Indicators	ICVI	Validation
1	Scheduled maintenance of building elements	1	Validated
2	Physical detection of building	1	Validated
3	Repair, renovation and refurbishment	1	Validated
4	Measurement of building elements if needed	0.88	Validated
5	ICT application	1	Validated
6	Understanding of building design	0.88	Validated
S.no	Human resource management Indicators		
1	Background of the facility manager	0.88	Validated
2	Improve the skill of facility manager by training and evaluate	0.88	Validated
3	Effective communication between the stakeholders in organization	1	Validated
4	Cooperation with real supplier/contractor	1	Validated
5	Time management of the facility employee	0.88	Validated
6	Leadership skill of top manager	1	Validated
7	Team management	1	Validated
S.no	Functional Indicators		
1	Building services like (drainage, piping, sanitary..)	1	Validated
2	Landscaping /Ground	0.88	Validated
3	Space utilization	1	Validated
4	Cleanliness	1	Validated
5	Health, safety, security, privacy and fire protection	1	Validated
6	Manage inventory and spare parts	0.5	Excluded
7	Emergency exit	1	Validated
8	Heating, ventilation, noise, artificial and natural light	1	Validated

9	Mechanical and electrical services	1	Validated
10	Ancillary services (mail, housing)	1	Validated
11	Insurance of property	0.63	Excluded
12	One window services	0.38	Excluded
13	Furniture's, fixtures and equipment	1	Validated
14	Accessibility for aged and disabled person	1	Validated
15	Productivity	1	Validated
16	Signal and waiting room	1	Validated
17	Recreational area	1	Validated
18	Transport accessibility and parking area	1	Validated
S.no	User perception/survey based indicators		
1	Customer satisfaction with the services	1	Validated
2	Complaints on the facility services	1	Validated
3	Occupant turn rate	0.88	Validated
4	Public image on facility condition	1	Validated
S.no	Socio-behavioural indicators		
1	Appearance/view out	1	Validated
2	Aesthetic Value	1	Validated
3	Feeling of Equality	1	Validated
4	Additional contribution for society	0.5	Excluded
5	Integration with the urban	1	Validated
6	Location of the building	0.88	Validated
S.no	Performance evaluation and improvement indicators		
1	Scope of monitory	1	Validated
2	Monitoring means and methods	0.88	Validated

3	Evaluation of the facility performance	1	Validated
4	Scheduled audit and top management review	1	Validated
5	Corrective measure (Proactive action)	1	Validated
6	Gap analysis on facility management	1	Validated
7	Documentation of the result	0.88	Validated
8	Continually improvement	1	Validated
S.no	Learning and management indicators		
1	Learning and management	1	Validated
2	Managing the change	1	Validated
3	Real estate management	0.13	Excluded
4	Understanding facility management professional practices	1	Validated
5	Understanding organizational structure and strategy	1	Validated
6	Develop facility management strategy (plan) in line with Organization structure	0.88	Validated
7	Risk management (Assessment, control, mitigation and emergency preparedness)	0.88	Validated
8	Evidence based decision making	1	Validated
9	Understanding international facility management requirement laws and criteria	1	Validated
10	Rate of the response by concerned body	1	Validated
11	Consultancy services	1	Validated
12	Roles, responsibility and authority management	1	Validated

Likewise, in the financial category, the experts have given comments on the other categories also. From the human management category, team management suggested to be reduced, it can be expressed in effective communication between the stakeholders in the organization. From the functional category, safety, and cleanliness are suggested to be under health items, emergency exit, and fire protection were suggested to be under emergency preparedness, security, privacy, and noise were suggested to be in one, and productivity also suggested to

be removed. From the user-based category, the public image of the facility condition is suggested as it can be revealed by user satisfaction and compliance. On top of that, according to experts suggest, the user-based and socio-behavioural categories should be merged and get a new name or modified name to decrease ambiguity on the items and category. Evaluation of the facility performance and scheduled audit and top management review from performance-based category suggested merging into one. Moreover, evidence-based decision item from learning and management indicated as it can be concluded under corrective measures or proactive action under performance-based. In addition, Learning and management item indicated as they can reveal roles, responsibilities and authority management item and understanding international facility management requirement laws and criteria item suggested to be included under understanding facility management professional practices. Moreover, two additional items were added and validated to the learning and management category. They were understanding Ethiopian laws (Formal and Informal laws) and Good governance (Free from any corruption). Those added variables were validated by the second round validated with I - CVI of 1. Except for those added items, all other items were extracted from the literature review. By following the above expert's comment and suggestion, team management from human management reduced, safety and from functional cleanliness items included under health item, emergency exit, and fire protection categorized under emergency preparedness, security, privacy, and noise categorized into one, productivity from functional category reduced. From user based category, the public image on the facility condition item was reduced, and the user-based and socio-behavioural categories merged into one and named as the socio-cultural category. Evaluation of the facility performance and scheduled audit and top management review from performance-based category emerged into one and named as scheduled performance evaluation, the evidence-based decision from learning and management reduced, roles, responsibility and authority management item reduced and included under learning and management. Understanding international facility management requirement laws and criteria item categorized under the understanding facility management professional practices item.

After correcting the expert's comments and suggestions on the extracted indicators, corrected and validated items (67 in 8 categories) presented in next Table 4.5 with coding/acronyms for further analysis.

Table 4.5 Indicators with Acronyms

Facility management assessment tool		**FMAT**
S.no	Financial indicator	FI
1	Operating cost	FI-1
2	Occupancy cost	FI-2
3	Utility cost	FI-3
4	Building maintenance cost	FI-4
5	Capital cost	FI-5
6	Capital renewal cost	FI-6
7	Custodial and janitorial cost	FI-7
8	Facility condition survey cost	FI-8
9	Financial management	FI-9
10	Time value of money	FI-10
S.no	Environmental aspect indicator	EI
1	Energy efficiency	E-1
2	Water consumption management	E-2
3	Waste management	E-3
4	Material management	E-4
5	Environment impact assessment practice	E-5
6	Ecological value	E-6
S.no	Technical Indicator	TI
1	Scheduled maintenance	TI-1
2	Physical detection of the building	TI-2

3	Repair, renovation and refurbishment	TI-3
4	Measurement of building elements	TI-4
5	ICT application	TI-5
6	Understanding Building design	TI-6
S.no	Human Resource management indicator	HMI
1	Background of facility manager	HM-1
2	Training for facility manager	HM-2
3	Effective communication in organization	HM-3
4	Cooperation with real supplier/contractors/facility specialist	HM-4
5	Time management of facility manager	HM-5
6	Leadership skill of top management	HM-6
S.no	Functional indicators	FUI
1	Building services like (drainage, piping, sanitary..)	FU-1
2	Space utilization	FU-2
3	Landscaping/ground shaping	FU-3
4	Health (including safety, cleanliness)	FU-4
5	Security, privacy and noise	FU-5
6	Emergency preparedness (emergency exit, fire protection)	FU-6
7	Heating, ventilation, lighting (i.e. artificial and natural light)	FU-7
8	Mechanical and electrical services	FU-8
9	Ancillary services (mail- housing)	FU-9
10	Furniture, fixtures and equipment	FU-10
11	Accessibility for aged and disabled person	FU-11

12	Signal and direction indicator (signs)	FU-12
13	Recreational area	FU-13
14	Transport accessibility and parking area	FU-14
S.no	Performance Based indicator	PBI
1	Scope of monitory	PB-1
2	Monitoring means and methods	PB-2
3	Scheduled performance evaluation	PB-3
4	Gap analysis on facility management	PB-4
5	Corrective measure (Proactive action)	PB-5
6	Documentation of result	PB-6
7	Continually improvement	PB-7
S.no	Socio-Cultural indicator	SCI
1	Appearance or view out of building	SC -1
2	Aesthetic value	SC- 2
3	Feeling of Equality (Cultural aspect)	SC- 3
4	Integration with urban	SC- 4
5	Location of the building	SC- 5
6	Customer satisfaction with facility services	SC- 6
7	Customer complaint on facility services(Record)	SC- 7
8	Occupancy turn of rate	SC- 8
S.no	Learning and management indicators	LMI
1	Learning and Management	LM-1
2	Managing the Change	LM-2

3	Understanding facility management professional practices	LM-3
4	Understanding organizational structure and strategy	LM-4
5	Develop facility management strategy (plan) in line with Organization structure	LM-5
6	Risk management (Assessment, control, mitigation and emergency preparedness)	LM-6
7	Understanding Ethiopian laws (Formal and Informal laws)	LM-7
8	Good governance (No corruption)	LM-8
9	Rate of the response by the concerned body	LM-9
10	Consultancy services	LM-10

The description of the relevant variables presented in Appendix-II.

In the next section, the prioritization and weighting analysis have been presented.

4.2.2 Prioritization and Weighting of Facility Management Variables

The facility management assessment criteria were identified from the literature review and two additional indicators from selected experts were set to be compared with each other by facility management professionals in provided AHP questionnaire format. After collecting data, the AHP analysis procedure was followed. Main steps required in the formulation of the AHP framework comprises of hierarch construction, pairwise comparisons, driving relative weights, consistency checking, and synthesizing results as discussed in Chapter Three.

Hierarchy Construction

The construction of the hierarchical structure for the analysis of AHP, it is the backbone for further analysis. For the construction of the hierarchy construction, Table 4.5 was used. The constructed hierarchy includes three main levels. Level one indicates the overall goal which is FMAT, level two is the eight categories found under the main goal of the hierarchy and the third level contains the 67 indicators or variables of the facility management (refer to Figure 4.1)

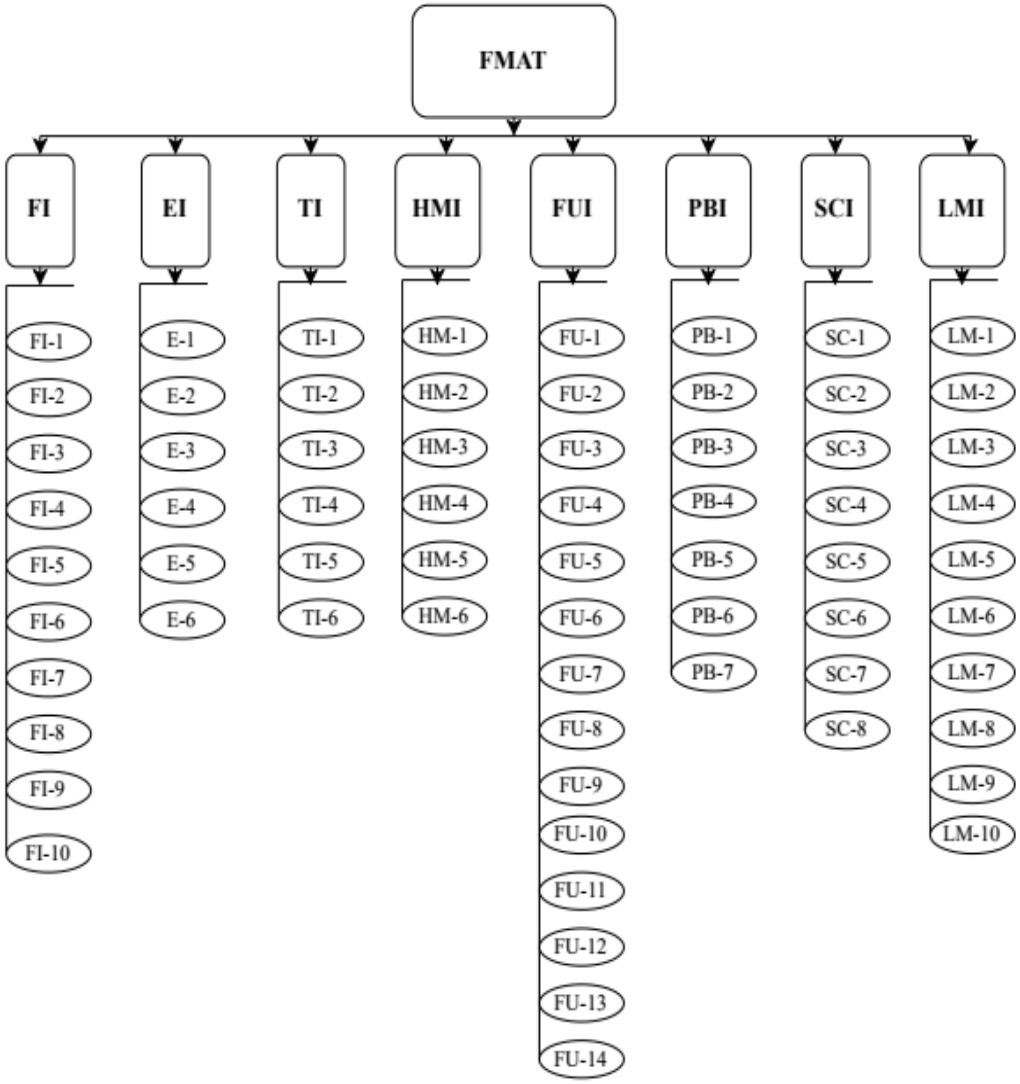

Figure 4.1 Analytical Hierarchy of AHP

I. Eight Categories AHP Analysis

Eight Categories Pairwise Comparison Matrix

In this stage, the average value of the respondents was used for the comparison matrix, and the sum value of each column was computed. The total number of the matrix in this category is 28.

For instance, the sum of the first column which represents FI (financial indicator) calculated as follows:

Sum = 1+0.34602+0.45872+0.35842+0.78125+0.28090+0.44843+0.48780 = 4.1615. the same procedure used for all categories.

Table 4.6 Eight category pairwise matrix comparison

FMAT	FI	EI	TI	HMI	FUI	PBI	SCI	LMI
FI	1	2.89	2.18	2.79	1.28	3.56	2.23	2.0500
EI	0.34602	1	0.5917	0.9615	0.3636	2.03	0.4673	0.3584
TI	0.45872	1.6900	1	2.14	0.4292	3.13	0.7634	0.7042
HMI	0.35842	1.0400	0.4673	1	0.3413	2.16	1.26	0.8621
FUI	0.78125	2.7500	2.3300	2.9300	1	2.68	1.02	1.3200
PBI	0.28090	0.4926	0.3195	0.4630	0.3731	1	0.4505	0.4082
SCI	0.44843	2.1400	1.3100	0.7937	0.9804	2.22	1	0.7519
LMI	0.48780	2.7900	1.4200	1.1600	0.7576	2.45	1.33	1
Sum	**4.1615**	**14.7926**	**9.6185**	**12.2382**	**5.5252**	**19.2300**	**8.5211**	**7.4548**

Normalization/Driving Eigen value

In this step, Eigen value, and rank of each category have been computed.

The first step in this stage is, divide the pairwise value to sum value of each column. For instance, FI (financial indicator) normalized value is $\frac{1}{4.1615} = 0.2403$, like this, 0.1954 is the normalized value of EI (Environmental indicators), 0.2266 is the normalized value of TI (technical indicators), 0.2280 is the normalized value of HMI (Human resource management indicator), 0.2317 is the normalized value of FUI (functional indicators), 0.1851 is the normalized value of PBI (performance-based indicators), 0.2617 is the normalized value of SCI (Socio-cultural indicators), 0.2750 is the normalized value of LMI (learning and management indicator).

SUM = 0.2403 + 0.1954 + 0.2266 + 0.2280 + 0.2317 + 0.1851 + 0.2617 + 0.2750 = 1.8438

EV(Eigen value of the financial indicator) = $\frac{sum\ value}{number\ of\ the\ item}$

where the sum value is 1.8438.

The number of item is 8

EV = $\frac{1.8438}{8} = 0.2305$,

EV (%) is CW in percentage, which is 23.05%. this means, the financial indicators category weighs 23.05% out of 100%, which is the total weight of the facility management assessment tool (FMAT). The same procedure applied for others also an presented in Table 4.7.

Table 4.7 Normalization of the Eight category

FMAT	FI	EI	TI	HMI	FUI	PBI	SCI	LMI	SUM	EV	CW(%)	Rank
FI	0.2403	0.1954	0.2266	0.2280	0.2317	0.1851	0.2617	0.2750	1.8438	0.2305	23.05%	1
EI	0.0831	0.0676	0.0615	0.0786	0.0658	0.1056	0.0548	0.0481	0.5651	0.0706	7.06%	7
TI	0.1102	0.1142	0.1040	0.1749	0.0777	0.1628	0.0896	0.0945	0.9278	0.1160	11.60%	5
HMI	0.0861	0.0703	0.0486	0.0817	0.0618	0.1123	0.1479	0.1156	0.7243	0.0905	9.05%	6
FUI	0.1877	0.1859	0.2422	0.2394	0.1810	0.1394	0.1197	0.1771	1.4724	0.1841	18.41%	2
PBI	0.0675	0.0333	0.0332	0.0378	0.0675	0.0520	0.0529	0.0548	0.3990	0.0499	4.99%	8
SCI	0.1078	0.1447	0.1362	0.0649	0.1774	0.1154	0.1174	0.1009	0.9646	0.1206	12.06%	4
LMI	0.1172	0.1886	0.1476	0.0948	0.1371	0.1274	0.1561	0.1341	1.1030	0.1379	13.79%	3
									Sum	**1**	**100%**	

Checking Consistency

After normalizing the criteria, a measure of consistency is a fundamental issue in AHP. A series of steps followed. To show how the consistency was checked for the eight categories, WSV (weighted sum value), WSV/CW were calculated. For financial indicators, the following steps were followed.

Step 1: The first column each value (unnormalized) was multiplied by the first criteria weight, which was calculated in Table 4.7. which means, CW*un normalized value from Pairwise comparison matrix = 0.2305*1 = 0.2305, the same calculation was done for the other remaining columns. According to this, 0.2042, 0.2528, 0.2526, 0.2356, 0.1776, 0.2689 and 0.2826 are the value of FI (financial indicator), EI (environmental indicator), TI (technical indicator), HMI (human resource management indicator), FUI (functional indicator), PBI (performance-based indicator), SCI (socio-cultural indicator), and LMI (learning and management indicator) respectively.

Step 2: WSV (weighted sum value) of (FI) financial indicator were calculated from summing up all rows value, according to this,

WSV=0.2305 + 0.2042 + 0.2528 + 0.2526 + 0.2356 + 0.1776 + 0.2689 + 0.2826 = 1.9047

Step 3: WSV/CW was computed, WSV/CW=$\frac{1.9047}{0.2305} = 8.2644$, for all categories also, the same computation was applied and presented in Table 4.9 Based on this, the sum of all columns (WSV/CW) is 65.9447.

Step 4: Consistency index(CI) and Consistency ratio (CR) were computed as follows

CI = $\frac{\lambda max - n}{n-1}$, where n is the number of items or criteria or categories, n = 8

λmax is the average of the values in Weighted Sum/Weight = 65.9447/8 = 8.24

CI = $\frac{8.24308-8}{8-1} = 0.0347$,

RI for n = 8 is 1.4 (From Table 3.4)

CR = $\frac{0.0347}{1.4} = 0.0248 \leq 0.1$, this shows the result was reliable as well as consistent

Table 4.8 Consistency verification results of Eight category indicators

Maximum Eigen Value	CI value	RI value	CR value	Consistency result
100	0.0347	1.4	0.0248	Pass/consistent

Table 4.9 Calculation of WSV, and WSV/CW for Eight Categories

FMAT	FI	EI	TI	HMI	FUI	PBI	SCI	LMI	WSV	EV	WSV/EV
FI	0.2305	0.2042	0.2528	0.2526	0.2356	0.1776	0.2689	0.2826	1.9047	0.2305	8.2644
EI	0.0797	0.0706	0.0686	0.0871	0.0669	0.1012	0.0563	0.0494	0.5800	0.0706	8.2105
TI	0.1057	0.1194	0.1160	0.1938	0.0790	0.1561	0.0920	0.0971	0.9591	0.1160	8.2697
HMI	0.0826	0.0735	0.0542	0.0905	0.0628	0.1077	0.1519	0.1189	0.7421	0.0905	8.1966
FUI	0.1801	0.1943	0.2702	0.2653	0.1841	0.1337	0.1230	0.1820	1.5325	0.1841	8.3265
PBI	0.0647	0.0348	0.0371	0.0419	0.0687	0.0499	0.0543	0.0563	0.4076	0.0499	8.1734
SCI	0.1034	0.1512	0.1519	0.0719	0.1804	0.1107	0.1206	0.1037	0.9937	0.1206	8.2417
LMI	0.1124	0.1971	0.1647	0.1050	0.1394	0.1222	0.1604	0.1379	1.1391	0.1379	8.2618
									Sum	**1**	**65.9447**

II. Financial Indicators Category

Pairwise Comparison Matrix of the Financial Indicators Category

The average value of the respondents on the comparison matrix was used in a total 45 number of the matrix. Pairwise comparison matrix of this category is presented in next Table 4.10. From the pairwise value the sum of each column also computed.

Table 4.10 Pairwise comparison matrix of financial indicators

FI	FI-1	FI-2	FI-3	FI-4	FI-5	FI-6	FI-7	FI-8	FI-9	FI-10
FI-1	1	3.12	2.56	2.13	1.75	2.43	4.56	3.34	2.75	4.21
FI-2	0.3205	1	2.17	1.34	1	0.57	4.44	3.12	1.98	3.78
FI-3	0.3906	0.4608	1	2.24	0.61	0.3003	3.21	1.82	2.45	2.31
FI-4	0.4695	0.7463	0.4464	1	0.6410	0.3584	2.89	1.79	2.22	2.23
FI-5	0.5714	1	1.6500	1.5600	1	0.8130	3.07	3.21	2.11	2.09
FI-6	0.4115	1.7500	3.3300	2.7900	1.2300	1	3.28	3.45	3.3100	2.32
FI-7	0.2193	0.2252	0.3115	0.3460	0.3257	0.3049	1	1	0.4695	2.16
FI-8	0.2994	0.3205	0.5495	0.5587	0.3115	0.2899	1.000	1	0.4695	1.89
FI-9	0.3636	0.5051	0.4082	0.4505	0.4739	0.3021	2.130	2.13	1	2.67
FI-10	0.2375	0.2646	0.4329	0.4484	0.4785	0.4310	0.463	0.5291	0.3745	1
Sum	**4.2834**	**9.3924**	**12.8585**	**12.8636**	**7.8167**	**6.8010**	**26.043**	**21.3891**	**17.1335**	**24.66**

Normalization or Driving Criteria Weight

In this step, criteria weight, criteria weight in percent (CW in %), and rank of each indicator in this category. The first step in this stage is, divide the pairwise value to sum value of each column. For instance, FI-1 (building maintenance cost) normalized value is $\frac{1}{4.2834} = 0.2335$, like this, 0.3322is normalized value of FI-2, 0.1991is normalized value of FI-3 , 0.1656 is normalized value of FI-4, 0.2239 is normalized value of FI-5 , 0.3573 is normalized value of FI-6, 0.1751 is normalized value of FI-7, 0.1562is normalized value of FI-8, 0.1605 is normalized value of the FI-9 and 0.1707 is normalized value of the FI-10

SUM(rows)=0.2335+0.3322+0.1991+0.1656+0.2239+0.3573+0.1751+0.1562+0.1605+0.1707=2.1740

CW(criteria weight of the FI-1) = $\frac{sum\ value}{number\ of\ the\ item}$, where sum value is 2.1740

Number of item is 10

CW = $\frac{2.1740}{10} = 0.2174$

CW (%) is CW in percentage, which is 21.74%. the same procedure was applied to other categories and presented in next Table 4.11.

Table 4.11 Normalization of financial indicator

FI	FI-1	FI-2	FI-3	FI-4	FI-5	FI-6	FI-7	FI-8	FI-9	FI-10	Sum	CW	CW(%)
FI-1	0.2335	0.3322	0.1991	0.1656	0.2239	0.3573	0.1751	0.1562	0.1605	0.1707	2.1740	0.2174	21.74%
FI-2	0.0748	0.1065	0.1688	0.1042	0.1279	0.0840	0.1705	0.1459	0.1156	0.1533	1.2514	0.1251	12.51%
FI-3	0.0912	0.0491	0.0778	0.1741	0.0775	0.0442	0.1233	0.0851	0.1430	0.0937	0.9589	0.0959	9.59%
FI-4	0.1096	0.0795	0.0347	0.0777	0.0820	0.0527	0.1110	0.0837	0.1296	0.0904	0.8509	0.0851	8.51%
FI-5	0.1334	0.1065	0.1283	0.1213	0.1279	0.1195	0.1179	0.1501	0.1232	0.0848	1.2128	0.1213	12.13%
FI-6	0.0961	0.1863	0.2590	0.2169	0.1574	0.1470	0.1259	0.1613	0.1932	0.0941	1.6372	0.1637	16.37%
FI-7	0.0512	0.0240	0.0242	0.0269	0.0417	0.0448	0.0384	0.0468	0.0274	0.0876	0.4129	0.0413	4.13%
FI-8	0.0699	0.0341	0.0427	0.0434	0.0399	0.0426	0.0384	0.0468	0.0274	0.0766	0.4618	0.0462	4.62%
FI-9	0.0849	0.0538	0.0317	0.0350	0.0606	0.0444	0.0818	0.0996	0.0584	0.1083	0.6585	0.0658	6.58%
FI-10	0.0555	0.0282	0.0337	0.0349	0.0612	0.0634	0.0178	0.0247	0.0219	0.0406	0.3817	0.0382	3.82%
											Sum	**1**	**100%**

Consistency Checking of Financial Category

after normalizing the criteria, measure of consistency is fundamental issues in AHP. A series of steps followed. To show how consistency checked for the financial indicators category, WSV (weighted sum value), WSV/CW were calculated. For financial indicator the following steps were followed.

Step 1: the first column each value (un normalized) was multiplied by the first criteria weight, that was calculated in Table 4.11. which means, CW*un normalized value from Pairwise comparison matrix. For example: for FI-1, =0.2174*1=0.2174, the same calculation was done for the other remained columns. According to this, 0.3904, 0.2455, 0.1812,0.2122,0.3978,0.1883,0.1543,0.1811 and 0.1607 are the value FI-2 up to FI-10 respectively.

Step 2: WSV (weighted sum value) of (FI-1) financial indicator were calculated from summing up all rows value,

according to this,

WSV=0.2174 +0.3904+0.2455+0.1812+0.2122+0.3978+0.1883+ 0.1543+0.1811+ 0.1607= 2.3289

Step 3: WSV/CW was computed, WSV/CW = $\frac{2.3289}{0.2174} = 10.7128$, for each indicators in this categories also, the same computation was applied and presented in Table 4.11. Based on this, the sum of all column (WSV/CW) is 105.4979.

Step 4: consistency index(CI) and consistency ratio (CR) were computed as follow

Number of the indicators/items (n) = 10

Random inconsistency index (RI) for n=10 is 1.49

λmax = average value of WSV/CW = $105.4979/10$ = 10.54979

Consistency Index (CI)

CI=$\frac{(\lambda max - n)}{n-1}$ = $\frac{10.54970-10}{10-1}$ =0.06109

Consistency Ratio (CR)

CR = $\left(\frac{CI}{RI}\right) = \left(\frac{0.06109}{1.49}\right)$ = 0.041

CR = 0.041 ≤ 0.1, ≈ Consistent and Reliable.

Table 4.12 Calculation of WSV, and WSV/CW for Financial indicator category

FI	FI-1	FI-2	FI-3	FI-4	FI-5	FI-6	FI-7	FI-8	FI-9	FI-10	WSV	CW	WSV/CW
FI-1	0.2174	0.3904	0.2455	0.1812	0.2122	0.3978	0.1883	0.1543	0.1811	0.1607	2.3289	0.2174	10.7128
FI-2	0.0697	0.1251	0.2081	0.1140	0.1213	0.0936	0.1833	0.1441	0.1304	0.1443	1.3338	0.1251	10.6589
FI-3	0.0849	0.0577	0.0959	0.1906	0.0735	0.0492	0.1326	0.0841	0.1613	0.0882	1.0178	0.0959	10.6151
FI-4	0.1021	0.0934	0.0428	0.0851	0.0777	0.0587	0.1193	0.0827	0.1462	0.0851	0.8931	0.0851	10.4959
FI-5	0.1242	0.1251	0.1582	0.1327	0.1213	0.1331	0.1268	0.1483	0.1389	0.0798	1.2884	0.1213	10.6236
FI-6	0.0895	0.2190	0.3193	0.2374	0.1492	0.1637	0.1354	0.1593	0.2180	0.0885	1.7793	0.1637	10.8684
FI-7	0.0477	0.0282	0.0299	0.0294	0.0395	0.0499	0.0413	0.0462	0.0309	0.082 4	0.4254	0.0413	10.3022
FI-8	0.0651	0.0401	0.0527	0.0475	0.0378	0.0475	0.0413	0.0462	0.0309	0.0721	0.4812	0.0462	10.4186
FI-9	0.0791	0.0632	0.0391	0.0383	0.0575	0.0495	0.0880	0.0984	0.0658	0.1019	0.6807	0.0658	10.3380
FI-10	0.0516	0.0331	0.0415	0.0382	0.0580	0.0706	0.0191	0.0244	0.0247	0.0382	0.3994	0.0382	10.4645
											Sum	**1**	**105.4979**

III. Environmental Indicators Category

Pairwise Matrix of Environmental Indicators

The filled comparison pairwise matrix of environmental indicators category presented in next Table 4.13.

Table 4.13 Pairwise matrix of Environmental indicator category

EI	E-1	E-2	E-3	E-4	E-5	E-6
E-1	1	3.23	3.18	2.98	2.11	2.97
E-2	0.3096	1	2.91	0.4082	1.71	2.34
E-3	0.3145	0.3436	1	0.2646	1.12	0.3115
E-4	0.3356	2.4498	3.7793	1	2.42	2.31
E-5	0.4739	0.5848	0.8929	0.4132	1	1
E-6	0.3367	0.4274	3.2103	0.4329	1	1
Sum	**2.7703**	**8.0356**	**14.9724**	**5.4989**	**9.36**	**9.9315**

Normalization /Driving Criteria Weight)

The normalization techniques were calculated by two steps for the environmental indicator category and presented in Table 4.14. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

Table 4.14 Normalization of Environmental indicator category

EI	E-1	E-2	E-3	E-4	E-5	E-6	SUM	CW	CW
E-1	0.3610	0.4020	0.2124	0.5419	0.2254	0.2990	2.0417	0.3403	34.03%
E-2	0.1118	0.1244	0.1944	0.0742	0.1827	0.2356	0.9231	0.1539	15.39%
E-3	0.1135	0.0428	0.0668	0.0481	0.1197	0.0314	0.4222	0.0704	7.04%
E-4	0.1211	0.3049	0.2524	0.1819	0.2585	0.2326	1.3514	0.2252	22.52%
E-5	0.1711	0.0728	0.0596	0.0751	0.1068	0.1007	0.5862	0.0977	9.77%
E-6	0.1215	0.0532	0.2144	0.0787	0.1068	0.1007	0.6754	0.1126	11.26%
							Sum	**1**	**100.00%**

Consistency Checking

For the environmental indicator category, WSV, and WSV/CW were calculated and presented in the next Table 4.15

Table 4.15 Calculation of WSV, and WSV/CW for Environmental indicator category

EI	E-1	E-2	E-3	E-4	E-5	E-6	WSV	CW	WSV/CW
E-1	0.3403	0.4969	0.2238	0.6712	0.2061	0.3343	2.2726	0.3403	6.6786
E-2	0.1054	0.1539	0.2048	0.0919	0.1671	0.2634	0.9864	0.1539	6.4113
E-3	0.1070	0.0529	0.0704	0.0596	0.1094	0.0351	0.4343	0.0704	6.1722
E-4	0.1142	0.3769	0.2659	0.2252	0.2364	0.2600	1.4787	0.2252	6.5652
E-5	0.1613	0.0900	0.0628	0.0931	0.0977	0.1126	0.6174	0.0977	6.3198
E-6	0.1146	0.0657	0.2259	0.0975	0.0977	0.1126	0.7140	0.1126	6.3429
							Sum	**1**	**38.4899**

Consistency index (CI) and Consistency ratio (CR) computation for environmental Indicator category

Number of the indicators/items (n) = 6

Random inconsistency index (RI) for n=6 is 1.25

λmax = average value of WSV/CW = $38.4899/6 = 6.4150$

Consistency Index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{6.4150-6}{6-1} = 0.0830$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.0830}{1.25}\right) = 0.0644$$

CR = 0.0644≤ 0.1, For this category matrix, the CR value is 0.0644, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent. With an index below the recommended (CR ≤ 0.1), the validity of the selected criteria is confirmed.

IV. Technical Indicators Category

Pairwise Matrix of Technical Indicators

The filled comparison pairwise matrix of technical indicators category presented in next Table 4.16.

Table 4.16 Pairwise matrix of technical indicator category

TI	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
TI-1	1	3.42	2.18	4.89	1.52	0.8333
TI-2	0.2924	1	0.3135	2.34	0.3012	0.2915
TI-3	0.4587	3.19	1	3.65	1.25	0.6289
TI-4	0.2045	0.4274	0.2740	1	0.2193	0.2375
TI-5	0.6579	3.32	0.8	4.56	1	0.4292
TI-6	1.2	3.43	1.59	4.21	2.33	1
Sum	**3.8135**	**14.7874**	**6.1575**	**20.6500**	**6.6205**	**3.4205**

Normalization/Driving Criteria Weight

The normalization techniques were calculated by two steps for the technical indicator category and presented in Table 4.17. First, sum up all each column value, then divide each criteria value to total value of column. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and Criteria weight in percent (CW in %).

Table 4.17 Normalization of technical indicator category

TI	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6	Sum	CW	CW(%)
TI-1	0.2622	0.2313	0.3540	0.2368	0.2296	0.2436	1.5576	0.2596	25.96%
TI-2	0.0767	0.0676	0.0509	0.1133	0.0455	0.0852	0.4393	0.0732	7.32%
TI-3	0.1203	0.2157	0.1624	0.1768	0.1888	0.1839	1.0478	0.1746	17.46%
TI-4	0.0536	0.0289	0.0445	0.0484	0.0331	0.0694	0.2780	0.0463	4.63%
TI-5	0.1725	0.2245	0.1299	0.2208	0.1510	0.1255	1.0243	0.1707	17.07%
TI-6	0.3147	0.2320	0.2582	0.2039	0.3519	0.2924	1.6530	0.2755	27.55%
							SUM	**1**	**100%**

Consistency Checking

For the financial indicator category, WSV, and WSV/CW were calculated and presented in the next Table 4.18.

Table 4.18 Calculation of WSV, and WSV/CW for technical indicator category

TI	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6	WSV	CW	WSV/CW
TI-1	0.2596	0.2504	0.3807	0.2266	0.2595	0.2296	1.6063	0.2596	6.1879
TI-2	0.0759	0.0732	0.0547	0.1084	0.0514	0.0803	0.4440	0.0732	6.0652
TI-3	0.1191	0.2335	0.1746	0.1691	0.2134	0.1733	1.0831	0.1746	6.2016
TI-4	0.0531	0.0313	0.0478	0.0463	0.0374	0.0654	0.2814	0.0463	6.0738
TI-5	0.1708	0.2431	0.1397	0.2113	0.1707	0.1182	1.0538	0.1707	6.1728
TI-6	0.3115	0.2511	0.2777	0.1951	0.3978	0.2755	1.7086	0.2755	6.2019
							Sum	**1**	**36.9032**

Consistency index (CI) and Consistency ratio (CR) computation for Technical indicator category

Number of the indicators/items (n) = 6

Random inconsistency index (RI) for n=6 is 1.25

λmax = average value of WSV/CW = $36.9032/6$ = 6.1505

Consistency index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{6.1505-6}{6-1} = 0.0301$$

Consistency ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.0301}{1.25}\right) = 0.0241$$

CR = 0.0241 ≤ 0.1, ≈ consistent,

Table 4.19 Consistency verification results of technical indicators category

Maximum Eigen value	CI value	RI value	CR value	Consistency result
11.6	0.0301	1.25	0.0241	Pass/consistent

For this category matrix, the CR value is 0.0241, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent. With an index below the recommended (CR ≤ 0.1), the validity of the selected criteria is confirmed.

V. Human Management Indicators

Pairwise Matrix of Human Management Indicators

The filled comparison pairwise matrix of human resources management indicators category presented in next Table 4.20.

Table 4.20 Pairwise matrix of human resource management indicator category

HMI	HM-1	HM-2	HM-3	HM-4	HM-5	HM-6
HM-1	1	3.2	1.69	1.44	1.87	0.2375
HM-2	0.3125	1	0.85	3.01	1.23	0.2174
HM-3	0.5917	1.1765	1	3.23	2.7	0.4717
HM-4	0.6944	0.3322	0.3096	1	2.88	0.3205
HM-5	0.5348	0.8130	0.3704	0.3472	1	0.2304
HM-6	4.21	4.6	2.12	3.12	4.34	1
Sum	**7.3434**	**11.1217**	**6.3400**	**12.1472**	**14.0200**	**2.4775**

Normalization/Driving Criteria Weight

The normalization techniques were calculated by two steps for the human resource management indicator category and presented in Table 4.21. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

Table 4.21 Normalization of human resource management indicators category

HMI	HM-1	HM-2	HM-3	HM-4	HM-5	HM-6	SUM	CW	CW(%)
HM-1	0.1362	0.2877	0.2666	0.1185	0.1334	0.0959	1.0383	0.1730	17.3%
HM-2	0.0426	0.0899	0.1341	0.2478	0.0877	0.0877	0.6898	0.1150	11.5%
HM-3	0.0806	0.1058	0.1577	0.2659	0.1926	0.1904	0.9930	0.1655	16.55%
HM-4	0.0946	0.0299	0.0488	0.0823	0.2054	0.1294	0.5904	0.0984	9.84%
HM-5	0.0728	0.0731	0.0584	0.0286	0.0713	0.0930	0.3973	0.0662	6.62%
HM-6	0.5733	0.4136	0.3344	0.2568	0.3096	0.4036	2.2913	0.3819	38.19%
							Sum	**1**	**100%**

Consistency Checking

For the human management indicator category, WSV, and WSV/CW were calculated and presented in the next Table 4.22.

Table 4.22 Calculation of WSV, and WSV/SW for human management indicator category

HFI	HF-1	HF-2	HF-3	HF-4	HF-5	HF-6	WSV	CW	WSV/CW
HF-1	0.1730	0.3679	0.2797	0.1417	0.1238	0.0907	1.1768	0.1730	6.8008
HF-2	0.0541	0.1150	0.1407	0.2962	0.0814	0.0830	0.7703	0.1150	6.7005
HF-3	0.1024	0.1353	0.1655	0.3178	0.1788	0.1801	1.0799	0.1655	6.5251
HF-4	0.1202	0.0382	0.0512	0.0984	0.1907	0.1224	0.6211	0.0984	6.3120
HF-5	0.0925	0.0935	0.0613	0.0342	0.0662	0.0880	0.4357	0.0662	6.5802
HF-6	0.7285	0.5289	0.3508	0.3070	0.2873	0.3819	2.5844	0.3819	6.7676
							Sum	**1**	**39.6862**

Consistency index (CI) and Consistency ratio (CR) computation for human resource management indicator category

Number of the indicators/items (n) = 6

Random inconsistency index (RI) for n=6 is 1.25

λmax = average value of WSV/CW = $39.6862/6 = 6.6144$

Consistency Index (Ci)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{6.6144-6}{6-1} = 0.1229$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.1229}{1.25}\right) = 0.0983$$

$CR = 0.0983 \leq 0.1$

For this category matrix, the CR value is 0.0983, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent.

VI. Functional Indicators Category

Pairwise Matrix of Functional Indicators

The mean value of the respondents answers for functional category were set for AHP analysis and presented in Table 4.23

Normalization (Driving Criteria Weight) and Computation of WSV, WSV/CR

The normalization techniques were calculated by two steps for the environmental indicator category and presented in Table 4.24. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

In addition, Weighted sum value (WSV) was calculated form multiplying criteria weight of the column with non-normalized value of each value of the column. WSV/CW also calculated form dividing WSV (weighted sum value) to CW (criteria weight) and presented in table 4.25.

Consistency index (CI) and Consistency ratio (CR) computation for functional Indicator category

Number of the indicators/items (n) = 14

Random inconsistency index (RI) for n=14 is 1.58

λmax = average value of WSV/CW = $204.8184/14 = 14.6299$

Consistency Index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{14.6299-14}{14-1} = 0.04845$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.04845}{1.58}\right) = 0.03067$$

$CR = 0.03067 \leq 0.1$

For this category matrix, the CR value is 0.03067, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent. With an index below the recommended ($CR \leq 0.1$), the validity of the selected criteria is confirmed.

Table 4.23 Pairwise matrix of functional indicator category

FUI	FU-1	FU-2	FU-3	FU-4	FU-5	FU-6	FU-7	FU-8	FU-9	FU-10	FU-11	FU-12	FU-13	FU-14
FU-1	1	0.4	3.64	0.3311	0.2809	0.7463	1.78	1.08	3.39	0.4049	2.31	2.44	3.78	3.43
FU-2	2.5	1	4.38	0.7299	0.3336	1.5300	2.51	2.35	4.03	1.2900	3.04	3.23	4.04	3.89
FU-3	0.2747	0.2283	1	0.2370	0.2101	0.2681	0.4049	0.34483	1.34	0.2571	0.7407	0.9174	2.18	1.79
FU-4	3.02	1.37	4.22	1	0.5291	2.48	2.89	2.56	4.45	2.1900	2.93	3.04	4.33	4.28
FU-5	3.56	2.998	4.76	1.89	1	2.73	2.94	2.85	4.78	2.4400	3.02	3.41	4.65	4.51
FU-6	1.34	0.6536	3.73	0.4032	0.3663	1	2.19	0.8130	3.57	0.7634	2.78	2.21	3.47	3.22
FU-7	0.5618	0.3984	2.47	0.3460	0.3401	0.4566	1	0.4630	2.69	0.3906	2.26	2.28	3.29	3.11
FU-8	0.9259	0.4255	2.9	0.3906	0.3509	1.2300	2.1600	1	2.83	0.3984	2.29	2.33	3.42	3.28
FU-9	0.2950	0.2481	0.7463	0.2247	0.2092	0.2801	0.3717	0.3534	1	0.2597	0.5155	0.5988	1.28	0.6329
FU-10	2.4700	0.7752	3.89	0.4566	0.4098	1.3100	2.5600	2.5100	3.8500	1	2.17	2.26	3.51	3.63
FU-11	0.4329	0.3289	1.35	0.3413	0.3311	0.3597	0.4425	0.4367	1.9400	0.4608	1	2.16	3.09	2.69
FU-12	0.4098	0.3096	1.09	0.3289	0.2933	0.4525	0.4386	0.4292	1.6700	0.4425	0.4630	1	2.38	2.34
FU-13	0.2646	0.2475	0.4587	0.2309	0.2151	0.2882	0.3040	0.2924	0.7813	0.2849	0.3236	0.4202	1	0.5291
FU-14	0.2915	0.2571	0.5587	0.2336	0.2217	0.3106	0.3215	0.3049	1.5800	0.2755	0.3717	0.4274	1.89	1
SUM	**17.3463**	**9.6403**	**35.1936**	**7.1441**	**5.0912**	**13.4420**	**20.3132**	**15.7873**	**37.9013**	**10.8577**	**24.2145**	**26.7238**	**42.31**	**38.3320**

Table 4.24 Normalization of functional indicator category

FUI	FU-1	FU-2	FU-3	FU-4	FU-5	FU-6	FU-7	FU-8	FU-9	FU-10	FU-11	FU-12	FU-13	FU-14	SUM	CW
FU-1	0.0576	0.0415	0.1034	0.0463	0.0552	0.0555	0.0876	0.0684	0.0894	0.0373	0.0954	0.0913	0.0893	0.0895	1.0079	0.0720
FU-2	0.1441	0.1037	0.1245	0.1022	0.0655	0.1138	0.1236	0.1489	0.1063	0.1188	0.1255	0.1209	0.0955	0.1015	1.5948	0.1139
FU-3	0.0158	0.0237	0.0284	0.0332	0.0413	0.0199	0.0199	0.0218	0.0354	0.0237	0.0306	0.0343	0.0515	0.0467	0.4263	0.0304
FU-4	0.1741	0.1421	0.1199	0.1400	0.1039	0.1845	0.1423	0.1622	0.1174	0.2017	0.1210	0.1138	0.1023	0.1117	1.9368	0.1383
FU-5	0.2052	0.3110	0.1353	0.2646	0.1964	0.2031	0.1447	0.1805	0.1261	0.2247	0.1247	0.1276	0.1099	0.1177	2.4715	0.1765
FU-6	0.0773	0.0678	0.1060	0.0564	0.0719	0.0744	0.1078	0.0515	0.0942	0.0703	0.1148	0.0827	0.0820	0.0840	1.1411	0.0815
FU-7	0.0324	0.0413	0.0702	0.0484	0.0668	0.0340	0.0492	0.0293	0.0710	0.0360	0.0933	0.0853	0.0778	0.0811	0.8162	0.0583
FU-8	0.0534	0.0441	0.0824	0.0547	0.0689	0.0915	0.1063	0.0633	0.0747	0.0367	0.0946	0.0872	0.0808	0.0856	1.0242	0.0732
FU-9	0.0170	0.0257	0.0212	0.0315	0.0411	0.0208	0.0183	0.0224	0.0264	0.0239	0.0213	0.0224	0.0303	0.0165	0.3388	0.0242
FU-10	0.1424	0.0804	0.1105	0.0639	0.0805	0.0975	0.1260	0.1590	0.1016	0.0921	0.0896	0.0846	0.0830	0.0947	1.4057	0.1004
FU-11	0.0250	0.0341	0.0384	0.0478	0.0650	0.0268	0.0218	0.0277	0.0512	0.0424	0.0413	0.0808	0.0730	0.0702	0.6454	0.0461
FU-12	0.0236	0.0321	0.0310	0.0460	0.0576	0.0337	0.0216	0.0272	0.0441	0.0408	0.0191	0.0374	0.0563	0.0610	0.5314	0.0380
FU-13	0.0153	0.0257	0.0130	0.0323	0.0422	0.0214	0.0150	0.0185	0.0206	0.0262	0.0134	0.0157	0.0236	0.0138	0.2968	0.0212
FU-14	0.0168	0.0267	0.0159	0.0327	0.0436	0.0231	0.0158	0.0193	0.0417	0.0254	0.0154	0.0160	0.0447	0.0261	0.3630	0.0259
															Sum	**1**

Table 4.25 Calculation of WSV, and WSV/CW for functional indicator category

FUI	FU-1	FU-2	FU-3	FU-4	FU-5	FU-6	FU-7	FU-8	FU-9	FU-10	FU-11	FU-12	FU-13	FU-14	WSV	CW	WSV/CW
FU-1	0.0720	0.0456	0.1108	0.0458	0.0496	0.0608	0.1038	0.0790	0.0820	0.0407	0.1065	0.0926	0.0801	0.0889	1.0583	0.0720	14.6997
FU-2	0.1800	0.1139	0.1334	0.1010	0.0589	0.1247	0.1463	0.1719	0.0975	0.1295	0.1401	0.1226	0.0857	0.1009	1.7064	0.1139	14.9802
FU-3	0.0198	0.0260	0.0304	0.0328	0.0371	0.0219	0.0236	0.0252	0.0324	0.0258	0.0341	0.0348	0.0462	0.0464	0.4366	0.0304	14.3407
FU-4	0.2174	0.1561	0.1285	0.1383	0.0934	0.2021	0.1685	0.1873	0.1077	0.2199	0.1351	0.1154	0.0918	0.1110	2.0725	0.1383	14.9806
FU-5	0.2563	0.3415	0.1449	0.2615	0.1765	0.2225	0.1714	0.2085	0.1157	0.2450	0.1392	0.1294	0.0986	0.1169	2.6280	0.1765	14.8866
FU-6	0.0965	0.0745	0.1136	0.0558	0.0647	0.0815	0.1277	0.0595	0.0864	0.0766	0.1282	0.0839	0.0736	0.0835	1.2058	0.0815	14.7927
FU-7	0.0404	0.0454	0.0752	0.0479	0.0600	0.0372	0.0583	0.0339	0.0651	0.0392	0.1042	0.0866	0.0698	0.0806	0.8438	0.0583	14.4739
FU-8	0.0667	0.0485	0.0883	0.0540	0.0619	0.1003	0.1259	0.0732	0.0685	0.0400	0.1056	0.0884	0.0725	0.0850	1.0788	0.0732	14.7463
FU-9	0.0212	0.0283	0.0227	0.0311	0.0369	0.0228	0.0217	0.0259	0.0242	0.0261	0.0238	0.0227	0.0271	0.0164	0.3509	0.0242	14.5017
FU-10	0.1778	0.0883	0.1184	0.0632	0.0724	0.1068	0.1492	0.1836	0.0932	0.1004	0.1000	0.0858	0.0744	0.0941	1.5077	0.1004	15.0152
FU-11	0.0312	0.0375	0.0411	0.0472	0.0585	0.0293	0.0258	0.0319	0.0469	0.0463	0.0461	0.0820	0.0655	0.0697	0.6591	0.0461	14.2958
FU-12	0.0295	0.0353	0.0332	0.0455	0.0518	0.0369	0.0256	0.0314	0.0404	0.0444	0.0213	0.0380	0.0505	0.0607	0.5444	0.0380	14.3403
FU-13	0.0190	0.0282	0.0140	0.0320	0.0380	0.0235	0.0177	0.0214	0.0189	0.0286	0.0149	0.0159	0.0212	0.0137	0.3070	0.0212	14.4809
FU-14	0.0210	0.0293	0.0170	0.0323	0.0391	0.0253	0.0187	0.0223	0.0382	0.0277	0.0171	0.0162	0.0401	0.0259	0.3704	0.0259	14.2838
															Sum	**1**	**204.8184**

VII. Performance Based Indicators Category

Pairwise Matrix of Performance Based Indicators Category

The filled comparison pairwise matrix of performance based indicators category presented in next Table 4.26.

Table 4.26 Pairwise matrix of performance based indicator category

PBI	PB-1	PB-2	PB-3	PB-4	PB-5	PB-6	PB-7
PB-1	1	2.12	1.33	1.27	1.11	4.14	2.39
PB-2	0.4717	1	1.09	1.02	0.8264	3.93	1.97
PB-3	0.7519	0.9174	1	1	1	3.89	2.29
PB-4	0.7874	0.9804	1	1	1	3.92	1.19
PB-5	0.9009	1.21	1	1	1	4.03	2.48
PB-6	0.2415	0.2545	0.2571	0.2551	0.2481	1	0.3745
PB-7	0.4184	0.5076	0.4367	0.8403	0.4032	2.67	1
sum	4.5718	6.9899	6.1138	6.3854	5.5878	23.58	11.6945

Normalization/Driving Criteria Weight)

The normalization techniques were calculated by two steps for the performance based indicator category and presented in Table 4.27. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

Table 4.27 Normalization of performance based indicator category

PBI	PB-1	PB-2	PB-3	PB-4	PB-5	PB-6	P B-7	SUM	CW	CW(%)
PB-1	0.2187	0.3033	0.2175	0.1989	0.1986	0.1756	0.2044	1.5170	0.2167	21.67%
PB-2	0.1032	0.1431	0.1783	0.1597	0.1479	0.1667	0.1685	1.0673	0.1525	15.25%
PB-3	0.1645	0.1313	0.1636	0.1566	0.1790	0.1650	0.1958	1.1556	0.1651	16.51%
PB-4	0.1722	0.1403	0.1636	0.1566	0.1790	0.1662	0.1018	1.0796	0.1542	15.42%
PB-5	0.1971	0.1731	0.1636	0.1566	0.1790	0.1709	0.2121	1.2523	0.1789	17.89%
PB-6	0.0528	0.0364	0.0420	0.0400	0.0444	0.0424	0.0320	0.2901	0.0414	4.14%
PB-7	0.0915	0.0726	0.0714	0.1316	0.0722	0.1132	0.0855	0.6381	0.0912	9.12%
								Sum	**1**	**100.00%**

Consistency Checking

For the performance based indicator category, WSV, and WSV/CW were calculated and presented in the next Table 4.28.

Table 4.28 Calculation of WSV, and WSV/CW for performance based indicator category

PBI	PB-1	PB-2	PB-3	PB-4	PB-5	PB-6	PB-7	WSV	CW	WSV/CW
PB-1	0.2167	0.3232	0.2196	0.1959	0.1986	0.1716	0.2179	1.5434	0.2167	7.1216
PB-2	0.1022	0.1525	0.1799	0.1573	0.1478	0.1629	0.1796	1.0822	0.1525	7.0981
PB-3	0.1629	0.1399	0.1651	0.1542	0.1789	0.1612	0.2087	1.1710	0.1651	7.0930
PB-4	0.1706	0.1495	0.1651	0.1542	0.1789	0.1624	0.1085	1.0893	0.1542	7.0625
PB-5	0.1952	0.1845	0.1651	0.1542	0.1789	0.1670	0.2261	1.2710	0.1789	7.1048
PB-6	0.0523	0.0388	0.0424	0.0393	0.0444	0.0414	0.0341	0.2929	0.0414	7.0681
PB-7	0.0907	0.0774	0.0721	0.1296	0.0721	0.1106	0.0912	0.6437	0.0912	7.0618
								Sum	**1**	**49.6098**

Consistency index (CI) and Consistency ratio (CR) computation for performance based indicator category

Number of the indicators/items (n) = 7

Random inconsistency index (RI) for n = 7 is 1.35

λmax = average value of WSV/CW = $49.6098/7 = 7.0871$

Consistency Index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{7.0871-7}{7-1} = 0.0145$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.0145}{1.35}\right) = 0.0108$$

CR = 0.0108 ≤ 0.1,

For this category matrix, the CR value is 0.0108, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent. With an index below the recommended (CR ≤ 0.1), the validity of the selected criteria is confirmed.

VIII. Socio-Cultural Indicators Category

Pairwise Matrix of Socio-Cultural Indicators Category

The filled comparison pairwise matrix of socio-cultural indicators category presented in next Table 4.29

Table 4.29 Pairwise matrix of socio-cultural indicator category

SCI	SC -1	SC- 2	SC- 3	SC- 4	SC- 5	SC- 6	SB- 7	SC- 8
SC -1	1	1	0.4525	0.2681	4.12	0.4292	2.67	2.82
SC- 2	1	1	0.3413	0.3460	4.51	0.3185	2.81	3.19
SC- 3	2.21	2.93	1	0.5682	2.74	0.6897	2.93	3.39
SC- 4	3.73	2.89	1.76	1	4.13	1.12	4.45	4.67
SC- 5	0.2427	0.2217	0.3650	0.2421	1	0.2545	0.7634	0.6711
SC- 6	2.33	3.14	1.45	0.8929	3.93	1	3.16	4.21
SB- 7	0.3745	0.3559	0.3413	0.2247	1.31	0.3165	1	1
SC- 8	0.3546	0.3135	0.2950	0.2141	1.49	0.2375	1	1
Sum	**11.2419**	**11.8511**	**6.0050**	**3.7561**	**23.23**	**4.3657**	**18.7834**	**20.9511**

Normalization (Driving Criteria Weight) and WSV, WS/CW of Socio-Cultural Category

The normalization techniques were calculated by two steps for the socio-cultural indicator category and presented in Table 4.31. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

For instance, the normalization of the SC-1, is followed the following steps:

Un normalized pairwise value divided to sum value of the column, i.e. 1/11.2419=0.089,

Likewise, for the other indicators also computed. According to this, 0.0844, 0.0754, 0.0714, 0.1774, 0.0983, 0.1421, 0.1346 in normalized value of the SC- 2, SC- 3, SC- 4, SC- 5, SC- 6, SB- 7 and SC- 8 respectively.

Then, the sum of the all normalized value of the rows computed.

Sum = 0.0890 +0.0844+0.0754+0.0714+0.1774+0.0983+0.1421+0.1346 = 0.8725

After this, criteria weight was calculated from, dividing the sum to the number of the items/indicator = 0.8725/8 = 0.1091. with the same the procedure, the other's criteria weight was computed.

The next step after normalization of the indicators, is consistency checking. To check the consistency of the socio – cultural category indicators, computation table of weighted sum value, weighted sum value/criteria weight and sum of weighted sum value/criteria weight presented in Table 4.32 next to normalization Table 4.31 of this category.

Consistency Index (CI) and Consistency Ratio (CR) computation for socio-cultural indicator category

Number of the indicators/items (n) = 8

Random inconsistency index (RI) for n=6 is 1.4

λmax = average value of WSV/CW = $66.5282/8 = 8.3160$

Consistency Index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{8.3160-8}{8-1} = 0.0451$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.0451}{1.4}\right) = 0.0322$$

CR = 0.0322≤ 0.1, Consistent and reliable

Table 4.30 Consistency verification results of socio-cultural indicators category

Maximum Eigen value	CI value	RI value	CR value	Consistency result
12.06	0.0451	1.4	0.0322	Pass/consistent

For this category matrix, the CR value is 0.0322, and it is less than 0.1, the matrix is regarded consistent, and the judgments are considered reliable and consistent. With an index below the recommended (CR ≤ 0.1), the validity of the selected criteria is confirmed.

Table 4.31 Normalization of Socio-Cultural indicator category

SCI	SC -1	SC- 2	SC- 3	SC- 4	SC- 5	SC- 6	SB- 7	SC- 8	SUM	CW	CW (%)
SC -1	0.0890	0.0844	0.0754	0.0714	0.1774	0.0983	0.1421	0.1346	0.8725	0.1091	10.91%
SC- 2	0.0890	0.0844	0.0568	0.0921	0.1941	0.0729	0.1496	0.1523	0.8912	0.1114	11.14%
SC- 3	0.1966	0.2472	0.1665	0.1513	0.1180	0.1580	0.1560	0.1618	1.3553	0.1694	16.9%
SC- 4	0.3318	0.2439	0.2931	0.2662	0.1778	0.2565	0.2369	0.2229	2.0291	0.2536	25.4%
SC- 5	0.0216	0.0187	0.0608	0.0645	0.0430	0.0583	0.0406	0.0320	0.3395	0.0424	4.24%
SC- 6	0.2073	0.2650	0.2415	0.2377	0.1692	0.2291	0.1682	0.2009	1.7188	0.2148	21.5%
SB- 7	0.0333	0.0300	0.0568	0.0598	0.0564	0.0725	0.0532	0.0477	0.4099	0.0512	5.12%
SC- 8	0.0315	0.0265	0.0491	0.0570	0.0641	0.0544	0.0532	0.0477	0.3836	0.0480	4.80%
									Sum	**1**	**100%**

Table 4.32 Calculation of WSV, and WSV/CW for Socio-cultural indicator category

SCI	SC -1	SC- 2	SC- 3	SC- 4	SC- 5	SC- 6	SC- 7	SC- 8	WSV	CW	WSV/CW
SC -1	0.1091	0.1114	0.0767	0.0680	0.1749	0.0922	0.1368	0.1352	0.9042	0.1091	8.2911
SC- 2	0.1091	0.1114	0.0578	0.0878	0.1914	0.0684	0.1440	0.1530	0.9228	0.1114	8.2835
SC- 3	0.2410	0.3264	0.1694	0.1441	0.1163	0.1482	0.1501	0.1626	1.4581	0.1694	8.6067
SC- 4	0.4068	0.3220	0.2982	0.2536	0.1753	0.2406	0.2280	0.2240	2.1484	0.2536	8.4704
SC- 5	0.0265	0.0247	0.0618	0.0614	0.0424	0.0547	0.0391	0.0322	0.3428	0.0424	8.0772
SC- 6	0.2541	0.3498	0.2457	0.2265	0.1668	0.2148	0.1619	0.2019	1.8215	0.2148	8.4779
SC- 7	0.0408	0.0396	0.0578	0.0570	0.0556	0.0680	0.0512	0.0480	0.4181	0.0512	8.1607
SC- 8	0.0387	0.0349	0.0500	0.0543	0.0632	0.0510	0.0512	0.0480	0.3913	0.0480	8.1606
									Sum	**1**	**66.5282**

IX. Learning and Management Indicators Category

Pairwise Matrix of Learning and Management Indicators Category

Likewise, other categories the average mean value of the respondent's comparison were set in to comparison pairwise matrix of performance based indicators category and presented in next table 4.33.

Normalization/Driving Criteria Weight

The normalization techniques were calculated by two steps for the learning and management indicator category and presented in Table 4.34. Each pairwise value divided to sum of column to normalize. The normalized pairwise comparison was created as consequence, sum, criteria weight (CW), and criteria weight in percent (CW in %).

Consistency Checking

the inputs for consistency checking of learning and management indicator category, WSV, and WSV/CW were calculated and presented in the next Table 4.35. Weighted sum value (WSV) and WSV/CW were calculated like others category computations.

Consistency Index (CI) and Consistency Ratio (CR) computation for learning and management indicator category

Number of the indicators/items (n) = 10

Random inconsistency index (RI) for n=7 is 1.49

λmax = average value of WSV/CW = $108.2527/10$ = 10.8253

Consistency Index (CI)

$$CI=\frac{(\lambda max-n)}{n-1} = \frac{10.8253-10}{10-1} = 0.0917$$

Consistency Ratio (CR)

$$CR = \left(\frac{CI}{RI}\right) = \left(\frac{0.0917}{1.49}\right) = 0.062$$

CR = 0.062 ≤ 0.1, consistent and reliable.

After checking all categories' consistency, the value of the Eigen value of each category, criteria weight of the sub criteria, rank from category and overall rank presented in Table 4. 36 to summarize the overall result of the AHP analysis .

Table 4.33 Pairwise matrix of learning and management indicator category

LMI	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	LM-8	LM-9	LM-10
LM-1	1	1.29	1.03	1	2.11	1.38	0.2571	0.4608	3.78	4.79
LM-2	0.7752	1	0.2770	0.3425	0.2967	0.87	0.2336	0.4237	1.12	3.17
LM-3	0.9709	3.61	1	1.07	1.26	3.14	0.2809	0.4785	3.43	4.38
LM-4	1.0000	2.92	0.9346	1	1.01	1.84	0.2717	0.4425	3.56	2.47
LM-5	0.4739	3.37	0.7937	0.9901	1	2.26	0.2488	0.4329	3.33	2.36
LM-6	0.7246	1.15	0.3185	0.5435	0.4425	1	0.2432	0.5988	3.18	4.63
LM-7	3.8900	4.28	3.56	3.68	4.02	4.111	1	3.87	4.54	4.93
LM-8	2.1700	2.36	2.09	2.26	2.31	1.67	0.2584	1	1.45	2.76
LM-9	0.2646	0.8929	0.2915	0.2809	0.3003	0.3145	0.2203	0.6897	1	2.42
LM-10	0.2088	0.3155	0.2283	0.4049	0.4237	0.2160	0.2028	0.3623	0.4132	1
Sum	11.4780	21.1883	10.5236	11.5718	13.1732	16.8010	3.2169	8.7592	25.8032	32.9100

Table 4.34 Normalization of learning and management indicator category

LMI	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	LM-8	LM-9	LM-10	Sum	CW	CW(%)
LM-1	0.0871	0.0609	0.0979	0.0864	0.1602	0.0821	0.0799	0.0526	0.1465	0.1455	0.9992	0.0999	9.99%
LM-2	0.0675	0.0472	0.0263	0.0296	0.0225	0.0518	0.0726	0.0484	0.0434	0.0963	0.5057	0.0506	5.06%
LM-3	0.0846	0.1704	0.0950	0.0925	0.0956	0.1869	0.0873	0.0546	0.1329	0.1331	1.1330	0.1133	11.33%
LM-4	0.0871	0.1378	0.0888	0.0864	0.0767	0.1095	0.0845	0.0505	0.1380	0.0751	0.9344	0.0934	9.34%
LM-5	0.0413	0.1590	0.0754	0.0856	0.0759	0.1345	0.0773	0.0494	0.1291	0.0717	0.8993	0.0899	8.99%
LM-6	0.0631	0.0543	0.0303	0.0470	0.0336	0.0595	0.0756	0.0684	0.1232	0.1407	0.6957	0.0696	6.96%
LM-7	0.3389	0.2020	0.3383	0.3180	0.3052	0.2447	0.3109	0.4418	0.1759	0.1498	2.8255	0.2825	28.25%
LM-8	0.1891	0.1114	0.1986	0.1953	0.1754	0.0994	0.0803	0.1142	0.0562	0.0839	1.3037	0.1304	13.04%
LM-9	0.0230	0.0421	0.0277	0.0243	0.0228	0.0187	0.0685	0.0787	0.0388	0.0735	0.4182	0.0418	4.18%
LM-10	0.0182	0.0149	0.0217	0.0350	0.0322	0.0129	0.0631	0.0414	0.0160	0.0304	0.2856	0.0286	2.86%
											Sum	1.0000	100%

Table 4.35 Calculation of WSV, and WSV/CW for learning and indicator category

LMI	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	LM-8	LM-9	LM-10	WSV	CW	WSV/CW
LM-1	0.0999	0.0652	0.1167	0.0934	0.1897	0.0960	0.0726	0.0601	0.1581	0.1368	1.0886	0.0999	10.8951
LM-2	0.0775	0.0506	0.0314	0.0320	0.0267	0.0605	0.0660	0.0552	0.0468	0.0905	0.5372	0.0506	10.6237
LM-3	0.0970	0.1825	0.1133	0.1000	0.1133	0.2184	0.0794	0.0624	0.1434	0.1251	1.2348	0.1133	10.8992
LM-4	0.0999	0.1477	0.1059	0.0934	0.0908	0.1280	0.0768	0.0577	0.1489	0.0705	1.0196	0.0934	10.9123
LM-5	0.0474	0.1704	0.0899	0.0925	0.0899	0.1572	0.0703	0.0564	0.1393	0.0674	0.9807	0.0899	10.9057
LM-6	0.0724	0.0582	0.0361	0.0508	0.0398	0.0696	0.0687	0.0781	0.1330	0.1322	0.7388	0.0696	10.6199
LM-7	0.3887	0.2164	0.4033	0.3438	0.3615	0.2860	0.2825	0.5045	0.1899	0.1408	3.1175	0.2825	11.0334
LM-8	0.2168	0.1193	0.2368	0.2112	0.2077	0.1162	0.0730	0.1304	0.0606	0.0788	1.4509	0.1304	11.1292
LM-9	0.0264	0.0451	0.0330	0.0262	0.0270	0.0219	0.0622	0.0899	0.0418	0.0691	0.4428	0.0418	10.5892
LM-10	0.0209	0.0160	0.0259	0.0378	0.0381	0.0150	0.0573	0.0472	0.0173	0.0286	0.3040	0.0286	10.6450
											Sum	1	108.2527

Table 4.36 Over all result of the AHP analysis

Facility Management Assessment Tool		FMAT	CW(%)	Rank by category	Overall rank
S.no	Financial indicator	FI(23.05%)			
1	Operating cost	FI-1	21.74%	1	8
2	Occupancy cost	FI-2	12.51%	3	25
3	Utility cost	FI-3	9.59%	5	37
4	Building maintenance cost	FI-4	8.51%	6	41
5	Capital cost	FI-5	12.13%	4	26
6	Capital renewal cost	FI-6	16.37%	2	19
7	Facility condition survey cost	FI-7	4.13%	9	60
8	Custodial and janitorial cost	FI-8	4.62%	8	55
9	Financial management	FI-9	6.58%	7	49
10	Time value of money	FI-10	3.82%	10	61
S.no	Environmental aspect indicator	EI(7.06%)			
1	Energy efficiency	E-1	34.03%	1	2
2	Water consumption management	E-2	15.39%	3	21

3	Waste management	E-3	7.04%	6	46
4	Material management	E-4	22.52%	2	7
5	Environment impact assessment practice	E-5	9.77%	5	36
6	Ecological value	E-6	11.26%	4	30
S.no	Technical Indicator	TI(11.06%)			
1	Scheduled maintenance	TI-1	25.96%	2	5
2	Physical detection(if needed)	TI-2	7.32%	5	43
3	Repair, renovation and refurbishment	TI-3	17.46%	3	13
4	Measurement of building elements(if needed)	TI-4	4.63%	6	54
5	ICT application	TI-5	17.07%	4	15
6	Understanding Building design	TI-6	27.55%	1	4
S.no	Human management indicator	HMI(9.05%)			
1	Background of facility manager	HM-1	17.30%	2	14
2	Training for facility manager	HM-2	11.50%	4	27
3	Effective communication in organization	HM-3	16.55%	3	17
4	Cooperation with real supplier/contractors/facility specialist	HM-4	9.84%	5	35
5	Time management of facility manager	HM-5	6.62%	6	48

6	Leadership skill of top management	HM-6	38.19%	1	1
S.no	Functional indicators	FUI(18.41%)			
1	Building services like (drainage, piping, sanitary..)	FU-1	7.20%	7	45
2	Space utilization	FU-2	11.39%	3	28
3	Landscaping/ground shaping	FU-3	3.04%	11	63
4	Health (including safety, cleanliness)	FU-4	13.83%	2	23
5	Security, privacy and noise	FU-5	17.65%	1	12
6	Emergency preparedness (emergency exit, fire protection)	FU-6	8.15%	5	42
7	Heating, ventilation, lighting(i.e. artificial and natural light)	FU-7	5.83%	8	50
8	Mechanical and electrical services	FU-8	7.32%	6	44
9	Ancillary services (mail- housing)	FU-9	2.42%	13	66
10	Furniture, fixtures and equipment	FU-10	10.04%	4	33
11	Accessibility for aged and disabled person	FU-11	4.61%	9	56
12	Signal and direction indicator(signs)	FU-12	3.80%	10	62
13	Recreational area	FU-13	2.12%	14	67
14	Transport accessibility and parking area	FU-14	2.59%	12	65

S.no	Performance based indicator	PBI(4.99%)			
1	Scope of monitory	PB-1	21.67%	1	9
2	Monitoring means and methods	PB-2	15.25%	5	22
3	Scheduled performance evaluation	PB-3	16.51%	3	18
4	Gap analysis on facility management	PB-4	15.42%	4	20
5	Corrective measure (proactive action)	PB-5	17.89%	2	11
6	Documentation of result	PB-6	4.14%	7	59
7	Continually improvement	PB-7	9.12%	6	39
S.no	Socio-cultural indicator	SCI(12.06%)			
1	Appearance or view out of building	SC -1	10.91%	5	32
2	Aesthetic value	SC- 2	11.14%	4	31
3	Feeling of equality (cultural aspect)	SC- 3	16.94%	3	16
4	Integration with urban	SC- 4	25.36%	1	6
5	Location of the building	SC- 5	4.24%	8	57
6	Customer satisfaction with facility services	SC- 6	21.48%	2	10
7	Customer complaint on facility services(record)	SB- 7	5.12%	6	51
8	Occupancy turn of rate	SC- 8	4.80%	7	53

S.no	Learning and management indicators	LMI(13.79%)			
1	Learning and management	LM-1	9.99%	4	34
2	Managing the change	LM-2	5.06%	8	52
3	Understanding facility management professional practices	LM-3	11.33%	3	29
4	Understanding organizational structure and strategy	LM-4	9.34%	5	38
5	Develop facility management strategy (plan) in line with Organization structure	LM-5	8.99%	6	40
6	Risk management (Assessment, control, mitigation and emergency preparedness)	LM-6	6.96%	7	47
7	Understanding Ethiopian facility related laws (formal and informal laws)	LM-7	28.25%	1	3
8	Good governance (no corruption)	LM-8	13.04%	2	24
9	Rate of the response by concerned body	LM-9	4.18%	9	58
10	Consultancy services	LM-10	2.86%	10	64

4.2.3 Discussion on Prioritization and Weighting of Facility Management Variables

After extracting 81 facility management indicators from the literature review, a content validity study was conducted by eight facility management professionals in nine categories. Two additional items were added by experts. Next to this, experts' comments and suggestions were taken into account for further AHP analysis. From content validity, 67 items in eight categories were summarized as the result of the content validity study after the second round of validation by experts.

In the next section, the result of the AHP analysis and discussion with relevant literature presented.

Financial Indicators Category

In this study, the proposed facility management assessment tool consists of eight categories. The category that emerged as the most important is financial or economic indicators, which received a criteria weight rate of 23.05% and ranked first according to professional comparisons. Within this particular category, operating cost, capital renewal cost, and occupancy cost obtained rankings from one to three, with corresponding criteria weights of 21.72%, 16.37%, and 12.51%. This shows how financial issues are significant for the prevalence of effective facility management in public office buildings. The researcher also confirms this result. Other studies also support the significance of financial indicators in facility management. One aspect of facility management is sustainability, which holds great importance. In terms of sustainability, economic factors obtained the highest rank with a weighted rate of 41.82% in facility management, as stated in Rimbalová & Vilčeková (2013). Additionally, facility management indicators have been examined in the context of various building types and institutions.

According to a study conducted by Kim et al. (2018), financial indicators were found to be significant in university facility management. The average performance score for financial indicators was 4.32, with utility cost receiving a performance score of 2.67, building maintenance cost scoring 2.5, and operating cost obtaining a score of 2.22. These factors ranked first in terms of importance. Another study by Raavi (2015), focused on education institutions and identified two types of financial management. The first type, referred to as financial management, had a mean score of 4.8 and ranked first in the business and

productivity category (mean score of 4.46). The second type, building maintenance cost management, had a mean score of 4.77 and ranked second under operative activities (mean score of 4.48). Financial indicators, expressed as financial management in managing organizational resources, scored a mean score of 5.056 and obtained the fourth rank, according to Awang et al (2014). In the context of public hospitals in developing countries, financial indicators ranked third with an Eigenvalue of 2.597, according to Amos et al. (2020).

In contrast to the previously mentioned findings, some studies have reported results that contradict the high ranking of financial indicators. For instance, in the case of office buildings, cost saving was ranked tenth with a mean score of 0.81 among critical success factors, as stated in the study conducted by (Shin et al., 2018). Similarly, in the context of green or sustainable buildings, financial indicators obtained a sixth score with weighted criteria of 9.9% among seven categories, according to research conducted by Ali & Al Nsairat (2009) in Jordan. Additionally, in the context of Ethiopia, financial indicators were ranked fifth with a relative priority of 10.41%, as reported by Anshebo et al., 2022). The consideration of the time value of money within this category was ranked last with a priority weight of 3.82%, according to facility management professionals in this study.

Environment Indicators Category

The environmental indicator category was ranked in the 7th level by facility management professionals with a priority rate of 7.06%. This is also supported by Awang et al (2014) and Rimbalová & Vilčeková (2013). according to those studies, environmental issues were ranked in the 8th level with a mean score of 4.979 and last rank with a 26.56% priority rate respectively.

According to the expert survey in the environmental indicators category, the following priority rates were assigned: energy management or efficiency (34.03%), water consumption management (15.39%), waste management (7.09%), material management (9.77%), and environmental impact assessment practices (11.26%). Similarly, in the context of sustainability, energy efficiency or management ranked first with a rate of 49.12% among environmental indicators, as reported by (Jayasena et al., 2020). In another study conducted in Saudi Arabia, energy efficiency was ranked second with an Eigenvalue of 24.29% (Banani et al., 2016). In the context of green building practices in Ethiopia, energy efficiency held the fourth rank with a relative priority of 12.6%, as reported by Anshebo et al. (2022). In a

study conducted by Shin et al (2018), energy management, expressed as energy monitoring, recording, optimization, and analysis, ranked third with a mean score of 6.0, and ranked eighth with a mean score of 5.81.

Additionally, energy consumption management obtained the second rank within the internal process category, with a mean score of 4.2, according to Kim et al (2018). In Nigerian university office buildings, energy performance was ranked sixth in terms of facility management's impact on office building performance, with a relative importance index of 4.06, as studied by Chinemenma et al. (2021). From an international institution perspective, energy efficiency was given a weight of 19% in BREEAM, 33% in LEED, 21% in Green Star, and 24% in both Estidama and SAT, as stated in Banani et al. (2016).

Another indicator of the environment category is water consumption management. In the context of Saudi Arabia and Jordan, water consumption management achieved the highest rank with Eigenvalues of 27.15% and 27.7% respectively out of 100%, as reported in the (Ali & Al Nsairat, 2009; Banani et al., 2016). Similarly, in Sri Lanka, the water management category obtained the second rank with a performance score of 21.39% (Jayasena et al., 2020). However, in the perspective of green building practice in Ethiopia, water efficiency was ranked seventh out of eight categories, with a relative priority of 8.06%, according to Anshebo et al. (2022).

Waste management serves as another environmental indicator. According to the expert's results, it was ranked last. Similarly, in the Shin et al (2018) study, waste management obtained the lowest rank with a mean score of 5.23 among 21 major facility management activities for office buildings. Furthermore, in the Jayasena et al. (2020) research, it was ranked last along with asset management, scoring a performance score of 9.64%. On the other hand, in a study conducted by Rimbalová & Vilčeková (2013), waste management of buildings achieved a performance score or weight of 6.08 from the environmental aspect category, with a relative weight of 26.56% out of 100%. In contrast to these findings, in South African public buildings, waste management was identified as the most effective and applicable indicator within facility management services, as stated by Mewomo et al. (2021).

The fourth indicator of the environmental category is material management. Material management obtained the second rank according to the expert's results, with a relative weight of 22.52% among environmental indicators, placing it in the second level. Material selection

from a sustainability perspective has been examined by various studies and institutions. Internationally recognized manuals allocate relative weights of 13% in BREEAM, 14% in LEED, 18% in Green Star, 15% in Estidama, and 10% in SAT for material selection, as stated in the Banani et al. (2016) research. From the mentioned studies, material management scored 10.03% in Saudi Arabia (Banani et al., 2016), 10.3% in Jordan (Ali & Al Nsairat, 2009), and 18.66% in Ethiopia (Anshebo et al., 2022) in the context of the sustainable building. In terms of quality, material provision for facility management services in office buildings, it was ranked in the fourth level among nine major criteria, as stated by Chinemenma et al.(2021) in Nigeria Office buildings.

An additional element of this category is environmental impact assessment. Environmental impact assessment during the operation of the building ranked second level from the environmental aspect with 6.83% relative weight, according to Rimbalová & Vilčeková (2013) and it was also ranked first with 25.97% performance score from the asset management category which has 7.85 relative weight out of 100%, whereas in this study it was ranked under fifth level with 9.77% according to expert's computation result. From the environmental indicators category, the ecologic value was one. It was ranked in the fourth level with 11.26%, according to the expert's comparison result. Finally, waste management got the least weight from the environmental category with a rate of 7.04%.

Technical Indicators Category

The experts ranked the technical indicators of facility management in fifth place, with a criteria weight rate of 11.60%. Within the technical category of this study, maintenance was ranked second with a criteria weight of 25.96% and fifth from overall. In the context of commercial office buildings in South Korea, the implementation of scheduled maintenance work was ranked 12th with a mean score of 5.63 out of 21 variables (Shin et al., 2018). In the context of higher education institutions, it was ranked third in terms of operational activities, with a mean score of 4.76, according to a study (Raavi, 2015). Another study which has been conducted in the context of a higher education institution by Awang et al (2014), revealed that from overall indicators, the implementation of maintenance and operation management ranked 14th with a score of 4.882. From a sustainability perspective, the maintenance management of the building was assigned a weight of 11.98% out of 100% and ranked in third level, based on computation of (Jayasena et al., 2020).

Another indicator is the application of ICT, in this study, the expert's computation was ranked in the fourth level with a priority rate of 17.07%, while the ICT application was ranked in first rank from the internal business category with 0.848 indicator load which has 1.313 Eigenvalue in public hospital context (Amos et al., 2020) and also it was ranked as 8th level among 9 indicators from internal process category with 3.80 mean scores (Kim et al., 2018). understanding building design scored the first rank in this study by experts under the technical category with 27.55% in this study, however, it was put in the least rank next to knowledge of real estate with a 4.393 mean score (Awang et al., 2014)**.** According to the expert's comparison, physical detection weight is 7.32%, repair, renovation, and refurbishment weight is 17.46%, and measurement of the building element weight is 4.63% from technical category weight.

Human Resource Management Indicators Category

The human resource management category was weight 9.05% from seven other facility management categories and ranked under the sixth level out of eight categories. Based on the expert's computation result, the top three indicators of human management were leadership skills of top management, the background of the facility manager, and effective communication or information flow in the organization with relative priority rates of 38.19%, 17.3%, and 16.55% respectively.

Human resources management was found in different forms in different studies from different angles of perspectives. According to literature by Awang et al (2014)**,** it was put in the form of human resources management in the facility management work process with a mean score of 5.071, this led its rank to third level, information management with a mean score of 5.032, ranked in sixth level and the other form is cooperation with the real supplier or specialist of facility management with 4.986 mean scores and ranked in seventh from other indicators. Also in a study by Raavi (2015), human resources were set in the form of people management under operation activities with 4.91 mean score and stakeholder relationships as one category separately containing five more indicators with a 4.52 mean score among the other six categories. Top management skill or commitment was categorized under the internal business strategy category in the study by Amos et al. (2020), which where did in a public hospital, and it scored 0.806 mean scores and got the third rank among the other two indicators. similarly, effective communication among stakeholders in this study got two rank priorities on top management commitment with a mean score of 8.879. on top

of that, effective communication or information management was not categorized under the category in a study by Awang et al (2014). it was ranked in the sixth level with a 5.032 mean score among all other indicator which were not categorized under categorization like effective communication of the stakeholders. Effective communication in the organization has a significant impact on the organization like major indicators that were analysed according to professional comparison. In contrast to this, the study by Chinemenma et al (2021), revealed that effective communication has no more effect on office building performance. And the study set it in the last rank with a 3.56 mean score.

In another way, human management competencies were set in two forms, in the study by Azasu et al (2018). The first competency form was people management, which ranked under the second level with a 4.2 mean score from the optional competency category. The second form was information management, which ranked under the tenth level among the other thirteen indicators from this category with a mean score of 3.65. another indicator from the top three indicators was the background of the facility management. this indicator has significant effects on the facility management work process in the office building and the result from experts revealed this. In the same study by Azasu et al (2018), the background facility manager described as personal, interpersonal, and professional skills. These descriptions were including a number of indicators. among the other indicators analytical skills, IT skills, ability to work in a team, ability to work in minimum supervision, communication skills, and Understanding of professional ethics were some. From this category, the ability to work and in minimum ability to work in a team ranked in first with a 4.55 mean score, communication skill of the facility manager ranked next to those indicators with 4.5 mean score. form human resources management time management of the facility ranked last with a 6.62% mean score. In the context of Nigerian university office buildings, the background of the facility manager or the competency of the staff has no significant impact on office facility management day to day activity (Chinemenma et al., 2021). Lastly, time management of the facility management ranked at the end of this category, according to the expert's comparison result.

Functional Indicators Category

According to the analysis, the functional category got the second rank with 18.41% relative priority weight. This is similar rank with the study by Christine Sotsek et al (2019). And functional category is one of the most critical categories used for the evaluation. Moreover,

according to this study, the functional performance weighed 36.7% out of 100%. The reason why the functional performance of the building is more required for office buildings is, a functional requirement of a building is closer to the needs of the user (Lützkendorf et al., 2005). Out of fourteen indicators of the functional category of this study, security, privacy, and noise group with 17.65% criteria weight ranked in first, the health group which contains safety and cleanliness with 13.83% priority weight was set in second level, and space utilization with 11.39% relative weight was ranked in third level. This show how much office buildings are sensitive to security, health, and space utilization. The confirmation of the high demand of security, safety, and health configuration of office and other building also seen as most required evaluation criteria (Amasuomo et al., 2017; Deuble & de Dear, 2014; Lützkendorf et al., 2005; Preiser & Schramm, 2002; Yasin & Egbu, 2009; Chinemenma et al., 2021; Fathian & Akhavan, 2006; Koleoso et al., 2017 and Shin et al., 2018). In addition to this, the necessity of the above key indicators of the functional category was discussed by Deuble & de Dear (2014), According to Deuble and de Dear (2014)**,** the importance of any building stated as: the main purpose of any building is to provide a safe and comfortable environment that neither impairs the health of its occupants nor hinders their performance. whereas in another direction, an office building contains a lot of secrets which contains clients' files, assets, and confidential documents. So, the security of the building should be taken into account. To elaborate more, to perform post-occupancy evaluation health, safety, and security aspects should be carried out(Preiser,1995 as cited in Lavy et al., 2014). Similarly, but not equally, space utilization has a significant weight on the evaluation of office facility building performance prior to furniture, fixtures, and equipment group. In another study, office functionality was categorized under a few major categories which determine the performance of office building (Yasin & Egbu, 2009). space utilization from functionality and efficiency aspects determine the evaluation performance of the post-occupancy evaluation method (Preiser ,1995, as cited in Lavy et al., 2014). Next to space utilization, the provision of the right furniture, fixtures, and equipment follows are most important criteria with 10.04% criteria weight and is set in the fourth level according to facility management experts in this study as presented in Table 4.45. This is relative to a similar study by Chinemenma et al (2021), in this study the provision of relevant and high quality was ranked in third level out of nine criteria with 4.28 relative important index; eighth out of 26 variables with weight 4.5.

In last from this category, the provision of the recreational area for customers weighs the least value based on the experts with 2.18% relative priority.

Performance-Based Indicators Category

Based on the expert's data computation, the performance-based category was ranked in last with a 4.99% Eigenvalue. The application of effective facility performance evaluation has important for both organizations as well as facility services providers. According to Meng and Minogue (2011), the organization will be benefited from high-standard service delivery, and facility management services providers will benefit from continuous improvement within the organization. Continuous improvement is one of the indicators under this category in this study. It is ranked in the sixth rank out of seven sub-criteria with 9.12% criteria weight. In another study by Awang et al. (2014), continuous improvement of facility management was ranked in tenth out of twenty-eight indicators with a mean score of 4.959. From analysis, the top three indicators from this category were defined scope of monitory ranked in first with 21.67% criteria weight, corrective action or reason-based decision ranked in second with 17.89% criteria weight and scheduled performance evaluation of the facility was ranked in third level with 16.51% criteria weight. gap analysis, monitoring means and method, documentation of result weight 15.42%, 15.25% and 4.14% respectively.

Socio-Cultural Indicators Category

Based on study analysis, the socio-cultural category ranked in fourth position with 12.06 % relative weight out of 100% from the other seven categories. This category contains both social aspects as well as cultural aspects. from an internationally acceptable building performance assessment manuals point of view, like BREEAM, LEED, Green star, and CASBEE, do not take into consideration aesthetic design parameters. Also, it should be mentioned that it does not account for any social parameters. But, Estidama, GBtool, and VERDE consider the socio-cultural aspect of the country for evaluation (Banani et al., 2016; Sinou & Kyvelou, 2006). However, socio-cultural aspect is considered by various studies like the study by Ali & Al Nsairat (2009), Banani et al.(2016), Christine Sotsek et al (2019), and Anshebo et al. (2022).

From this category, the indicators integration with urban, customer satisfaction with facility services, and feeling of equality (cultural aspect) were analysed as the top three indicators with a relative weight of 25.36%, 21.48%, and 16.94 % consequently. To confirm this result, integrating with urban has been listed as related with the surrounding in Estidama (Banani

et al., 2016). Next to this, customer satisfaction in facility management is referred as one of the critical success factors in facility management, according to Yoon & Cha (2018). In another study, customer satisfaction with services ranked second level from economic aspects with 10.62% relative weight (Rimbalová & Vilčeková, 2013). In contrast to this, the management of complaints tenants has high significance than an assessment of customer satisfaction in services, according to Shin et al. (2018).

Learning and Management Indicators Category

This category was scored the third level with 13.79% criteria weight containing ten other sub-criteria. From this category, understanding Ethiopian laws (formal and informal laws), Good governance (free from any type of corruption), and understanding facility management professional practices were selected as the top three indicators from this category with respective criteria weight of 28.25%, 13.04%, and 11.33%. learning and management category more focused on the management part. The above top three top three indicators as well as some other indicators were supported by other studies. According to Raavi (2015)**,** understanding the local law of the country related to the facility was ranked third out of five indicators from the category of industrial knowledge with a 3.91 mean score, and facility management formulation ranked in second from the strategic activities category. Based on subjective analysis in this study, policy (strategy or plan) formulation was ranked in sixth out of ten sub-criteria's. Policy formulation in line with the organization has a positive impact on the organization. According to Mewomo et al. (2022), the absence of policy guiding facility management practice is a major challenge that affects facility management practices in public buildings in South Africa. Another major challenge that affects facility management in Nigeria is corruption, according to Ogungbile and Oke (2015), Which is ranked in the second level in this study. For this category, consultancy service was set in least value with 2.86% criteria weight. In the same manner, it was also ranked in last from optional facility management competencies (Azasu et al., 2018).

Finally, the result of the analytical hierarchical process is presented in Figure 4.2. This figure aimed to represent the overall result of the analytical hierarchical process in simple rank methods. The figure contains two axes, the x, and y-axis. The x and y-axis shows the level of importance of the category for the facility management assessment of the public office building.

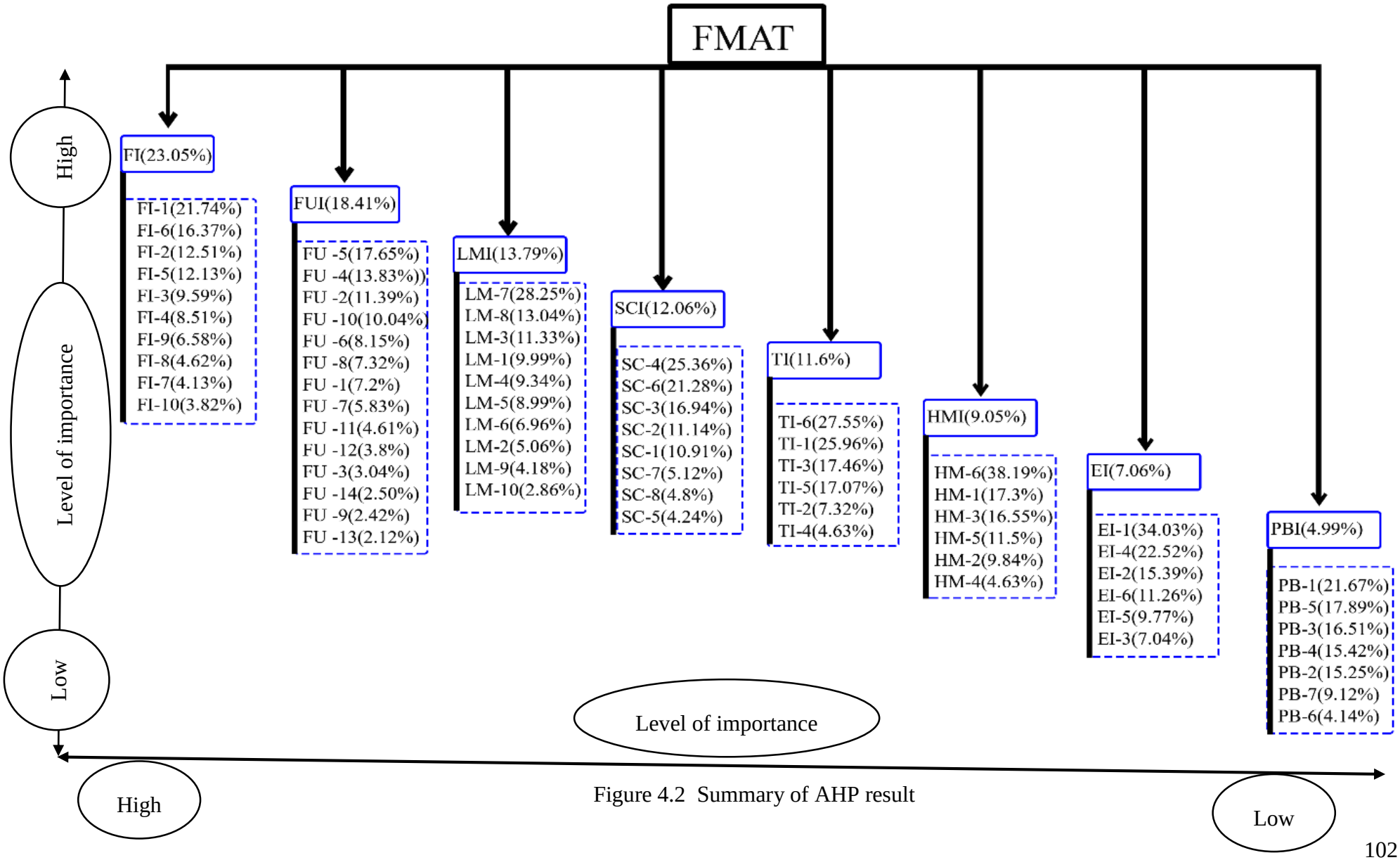

Figure 4.2 Summary of AHP result

4.3 Ranking System for Facility Management Performance Evaluation

Seven experts participated in the preparation of the rating scale and assessment format.

For rating scale preparation, the focus group was conducted on different evaluation systems which presented in section 2.7. Generally, the applicability of local contextual words would be more advantageous, according to the experts. on top of that, experts considered Ethiopia's context, like economic status, practice facility management practice, and others during the discussion. Consequently, decided not to adopt the LEED and BOMA scaling system. Instead, experts agreed to implement Khalil et al. (2016) ranking system with some minor enhancements. The detail of the selected ranking system presented herein below. The ranking system presented in a research article in the area of building performance, Country: Malaysia, Economic status of the country: Developing, Continent: Asia, Publisher/Journal: Elsevier, Year of publication: 2016 GC. The above information from the ranking system was used as input for selection. According to the focus group discussion result, most of the provided information was compactable with the Ethiopian context.

Evaluation procedures of the facility management performance in public office buildings in Hawassa City presented in the next section.

Performance evaluation of each indicator should follow the following evaluation points which presented in Table 4.37.

Table 4.37 Scale and Description

Scale	Description
≤0.2	Poor facility performance with extremely high lack of facility provision
0.4	Low performance with major lack of facility provision
0.6	Medium or good performance with medium lack of facility performance
0.8	Very good performance with minor lack of facility provision
1	Excellent performance with very little or no lack of facility provision

Next to this, the overall performance as well as categories performance should be computed by using the assessment format (Table 4.39). To evaluate the overall performance of the

office building, the following indicator score, category score and total performance score should be calculated as follow:

Table 4.38 Analysis of performance score

Indicator score	CW *PS
Category score	EV*Sum of indicators score
Total performance score	A sum of all categories score

where EV: Eigenvalue of category

CW: criteria weight of indicator and PS: performance score of the indicator

Table 4.39 Facility management performance assessment format

PUBLIC OFFICE BUILDING FACILITY PERFORMANCE ASSESSMENT

Name of organization:

Location: Hawassa (insert sub-city and kebele)

Assessment Category :

Eigenvalue of category :

S.no	Name of indicator	Criteria weight (CW)	Performance score (PS)					Total score
			≤0.2	0.4	0.6	0.8	1	CW*PS
1								
2								
.								
.								
.								
n								
							Sum	

Performance score of category = ∑total score of indicators*Eigen value of category=_____

Examiner: _____ Signature: _____ Date: _____

Approval: _____ Signature: _____ Date: _____

After computing the total score of the building, identification of the range of award points is a critical issue in weighing of the building's performance as a whole.

The suggested evaluation scale range is presented in Table 4.40. Which is used for the evaluation of facility management performance of public office building in Hawassa (Sidama region, Ethiopia).

Table 4.40 FMAT rating range

Total performance score	Rating	Description
≤ 20	Poor	Poor performance with extremely high lack of facility provision
21-40	Low	Low performance with major lack of facility provision
41-60	Good/Medium	Medium or good performance with medium lack of facility performance
61-80	Very Good	Very good performance with minor lack of facility provision
81-100	Excellent	Excellent performance with very little or No lack of facility provision

The suggested range for certification of performance were presented in above Table 4.40. According to this, 81-100 points, refer the excellent performance of the facility in the office building, 61-80 refer the Very Good performance of the facility in the office building, 41-60 refer Medium/Good performance of the facility in the office building, 21-40: refer low performance of the facility in the office building and ≤ 20 refer poor performance of the facility in the office building.

4.4 Facility Management Assessment Tool for Public Office Buildings

The facility management assessment tool was developed by utilizing the results of a comparative survey and prioritization, as well as the outcomes of focus group discussions. The comparative survey and prioritization provided the Eigen value for each category and the criteria weights for each variable. On the other hand, the focus group discussions yielded the format for evaluating facility management performance and the ranking system.

The developed facility management assessment tool includes the indicator name, Eigen value for the category, criteria weights for each variable, organization name, performance score (which represents the precise evaluation score), total score for the category, as well as the indicator. To obtain the performance score, the evaluator or evaluation team needs to observe the actual work on the ground through post-occupancy evaluation.

For the purpose of comprehensiveness, the facility management tool has been prepared for the functional category as shown in Table 4.40 below. The same procedure should be followed for other categories, with the only difference being the values of the criteria weights for variables and the Eigen value for the category. Please refer to Table 3.35 for Eigen value and Criteria weight of each variable. The section of evaluator and approval should be set under the Table 4.41. See Table 4.39 for evaluation and approval section.

Description

i. The first column contains the serial number and the second column contains the name of the variables in category.
ii. The third column contain the criteria weight of each variable (refer to Table 3.36)
iii. The fourth column contain the performance score of each variable, which has given by evaluation team or evaluator
iv. The fifth column contains the total score of the criteria weight (See Table 4.38)
v. The sixth column contain the facility management performance award range (See 4.39)
vi. The seventh column contains the remarks, which provided based on evaluation status of the facility management (see Table 4.41 under description section).

As note: CS stands for category score, PS stands for performance score

EV stands for Eigen value, CW stands for criteria weight

Table 4.41 Facility management Assessment tool

PUBLIC OFFICE BUILDING FACILITY PERFORMANCE ASSESSMENT

Name of organization:

Location: Hawassa (Insert sub-city and kebele)

Assessment Category : Financial category

Eigenvalue of category/EV/ : 0.2305 (23.05%)

S.no	Name of Indicator	Criteria weight (CW)	Performance score (PS) ≤0.2	0.4	0.6	0.8	1	Total score CW*PS	Status award range If CS is between	Remark
1	Operating cost	21.74%							81-100 (Excellent)	Very little or no lack of facility provision
2	Occupancy cost	12.51%								
3	Utility cost	9.59%							61-80 (Very Good)	minor lack of facility provision
4	Building maintenance cost	8.51%								
5	Capital cost	12.13%							41-60 (Medium/Good)	Medium lack of facility performance
6	Capital renewal cost	16.37%								
7	Facility condition survey cost	4.13%							21-40 (Low)	Major lack of facility provision
8	Custodial and janitorial cost	4.62%								
9	Financial management	6.58%							<= 20 (Poor)	Extremely high lack of facility provision
10	Time value of money	3.82%								
							Sum	∑CW*PS		
							CS	Sum*EV		

4.5 Assessment/Evaluation of the Current Facility Management Practice in Public Office Buildings

For the evaluation of the facility management practice in the public office building in Hawassa city, the developed FMAT was used. As indicated in chapter three (section 3.7.1), generally 20 public office buildings (G+4 = 5, G+3 = 3, G+2=9, G+1=3) were presented and evaluated. For analysis, the mean score of the respondents was used and analysed.

In the following Table 4.46, the mean score of the each building groups (G+1, G+2, G+3 and G+4) is presented. Next to this, the correlation between the groups is also computed and discussed. Column 2 up to 5 contains the performance evaluation or mean score, column 6 contains the average mean of columns 2 - 5. Before to computation of the next analysis, the correlation of the data among groups was checked using Spearman's correlation coefficients.

Table 4.42 Spearman correlation between responses

	G+4	*G+3*	*G+2*	*G+1*
G+4	1			
G+3	0.7823	1		
G+2	0.6907	0.7077	1	
G+1	0.7612	0.7665	0.7364	1

As presented in the above Table 4.42 the correlation/agreement between groups shows that strong relationship. As stated by Stats tutor, the correlation ranges from 0.6 to 0.79 shows that the strong correlation/relationship. Hence, all groups with each other lies on strong relationship. After correlation checking, the mean comparison of the groups checked by using one way Anova.

Table 4.43 one way ANOVA result/Sum, average, variance (Descriptive)

Groups	Count	Sum	Average	Variance
G+4	67	28.67	0.4280	0.0253
G+3	67	26.20	0.3911	0.0161
G+2	67	20.54	0.3065	0.0117
G+1	67	26.99	0.4028	0.0173

The sum of the mean of each group, average, and variance computed. According to this, the sum of the G+1 is 26.99179, G+2 is 20.54176, G+3 is 26.20545, and G+4 is 28.67787. this shows, the mean score of G + 1, G + 3 and G + 4 are closer to themselves, while mean score of G+2, is far from them in some extent. The average of each group shows the respondent's answers. Most of the G+4 respondents responded 0.428 (42.8%), which lies in the range of

medium performance, most of the G+3 respondents responded 0.3911 (39.11 %), which lies in the range of low performance, most of the G+2 respondents responded 0.3065 (30.65 %), this lies in the range low performance, and most of G+1 respondent's respond 0.4028 (40.28 %), this lies in the range medium performance. The variance of the data indicates how much data varies in the category. In this study, the variance of the data is not significant, i.e. all category data varies in 0.0 digits as presented in Table 4.43.

Further, the level of the significant difference between groups was checked using a 95% confidence level.

Table 4.44 One way ANOVA result

Source of Variation	SS	df	MS	F	*P-value*	F crit
Between Groups	0.56	3	0.1858	10.52	1.46E-06	2.63
Within Groups	4.66	264	0.0176			
Total	**5.22**	**267**				

The data obtained from the above Table 4.44 of the ANOVA result shows that there are significant differences among the groups (Computed *P-values* < *0.05*) with 3 - degree of freedom. One-way ANOVA cannot show at which groups significant differences were created. To address this, an additional test called Post-Hock (Tukey) is used and presented in next Table 4.45.

Table 4.45 *P-value* among groups Post–hock (Tukey) – Multiple comparisons

	G+3	G+2	G+1
G+4	0.1408	*8.91E-07*	0.3207
G+3		*6.15E-05*	0.6006
G+2			*8.99E-06*

As presented in above Table 4.45, there is no significant difference between G+4 Vs G+3, G+4 Vs G+1, and G+3 Vs G+1, because the *P-value* among them is greater than 0.05. While, there is a significant difference between G+4 Vs G+2, G+3 Vs G+2, and G+2 Vs G+1 (Computed P-value < 0.05). The overall computation of the evaluation is presented in the following table which computed as per section 4.4.

Table 4.46 Facility management performance evaluation result

	Mean score										
FMAT	G+4	G+3	G+2	G+1	Average mean	Rank	Overall rank	CW	CW*PS	Eigen value	TS
FI											
FI-1	0.7345	0.6198	0.571	0.5912	0.6291	1	3	0.217	0.1368		
FI-2	0.4891	0.5137	0.3272	0.459	0.4473	5	16	0.125	0.0560		
FI-3	0.6679	0.6419	0.4813	0.5827	0.5935	3	5	0.096	0.0569		
FI-4	0.2934	0.3871	0.209	0.3057	0.2988	7	51	0.085	0.0254		
FI-5	0.3418	0.4741	0.2179	0.3283	0.3405	6	43	0.121	0.0413		
FI-6	0.2568	0.3156	0.2117	0.2685	0.2632	8	56	0.164	0.0431		
FI-7	0.2112	0.2019	0.276	0.2321	0.2303	9	62	0.041	0.0095		
FI-8	0.7912	0.6152	0.4813	0.5129	0.6002	2	4	0.046	0.0277		
FI-9	0.6891	0.7143	0.3791	0.4814	0.5660	4	6	0.066	0.0372		
FI-10	0.2189	0.2178	0.2019	0.2733	0.2280	10	64	0.038	0.0087		
SUM	4.6939	4.7014	3.3564	4.0351				SUM	0.4426	23.05%	10.20%
EI											
E-1	0.4572	0.4719	0.2926	0.4028	0.4061	3	23	0.3403	0.1382		
E-2	0.5173	0.3173	0.2779	0.4225	0.3838	4	26	0.1539	0.0591		
E-3	0.4811	0.5128	0.2738	0.4902	0.4395	2	18	0.0704	0.0309		
E-4	0.4729	0.3719	0.2992	0.378	0.3805	5	28	0.2252	0.0857		
E-5	0.2237	0.2124	0.2022	0.2817	0.2300	6	63	0.0977	0.0225		
E-6	0.717	0.4268	0.3164	0.6251	0.5213	1	8	0.1126	0.0587		
SUM	2.8692	2.3131	1.6621	2.6003				SUM	0.3951	7.06%	2.79%
TI											
TI-1	0.3271	0.3346	0.2748	0.3216	0.3145	3	49	0.2596	0.0817		
TI-2	0.2102	0.2231	0.2001	0.2115	0.2112	6	67	0.0732	0.0155		

TI-3	0.3489	0.35813	0.23146	0.39582	0.3336	2	44	0.1746	0.0582		
TI-4	0.23691	0.2475	0.2701	0.26136	0.2540	4	59	0.0463	0.0118		
TI-5	0.2341	0.2138	0.2104	0.2112	0.2174	5	66	0.1707	0.0371		
TI-6	0.5644	0.5413	0.3143	0.399	0.4548	1	15	0.2755	0.1253		
SUM	1.9216	1.9184	1.5012	1.8005				SUM	0.3295	0.1106	3.64%
HMI									0.3951		
HM-1	0.2583	0.3691	0.2149	0.3471	0.2974	4	52	0.1730	0.0514		
HM-2	0.2419	0.28519	0.2091	0.24361	0.2450	6	60	0.1150	0.0282		
HM-3	0.5811	0.6913	0.6143	0.7103	0.6493	1	2	0.1655	0.1075		
HM-4	0.25819	0.3781	0.2618	0.3312	0.3073	3	50	0.0984	0.0302		
HM-5	0.34517	0.2471	0.2681	0.2117	0.2680	5	55	0.0662	0.0177		
HM-6	0.5418	0.4611	0.2635	0.6451	0.4779	2	14	0.3819	0.1825		
SUM	2.2265	2.4319	1.8317	2.489				SUM	0.4175	9.05%	3.78%
FUI											
FU-1	0.4179	0.3801	0.3011	0.5719	0.4178	6	22	0.0720	0.0301		
FU-2	0.4818	0.3681	0.2802	0.3417	0.3680	8	30	0.1139	0.0419		
FU-3	0.5619	0.4637	0.3125	0.3781	0.4291	5	21	0.0304	0.0130		
FU-4	0.5318	0.3572	0.2587	0.3219	0.3674	9	31	0.1383	0.0508		
FU-5	0.7177	0.46591	0.3921	0.4216	0.4993	2	10	0.1765	0.0881		
FU-6	0.4602	0.3357	0.2245	0.2663	0.3217	12	46	0.0815	0.0262		
FU-7	0.3461	0.4199	0.2314	0.2891	0.3216	13	47	0.0583	0.0188		
FU-8	0.4693	0.4418	0.3326	0.3583	0.4005	7	24	0.0732	0.0293		
FU-9	0.3893	0.3672	0.2768	0.4182	0.3629	10	35	0.0242	0.0088		
FU-10	0.5829	0.4977	0.3321	0.6422	0.5137	1	9	0.1004	0.0516		
FU-11	0.324	0.2331	0.3954	0.4133	0.3415	11	42	0.0461	0.0157		
FU-12	0.5538	0.5292	0.3269	0.5471	0.4893	4	12	0.0380	0.0186		
FU-13	0.3447	0.3454	0.2011	0.3866	0.3195	14	48	0.0212	0.0068		

FU-14	0.4779	0.4237	0.5863	0.4811	0.4923	3	11	0.0259	0.0127		
SUM	6.6593	5.6287	4.4517	5.8374				SUM	0.4125	0.1841	7.59%
PBI											
PB-1	0.2475	0.3531	0.3118	0.3793	0.3229	5	45	0.2167	0.0700		
PB-2	0.3582	0.4957	0.2803	0.3229	0.3643	2	33	0.1525	0.0556		
PB-3	0.3196	0.3754	0.3227	0.4259	0.3609	3	36	0.1651	0.0596		
PB-4	0.3957	0.38542	0.2653	0.4852	0.3829	1	27	0.1542	0.0590		
PB-5	0.4837	0.3289	0.2684	0.3352	0.3541	4	39	0.1789	0.0633		
PB-6	0.2168	0.2371	0.2011	0.2386	0.2234	7	65	0.0414	0.0092		
PB-7	0.2954	0.2475	0.2596	0.2879	0.2726	6	54	0.0912	0.0249		
SUM	2.3169	2.4231	1.9092	2.475				SUM	0.3416	0.0499	1.70%
SCI											
SC -1	0.5672	0.3453	0.2201	0.3244	0.3643	5	34	0.1091	0.0397		
SC- 2	0.4556	0.2998	0.2465	0.3857	0.3469	7	41	0.1114	0.0386		
SC- 3	0.4788	0.2783	0.2331	0.4293	0.3549	6	38	0.1694	0.0601		
SC- 4	0.6992	0.4892	0.4682	0.5659	0.5556	2	7	0.2536	0.1409		
SC- 5	0.8721	0.7781	0.7332	0.8412	0.8062	1	1	0.0424	0.0342		
SC- 6	0.4985	0.4109	0.3381	0.5129	0.4401	4	17	0.2148	0.0945		
SB- 7	0.3719	0.2796	0.2352	0.2681	0.2887	8	53	0.0512	0.0148		
SC- 8	0.5316	0.3792	0.4794	0.5297	0.4800	3	13	0.0480	0.0230		
SUM	4.4749	3.2604	2.9538	3.8572				SUM	0.4459	0.1206	5.38%
LMI											
LM-1	0.2585	0.2872	0.2247	0.2795	0.2625	8	57	0.0999	0.0262		
LM-2	0.4286	0.4575	0.3488	0.4853	0.4301	2	20	0.0506	0.0218		
LM-3	0.3671	0.3538	0.3652	0.3345	0.3552	6	37	0.1133	0.0402		
LM-4	0.4648	0.4116	0.2868	0.5756	0.4347	1	19	0.0934	0.0406		
LM-5	0.3572	0.4522	0.2312	0.4334	0.3685	4	29	0.0899	0.0331		

LM-6	0.4759	0.3642	0.3227	0.4371	0.4000	3	25	0.0696	0.0278		
LM-7	0.2556	0.3864	0.3574	0.3932	0.3482	7	40	0.2825	0.0984		
LM-8	0.2943	0.2475	0.2116	0.2758	0.2573	9	58	0.1304	0.0336		
LM-9	0.3789	0.3537	0.3226	0.4035	0.3647	5	32	0.0418	0.0152		
LM-10	0.2347	0.2143	0.2047	0.2794	0.2333	10	61	0.0286	0.0067		
SUM	3.5156	3.5284	2.8757	3.8973				SUM	0.3436	0.1379	4.74%

SUM	**39.83%**
STATUS	**Low**

Table 4.47 AHP result Vs Evaluation result

S.no		AHP result		Evaluation result/Assessment	
	Category	Eigen value	Rank	performance score	Rank
1	Financial	0.2305	1	0.4426	2
2	Environmental	0.0706	7	0.3951	5
3	Technical	0.1106	5	0.3295	8
4	Human resource management	0.0905	6	0.4175	3
5	Functional	0.1841	2	0.4125	4
6	Performance based	0.0499	8	0.3416	7
7	Socio-cultural	0.1206	4	0.4459	1
8	Learning and management	0.1379	3	0.3436	6
	Sum	1			

4.5.1 Discussion on Current Practice of Facility Management

The above table 4.46, illustrates that the facility management performance in public office buildings in Hawassa City was 39.83%, falling within the low-performance range as indicated in Table 4.39. Other studies conducted in Ethiopia have also described the status of facility management performance using varying terms. However, the overall performance of facility management in different types of buildings was unsatisfactory, as stated in studies by Bekele (2022), Sahelu (2015), Nibret (2015), and Seyoum (2017). A detailed discussion of each category have been presented below.

As demonstrated in the previous section on AHP analysis, the financial category obtained the highest Eigenvalue (23.05%), indicating its significant role as an indicator of facility management performance of Public office buildings in Hawassa city. Following the evaluation of facility management performance, it obtained the second rank with a performance score of 0.4426 (44.26%), falling within the range of medium performance (41%-60%). However, certain indicators within this category, such as FI-1 (Operating cost/Budget) and FI-10 (time value of money consideration), remained consistent in their level of rank before and after evaluation. Other indicators experienced variations in their level of importance before evaluation and after performance evaluation. For instance, capital renewal cost/budget initially ranked second in terms of importance before evaluation but dropped to eighteenth after evaluation, with a performance score of 0.2632 (26.32%).

In other studies, facility management practices were examined in different building types and locations. For example, Cheriye (2021) found that poor facility maintenance management practices in condominium buildings in Addis Ababa, Ethiopia were primarily due to a lack of funds. Similarly, Oke et al. (2015) revealed that the provision of funds for facility management in Nigeria was inadequate, posing a major challenge to effective implementation. Additionally, in South Africa, Mewomo et al. (2022) highlighted the poor provision of budgetary resources for facility management, which poses challenges to facility management work. These findings emphasize the importance and challenges associated with financial management in facility management.

The next category is environmental category exhibits a relatively low performance, indicated by a mean score of 0.3951 (39.51%). This places it in the 5th rank among the other seven categories. This category plays a critical role in enhancing sustainable facility management by incorporating important components or elements. However, the results of the study

contradict the features expected in future facility management. According to studies by Atkin & Bildsten (2017), Mari & Poggesi (2014), and Opoku & Lee (2022), the features of future facility management include sustainability and digitalization. In contrast, the facility management practices observed in public office buildings in Hawassa City are lacking, which creates a discrepancy with the anticipated features of future facility management.

The technical indicators category. the performance of technical category indicators in office public buildings is rated as low, with a performance score of 0.3295 (32.95%). When evaluated, the technical category of facility management indicators ranked at the 8th level, which is the lowest position. However, prior to evaluation or based on the level of importance, it was initially ranked 7th with an Eigenvalue of 7.06%. The rank of importance and performance score for the understanding of building design during building operation is the same, but they are not equal in magnitude. Additionally, the scheduled maintenance of the building is also rated as low within this category. This study indicates that the performance of scheduled maintenance is inadequate, suggesting a greater reliance on traditional maintenance practices rather than scheduled or preventive maintenance. Similar findings have been observed in other studies conducted by Cheriye (2021), Nibret (2015), Seyoum (2017), and Oke et al. (2015).

The other category is human resource management. In this study, the human resource management performance was found to be at a medium/good level, with a performance score of 0.4175 (41.75%). This placed the category at the third level in terms of performance compared to other categories. Among the variables analysed in the AHP analysis, the leadership skill of the top management was identified as the most critical factor for the effective implementation of facility management. It ranked second after effective communication within the organization. This category specifically focuses on the personnel involved in facility management and highlights the challenges faced in developing countries. Previous research by Isa et al. (2016) pointed out that the lack of skilled manpower in facility management posed challenges in Malaysia. Similarly, in South Africa, the poor performance of human management significantly affected facility management (Mewomo et al., 2022). Additionally, in the Amhara region of Ethiopia, the absence of skilled human resource management, specifically facility management professionals, posed major challenges in implementing effective facility management in higher education institutes (Nibret, 2015).

The functional category of facility management is another category. The functional category performance falls within the medium performance range, as indicated by a cumulative performance score of 0.4125 (41.25%). This places the category at the 4th level. This particular category consists of a larger number of items compared to other categories. Within this category, public office buildings primarily offer services related to furniture, fixtures, and equipment provision, although not in a comprehensive package. Additionally, security, privacy, and noise services are commonly available. A study conducted by Bekele (2022) aligns with these findings, highlighting that security and cleaning services are prevalent in both public and private buildings in Addis Ababa.

As discussed in the AHP analysis section, the functional performance category primarily focuses on the day-to-day activities involved in facility management operations. In addition to the aforementioned indicators, public office buildings in the city also provide services such as parking area provision and transport accessibility, direction indicator signs, and landscaping/ground shaping to some extent. However, the least offered services in public office buildings include emergency exits, heating, ventilation, lighting (both artificial and natural), and recreational areas, respectively.

The performance-based category second to learning and management in terms of the order. The performance evaluation of the public office building in the city was conducted using the performance-based evaluation category, which resulted in a performance score of 0.3416 (34.16%). This indicates that the evaluation of facility management performance is relatively low. This category encompasses aspects such as monitoring the scope and providing strategies for the continuous improvement of facility management in the building.

Moreover, the first category in the ranking of facility management is the socio-cultural category, which obtained a performance score of 0.4459 (44.59%), indicating medium performance. This category encompasses aspects such as the cultural and physical environment of the building, as well as customer satisfaction surveys. Given that Hawassa city is known for its diversity, cultural and social factors receive high priority in building management. The study also revealed the significance of socio-cultural aspects in the operation of facility management in the city, despite not meeting the required performance standards. The location of the building within this category was found to be relatively suitable for achieving the organization's objectives, as evidenced by the high-performance score (80.62%) in assessing the location's suitability. Following the location, the integration

with the urban environment and occupancy rate ranked consecutively. On the other hand, the complaint response method and record-keeping ranked the lowest, indicating that the customer complaint system is not effectively implemented in most public office buildings in the city.

The final category in facility management is the learning and management category, which is ranked at the 6th level with a performance score of 0.3436 (34.36%). This category encompasses the fundamental aspects of facility management, starting from understanding the overall practice of facility management to promoting good governance, which includes the prevention of corruption. The performance score of this category is considered low based on the scale development section mentioned earlier. Despite the importance of good governance in facility management processes, the overall performance of this category remains low, including in the area of good governance. Oke et al. (2015) highlight that corruption poses significant challenges to facility management processes in Nigeria. This study was referenced to confirm the extent of corruption as a hindrance to effective facility management implementation. Overall, the researcher agrees with the assessment outcomes.

4.6 Conceptual Framework Development and Validation

As data analysed in the above section, the practice of facility management is low. This shows the advancement required in the work of facility management in public office buildings in Hawassa City. For this, the following conceptual framework has been developed and proposed for better application of facility management in public office buildings in the city. The conceptual framework has been developed by reviewing facility management-related literature, the result of AHP analysis, assessment results, and the researcher's walkthrough observations. The framework consists of the introduction section, identification of facility management competency, develop a facility management plan, implement a facility management plan, assess facility management, and remedial action section/stage. The contents of each stage are described in the framework which presented in Figure 4.3. After developing it, it was subjected to validation. Framework validation was conducted by five senior experts. The experts were asked to evaluate the applicability, appropriateness, effectiveness, responsiveness, and user-friendliness of the developed framework.

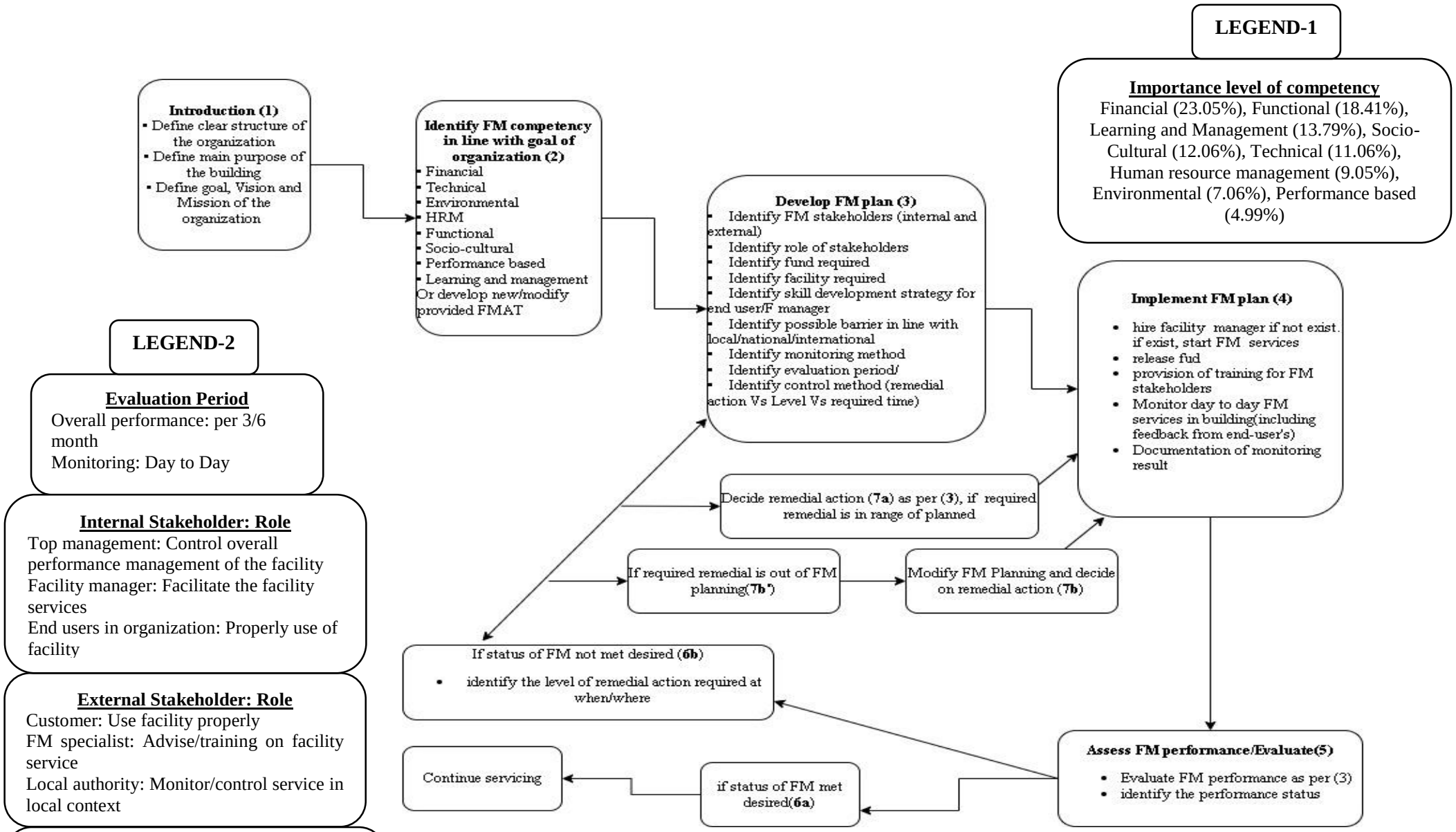

Figure 4.3 Proposed conceptual framework of facility management

The respondents answer was evaluated by using the equation of LEE (2001), which was presented in the of data analysis method section of chapter three. and the result presented in following Table 4.48.

Table 4.48 Validation of framework

Category	Average score	Mdn	Q1	Q3	Level of agreement
Applicability	6.2	6	6	7	0.83
Appropriateness	5.8	6	6	6	1.00
Effectiveness	5.6	5	5	6	0.80
Responsiveness	6	6	6	6	1.00
User friendliness	5.6	6	5	6	0.83
Average	5.84				0.89

The average evaluation score of selected experts is 5.84 out of 7. The experts assessed the proposed conceptual framework of facility management is applicable in public office buildings in the context of Hawassa City. The level of agreement on applicability and user-friendliness was scored 0.83. Likewise, the level of agreement on responsiveness and appropriateness was 1. The level of agreement on effectiveness was lower than the other evaluation metrics. The overall degree of agreement was 0.89. A degree close to 1 indicates that the answers to the question are valid (LEE, 2001, as cited in Shin et al., 2018). From the expert's evaluation, it can be summarized as the proposed conceptual framework of facility management is applicable, appropriate, effective, responsive, and user-friendly for the facility management of public office buildings in the context of Hawassa city (Sidama region: Ethiopia).

5. CONCLUSION AND RECOMMENDATION

This section summarizes the research study. First, it provides the conclusion based on major findings of the study, then it provides recommendations for both practitioners as well as future studies based on the implication of conclusion of the study.

5.1 Conclusion

Based on the major findings of the study, the following conclusions have been drawn.

- For the evaluation of public office building facility management performance, the financial, functional, learning, and management categories are the top three important categories. While the performance-based category is low in significance than others.
- From the list of facility management variables, leadership skills of top management, energy efficiency, and understanding of Ethiopian law (both formal and informal) related to facility management are the top three significant criteria for facility management performance, whereas the provision of the recreational area is low in significance.
- For the certification of the status of the public office building facility management performance, the award range is proposed. Accordingly, a score of ≤ 20 indicates poor performance, 21- 40 indicates low performance, 41- 60 indicates medium/good performance, 61- 80 indicates very good performance and 81-100 indicates excellent performance of facility management in public office building.
- Overall Public office building, facility management practice in Hawassa City found in low performance. However, from the list of categories socio-cultural, financial, and human resource management practices are found in medium or good performance while technical category services are found in the lowest range of performance than others.
- From sub-criteria/variables, suitability of building location for surrounding found in extreme performance condition, effective communication in the organization, and the practice of operating budget provision for facility services found in very good performance condition. In another hand, the practice of physical detection of the building found in the lowest range among overall variables.
- Based on the result of the analysis and other sources' consideration, a conceptual framework of facility management has been developed which can be applied for

facility management in the public office building of Hawassa City, which can improve the existing facility management practice.

5.2 Recommendation

The following recommendations were drawn for both practitioners and future studies based on the implication of the study conclusion.

Recommendation for Public Office Building Organizations

- The proposed facility management assessment tool, framework, and evaluation score should be used by relevant organizations properly.
- Evaluation should be done by the facility manager and related professionals only
- Organizations should address facility management as the major aim of their organization to improve the practice of facility management in the city.
- Organizations should learn from each other's work to share experience in facility management. This is because facility management requires collaborative efforts from all concerned bodies.

Recommendation for Future Studies

- Future studies are encouraged to explore alternative multi-criteria decision methods within the same research area to compare and contrast their value with AHP. This approach is used to minimize uncertainty and obtain optimized solutions for different decision-making scenarios.
- Further research may develop facility management assessment tool in context of different types of building, which can be used by building performance evaluation.
- Future studies should expand the number of participants from different concerned bodies to enhance the better facility management assessment tool in different types of buildings.
- Future studies may develop further evaluation criteria for each facility management variable in the context of public office buildings and others.

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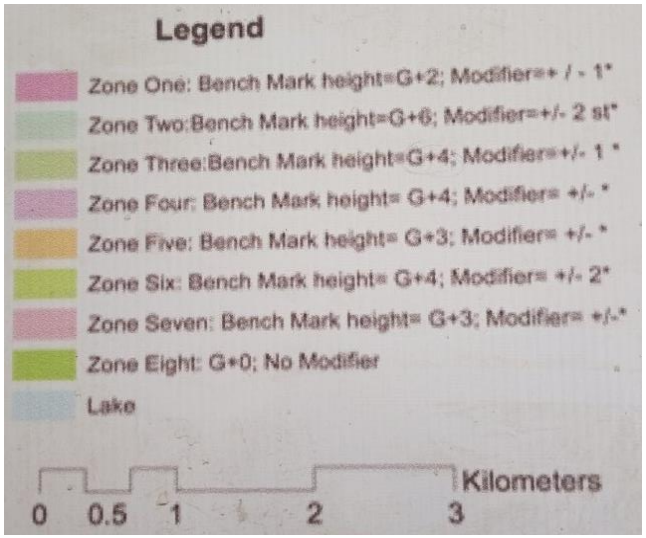
APPENDICES

Appendix –I: Maximum height of Building construction

Building height prohibition and permission



Zone	Bench mark height	Modifier
1	G+2	+/- 1 *
2	G+6	+/- 2 st*
3	G+4	+/- 1*
4	G+4	+/- *
5	G+3	+/- *
6	G+4	+/- 2*
7	G+3	+/- *
8	G+0	No modifier

Source; Hawassa city municipality (2023)

Appendix –II: Description of facility management variables

Description of the indicators which has been used in formulation of FMAT

Financial category	
Indicator	Description
Operating cost/budget	Provision of budget related with all cost related with day to day facility operation of the building. Including cost of insurance, general administration cost
Occupancy Cost/budget	Provision of budget for cost related with building occupancy, from building occupation to disposal. This cost can be subset of operating cost
Utility Cost/budget	Provision of budget for monthly or annual cost of utilities, including electricity, fuel oil, gas, steam, water, sewage, etc.

Building Maintenance Cost/budget	Provision of budget for costs for labour (in-house or contracted-out) and materials required for building monitoring, inspection, repairs, maintenance, and response to service requests
Capital Cost/budget	Provision of budget for all costs required to purchase and extend building property, to procure plant and equipment, and to operate organization
Capital Renewal Cost/budget	Provision of budget required for performing major renovations in the building, its systems, subsystems, and component
Facility Condition Survey Cost/budget	Provision of budget for costs related with comprehensive assessment or evaluation of the overall condition of a building's components, systems, and infrastructure
Custodial and Janitorial Cost/budget	Provision of budget for costs for labour, personnel, supplies, and equipment used for providing janitorial and custodial services
Financial Management/budget	Overall contract and procurement management practices, cost feasibility, analysis and report
Time Value of Money/budget	Practice of consideration of the time value of the money/inflation on financial statement
Technical category	
Indicator	Description
Scheduled maintenance	Planned and regular maintenance activities that are performed at predetermined intervals to ensure the ongoing functionality and performance of building systems and components. Including: inspections, cleaning, lubrication, filter replacements, and other preventive measures.
Physical detection	Practice of identifying and acknowledging physical problems, flaws, or irregularities in a building's structure, systems, or components
Repair, renovation and refurbishment	Practice of fixing or restoring a damaged or malfunctioning building element, system, or component to its functional state, making significant changes or improvements to a building's interior or exterior,
Measurement of building elements	Practice of quantitatively evaluating the physical characteristics, dimensions, and performance parameters of various components within a building
ICT application	Use of technology and software tools to improve and streamline various aspects of building operations, maintenance, and management. It includes the application of digital solutions, automation, data analytics, and communication systems to enhance efficiency, optimize resource utilization, monitor performance, and enable effective decision-making in building management processes.
Understanding building design	Practice of recognition and consideration of the relationship between building design decisions and their impact on building operations, maintenance, and overall management throughout the building's lifecycle
Environmental category	
Indicator	Description
Energy efficiency	Practice of optimizing energy uses within a building to minimize energy consumption, implementation of strategies and technologies that improve the performance of building systems, equipment, and operations to achieve maximum energy savings without compromising comfort or functionality
Water consumption management	Practice of monitoring, controlling, and reducing water usage within a building.

	It includes implementing water-efficient fixtures, conducting regular inspections for leaks, implementing water recycling or reuse systems, and promoting water conservation practices among occupants and staff.
Waste management	Practice of proper handling, disposal, and recycling of waste generated It involves implementing waste segregation systems, recycling programs, and proper waste disposal practices to minimize the environmental impact and promote sustainability.
Material management	Practice of management of quantity of total material used in the process, total material consumption minus waste, reused, and recycled material of operation and/or production
Environment impact assessment practice	Evaluation and assessment of the potential environmental consequences and impacts associated with building, operations, or modifications. involves identifying, analysing, and mitigating potential environmental risks and ensuring compliance with relevant environmental regulations and standards.
Ecological value	Practice of preservation and promotion of biodiversity, natural habitats, and ecological balance within and around the building
Human resource management	
Background of facility manager	Refers to the education, experience, skills, and knowledge that a facility manager possesses in order to effectively manage the operations and maintenance of a building or facility
Training for facility manager	Practice of providing education, professional development, and skills enhancement to facility managers
Effective communication in organization	Practice of provision of clear and timely exchange of information and instructions among all stakeholders involved in the operation and maintenance of a building
Cooperation with real supplier/contractors/	Practice of cooperative relationships with suppliers, contractors, who provide services, equipment, or expertise related to building maintenance, repairs, or upgrades
Time management of facility manager	Time management skills of facility managers to stay organized, meet deadlines, respond to emergencies promptly, and ensure that maintenance activities and projects are carried out in a timely manner and timely availability of the facility manager in the organization.
Leadership skill of top management	Ability of top management, such as executives or senior facility managers, to provide direction, set goals, inspire and motivate teams, and make strategic decisions.
Functional indicators category	
Indicators	Description
building services like (drainage, piping, sanitary..)	Availability of systems and infrastructure responsible for managing and maintaining the water supply, drainage, and sanitary facilities within a building.
Space utilization	Provision of efficient and effective utilization of available space within a building. This involves optimizing the layout, arrangement, and allocation of spaces to meet the functional requirements and maximize the use of available square footage.
Landscaping/ground shaping	Practice of the design, planning, and maintenance of outdoor spaces surrounding a building. This includes activities such as gardening, horticulture, lawn care, and shaping the landscape
Health (including safety, cleanliness)	measures and practices implemented to ensure the health, safety, and cleanliness of the building and its occupants

Security, privacy, and noise	measures and systems in place to ensure the security and privacy of the building and its occupants. It includes security systems, access control, surveillance, privacy measures, and management of noise levels to create a safe and comfortable environment.
Emergency preparedness tool (emergency exit, fire protection)	Installation of the emergency escape tool and fire protection tool in the office building
Heating, ventilation, and lighting	The systems and infrastructure for providing heating, cooling, ventilation, and lighting within the building This includes HVAC (heating, ventilation, and air conditioning) systems, artificial and natural lighting systems, and ensuring appropriate temperature and air quality levels.
Mechanical and electrical services	The practice of maintenance and management of mechanical and electrical systems within the building. This includes electrical distribution systems, power supply, electrical equipment maintenance, mechanical systems (e.g., elevators, escalators), and ensuring their efficient and safe operation
Ancillary services (mail, housing)	Provision of the services like mail delivery and distribution, on-site housing or accommodation facilities for staff or residents, and other amenities that complement the primary functions of the building.
Furniture, fixtures, and equipment	Better selection, installation, and maintenance of furniture, fixtures, and equipment within the building. This includes items such as desks, chairs, lighting fixtures, appliances, and other equipment necessary for the smooth operation of the building.
Signal and direction indicators (signs):	Signage and wayfinding systems implemented within the building to provide clear and visible guidance to occupants and visitors. Signs include directional signs, safety signs, informational signs, and other visual indicators to facilitate navigation and communication within the building
Recreational area	Designation of the space for the leisure and recreational activities, including Toilet
Transport accessibility and parking area	Provision of convenient access to transportation options and designated parking areas for vehicles. This includes considerations for public transportation access, parking facilities, and provisions for bicycle parking or other alternative modes of transportation
Socio-cultural indicator categories	
Indicators	Description
Appearance or View out of Building	External visual characteristics and how it presents itself to observers
Aesthetic of a building	overall visual and artistic qualities, style, and design principles applied in its creation
Feeling of Equality (Cultural Aspect)	Creating an environment that promotes inclusivity and respects cultural diversity, It involves ensuring that the facility accommodates the needs and preferences of various cultural backgrounds, avoiding discrimination or biases, and fostering an atmosphere where everyone feels valued and respected
Integration with Urban	How well a building or facility harmonizes with its surrounding urban context. Consideration of factors such as architectural style, scale, density connectivity, and the overall compatibility of the building within the existing urban fabric. Compatibility with city's law, guideline, standard.
Location of the Building	Physical placement or position within a specific area or site. Factors such as, proximity to amenities, facilities, and the surrounding community

Customer Satisfaction with Facility Services	The level of contentment or fulfilment experienced by the facility's users or customers regarding the services provided and practice of end user's satisfaction survey.
Customer Complaint on Facility Services (Record)	Customer complaints on facility services refer to documented instances where users or customer's express dissatisfaction or raise issues related to the facility's services or operations.
Occupancy Turnover Rate	measure of how frequently tenants or occupants change or vacate the building or facility
Performance based category	
Indicators	Description
Scope of Monitory	The defined/identified extent or range of activities and areas that are subject to monitoring.
Monitoring Means and Methods	Practice of setting out of provision of defined techniques, tools, and processes used to collect data and track performance indicators.
Scheduled performance evaluation	Practice of planned and regular assessments of the building's performance against established goals, standards, or benchmarks, including strategy.
Gap Analysis on Facility Management	Practice of gap analysis in defined way after assessing the current practice of facility management in the building..
Corrective Measures (Proactive Action)	Practice of proactive actions, that are taken to address identified gaps or deficiencies in facility management. good decision making in facility management.
Documentation of Results	Practice of recording and maintaining records of monitoring data, evaluation findings, corrective actions, and other relevant information related to facility management
Continual Improvement	Availability of ongoing process of enhancing practices, processes, and performance over time in facility management.
Learning and management indicators category	
Indicators	Description
Learning and Management	Practice of training provision for end-users about facility management and management
Managing the Change	Practice of effectively handling and implementing changes in building operations, processes, or systems
Understanding Facility Management Professional Practices	Practice of understanding core principles, standards, and best practices in facility management. generally having knowledge of industry-specific methodologies, techniques, and frameworks used to manage and optimize building facilities, resources, and services by facility manager/top manager.
Understanding Organizational Structure and Strategy	Practice of having knowledge and comprehension of the hierarchical structure, roles, and responsibilities within an organization It also involves understanding/defining the organization's strategic goals, objectives, and how facility management aligns with and supports those goals.
Developing Facility Management Strategy (Plan) in line with Organizational Structure	Creating a strategic plan for facility management that aligns with the organizational structure and objectives. includes defining goals, setting priorities, allocating resources, and establishing action plans to effectively manage and maintain building facilities in support of the organization's overall strategy
Risk Management	Practice of identifying, assessing, controlling, and mitigating potential risks and hazards associated with building operations
Understanding Ethiopian Facility-Related Laws	Familiarity with the legal framework and regulations governing facility management in Ethiopia.

(Formal and Informal Laws):	It includes knowledge of formal laws, regulations, codes, and standards related to building operations, safety, environmental compliance, and other relevant aspects. Informal laws may refer to customary practices or unwritten guidelines followed within the Ethiopian facility management context
Good Governance(free from corruption)	Emphasises of the principles of transparency, accountability, and integrity in managing building facilities and resources. Practice of ethical practices, fair decision-making processes, and the prevention of corruption or unethical behaviour within the facility management practices and operations
Rate of Response by Concerned Body	The speed and effectiveness of response by the relevant authority or responsible entity in addressing facility management issues or concerns
Consultancy Services	Practice of seeking expert advice, guidance, or support from external consultants or professionals provision of the guidance and consultancy for the employee on work process, use of the equipment

Appendix- III: Content validity study

Development of facility management assessment tool for public office buildings - In the of context Hawassa city (Sidama region: Ethiopia): Content validity study

Dear Expert,

My name is Tigilu Eshetu, currently I am undertaking MSc thesis at Adama science and technology university (ASTU) for partial fulfilment of MSc degree in Construction Engineering and Management under the title of ***"Development of facility management assessment tool for public office buildings: In context of Ethiopia (Sidama region: Hawassa city)".*** The objectives of the study are:

- To refine, prioritize and weight relevant variables of facility management in the context of Hawassa city (Sidama region: Ethiopia).
- To evaluate the current practice of the facility management in public office buildings in Hawassa city.
- To develop conceptual framework which ensure the public office building facility management performance in the context of Hawassa city (Sidama region: Ethiopia).

This content validity study contains 9 main categories and 84 items related to facility management. I need your expert judgment on the degree of relevant of each item to the measured domains in context of Hawassa (Sidama region: Ethiopia) by ticking on provided tables. Your review should be based on the operational definition and relevant terminologies that are provided to you.

Please be as objective and constructive as possible in your review and use the following rating scale:

Scale	Degree of relevance
1	item is not relevant to the measured domain
2	the item is somewhat relevant to the measured domain
3	item is quite relevant to the measured domain
4	item is highly relevant to the measured domain

Thank you in advance

Name of Candidate: Tigilu Eshetu Nare Advisor: Lemma. B, Ph.D.
Contact address: P.no: +251947219873
E-mail: www.tigilueshetu@gmail.com

Section -1: Background of Expert

1. Sex
   Male☐ Female ☐
2. Level of highest degree
   BSc/B.A ☐ MSc/MA ☐ Ph.D. ☐
3. Discipline of your highest degree
   Architecture ☐ Civil Engineering ☐ construction management ☐ Other ☐, specify -
4. Experience year on the facility management
   5-7 years ☐ 7-10 years ☐ >10 years ☐

Section -2: Selection of relevant variables on given information

Financial indicators

S.no	Tested items	Relevance			
		1	2	3	4
1	Building maintenance cost				
2	utility cost				
3	operating cost				
4	custodial and janitorial cost				
5	differed maintenance & differed maintenance backlog				
6	capital cost				
7	capital renewal cost				
8	churn cost and churn rate				
9	proportion of facility management budget				
10	facility condition assessment cost				
11	occupancy cost				
12	financial management (procurement and contract management				
13	time value of the money				

14	cost feasibility, review, analyse and report				

Do you consider any other indicators to be important for the financial competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

Technical indicators category

S.no	Tested items	Relevance 1	2	3	4
1	Scheduled maintenance of building elements				
2	Physical detection of building				
3	Repair, renovation and refurbishment				
4	Measurement of building elements if needed				
5	ICT application				
6	Understanding of building design				

Do you consider any other indicators to be important for the Technical competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

Human management indicators category

S.no	Tested items	Relevance 1	2	3	4
1	Background of the facility manager				
2	Improve the skill of facility manager by training and evaluate				
3	Effective communication between the stakeholders in organization				
4	Cooperation with real supplier/contractor/FM specialist				
5	Time management of the facility employee				
6	Leadership skill of top manager				
7	Team management				

Do you consider any other indicators to be important for the Human resources management competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

Environmental indicators category

S.no	Tested items	Relevance 1	2	3	4
1	Energy efficiency				
2	Water consumption management				
3	Waste management and discharge				
4	Material consumption for maintenance				
5	Environmental impact assessment				
6	Ecologic value				

Do you consider any other indicators to be important for the environmental competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

Functional indicators category					
		Relevance			
S.no	Tested items	1	2	3	4
1	Building services like (drainage, piping, sanitary..)				
2	Landscaping /Ground				
3	Space utilization				
4	Cleanliness				
5	Health, safety, security, privacy and fire protection				
6	Manage inventory and spare parts				
7	Emergency exit				
8	Heating, ventilation, noise, artificial and natural light				
9	Mechanical and electrical services				
10	Ancillary services (mail, housing)				
11	Insurance of property				
12	One window services				
13	Furniture's, fixtures and equipment				
14	Accessibility for aged and disabled person				
15	Productivity				
16	Signal and waiting room				
17	recreational area				
18	Transport accessibility and parking area				

Do you consider any other indicators to be important for the functional competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

	User based indicators category				
		Relevance			
S.no	Tested items	1	2	3	4
1	Customer satisfaction with the services				
2	Complaints on the facility services				
3	Occupant turn rate				
4	Public image on facility condition				

Do you consider any other indicators to be important for the user based competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

	socio-behavioural indicators category				
		Relevance			
S.no	Tested items	1	2	3	4
1	Appearance/view out				
2	Aesthetic value				
3	Feeling of equality				
4	Additional contribution for society				
5	Integration with the urban				
6	Location of the building				

Do you consider any other indicators to be important for the socio-behavioural competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

S.no	performance based indicators category				
	Tested items	Relevance			
		1	2	3	4
1	Scope of monitory				
2	Monitoring means and methods				
3	Evaluation of the facility performance				
4	scheduled audit and top management review				
5	corrective measure (proactive action)				
6	gap analysis on facility management				
7	documentation of the result				
8	continually improvement				

Do you consider any other indicators to be important for the performance based competency and comments? If yes, please specify indicators with rate of relevance and comments on improvement. _____

S.no	learning and management indicators category				
	Tested items	Relevance			
		1	2	3	4
1	Learning and management				
2	managing the change				
3	real estate management				
4	understanding facility management professional practices				
5	understanding organizational structure and strategy				
6	develop facility management strategy (plan) in line with Organization structure				
7	Risk management (Assessment, control, mitigation and emergency preparedness)				
8	evidence based decision making				
9	understanding international facility management requirement laws and criteria				
10	Rate of return by concerned body				
11	Consultancy services				
12	roles, responsibility and authority management				

Do you consider any other indicators to be important for the Learning and management competency and comments?

If yes, please specify indicators with rate of relevance and comments on improvement. _____

Appendix- IV: Prioritization and Weighting

Development of facility management assessment tool for public office buildings - In context of Hawassa city (Sidama region: Ethiopia)

Dear Sir/Madam,

My name is Tigilu Eshetu, currently I am undertaking MSc thesis at Adama Science and Technology University (ASTU) for partial fulfilment of MSc degree in construction engineering and management under the title of **"Development of facility management assessment tool for public office buildings: In the context of Hawassa city (Sidama region: Ethiopia)''.** The objectives of the study are:

- To refine, prioritize and weight relevant variables of facility management in the context of Hawassa city (Sidama region: Ethiopia).
- To evaluate the current practice of the facility management in public office buildings in Hawassa city.
- To develop conceptual framework which ensure the public office building facility management performance in the context of Hawassa city (Sidama region: Ethiopia).

This Analytical hierarchy process (AHP) template contains 9 main category tables of facility management with acronyms and total 9 AHP format tables for main category tables of facility management, which used for prioritization and weighting objective of the study. I need your judgment on the comparison of each item with itself and with others in provided white section of AHP tables. Your comparison review should be based on the rate of the importance to the facility management.

Please be as objective and constructive as possible in your comparison and use the following comparing scale:

Pairwise comparison numerical scale

Intensity of importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Moderate importance	Experience and judgment moderately favour one activity over another
3	Essential or Strong importance	Experience and judgment strongly favour one activity over another
4	Very strong importance	An activity is strongly favoured and its dominance demonstrated in practice
5	Extreme importance	An activity is extremely favoured and its dominance demonstrated in practice
1.5,2.5,3.5, 4.5	Intermediate values between the two adjacent judgments	
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	

Thank you in advance

Candidate: Tigilu Eshetu

Phone no: +251947219873/ 33319684 *E-mail: www.tigilueshetu@gmail.com*

Advisor: Lemma. B, Ph.D.

Section -1: Background of Expert

1. Sex

   Male☐ Female ☐

2. Level of your highest degree

   BSc/B.A ☐ MSc/M.A ☐ Ph.D. ☐

3. Discipline of your highest degree

   Architecture ☐ Civil Engineering ☐ construction management ☐ Management ☐ Other ☒, specify _____

4. Experience year on facility management area

   2-5 years ☐ 5-7 years ☐ 7-10 years ☐ >10 years ☐

Section -2: AHP analysis template

Table 1: facility management assessment tool main indicator with acronyms

S.no	Facility management assessment tool	FMAT
1	Financial indicators	FI
2	Environmental indicators	EI

3	Technical indicators	TI
4	Human resources management Indicators	HMI
5	Functional Indicators	FUI
6	Performance based indicators	PBI
7	Socio-cultural indicators	SCI
8	Learning and management indicators	LMI

Table 2: AHP format for facility management assessment tool main indicator

FMAT	FI	EI	TI	HMI	FUI	PBI	SCI	LMI
FI	1							
EI		1						
TI			1					
HMI				1				
FUI					1			
PBI						1		
SCI							1	
LMI								1

Table 3: financial indicators with acronyms

S.no	**Financial indicators**	**FI**
1	operating cost	FI-1
2	occupancy cost	FI-2
3	utility cost	FI-3
4	Building maintenance cost	FI-4
5	capital cost	FI-5
6	capital renewal cost	FI-6
7	custodial and janitorial cost	FI-7
8	facility condition survey cost	FI-8
9	financial management	FI-9
10	time value of money	FI-10

Table 4: AHP format for Financial indicator

FI	FI-1	FI-2	FI-3	FI-4	FI-5	FI-6	FI-7	FI-8	FI-9	FI-10
FI-1	1									
FI-2		1								
FI-3			1							
FI-4				1						
FI-5					1					
FI-6						1				
FI-7							1			
FI-8								1		
FI-9									1	
FI-10										1

Table 5: **Environmental indicators** with acronyms

S.no	**Environmental indicators**	**EI**

1	Energy efficiency	E-1
2	Water consumption management	E-2
3	Waste management	E-3
4	Material management	E-4
5	Environment impact assessment practice	E-5
6	Ecological value	E-6

Table 6: AHP format for **Environmental indicators**

SI	E-1	E-2	E-3	E-4	E-5	E-6
E-1	1					
E-2		1				
E-3			1			
E-4				1		
E-5					1	
E-6						1

Table 7: Technical indicators with acronyms

S.no	**Technical Indicators**	**TI**
1	Scheduled maintenance	TI-1
2	physical detection(if needed)	TI-2
3	Repair, renovation and refurbishment	TI-3
4	Measurement of building elements(if needed)	TI-4
5	ICT application	TI-5
6	understanding Building design	TI-6

Table 8: AHP format for Technical indicators

TI	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
TI-1	1					
TI-2		1				
TI-3			1			
TI-4				1		
TI-5					1	
TI-6						1

Table 9: Human Resource management indicators with acronyms

S.no	**Human Resource management Indicators**	**HMI**
1	Background of the facility manager	HM-1
2	improve the skill of facility manager by training and evaluate	HM-2
3	effective communication between the stakeholders in organization	HM-3
4	cooperation with real supplier/contractor/FM specialist	HM-4
5	Time management of the facility employee	HM-5
6	leadership skill of top manager	HM-6

Table 10: AHP format for Human factor indicators

HFI	HM-1	HM-2	HM-3	HM-4	HM-5	HM-6
HM-1	1					
HM-2		1				

HM-3			1			
HM-4				1		
HM-5					1	
HM-6						1

Table 11: Functional indicators with acronyms

S.no	Functional Indicators	FUI
1	building services like (drainage, piping, sanitary..)	FU-1
2	space utilization	FU-2
3	landscaping/ground shaping	FU-3
4	health (including safety, cleanliness)	FU-4
5	security, privacy and noise	FU-5
6	emergency preparedness(emergency exit, fire protection)	FU-6
7	heating, ventilation, lighting(i.e. artificial and natural light)	FU-7
8	mechanical and electrical services	FU-8
9	ancillary services (mail- housing)	FU-9
10	furniture, fixtures and equipment	FU-10
11	accessibility for aged and disabled person	FU-11
12	signal and direction indicator(signs)	FU-12
13	Recreational area	FU-13
14	transport accessibility and parking area	FU-14

Table 12: AHP format for functional indicators

FUI	FU-1	FU-2	FU-3	FU-4	FU-5	FU-6	FU-7	FU-8	FU-9	FU-10	FU-11	FU-12	FU-13	FU-14
FU-1	1													
FU-2		1												
FU-3			1											
FU-4				1										
FU-5					1									
FU-6						1								
FU-7							1							
FU-8								1						
FU-9									1					
FU-10										1				
FU-11											1			
FU-12												1		
FU-13													1	

FU-14														1

Table 13: Performance evaluation and improvement indicators with acronyms

S.no	Performance based indicators	PBI
1	Scope of monitory	PB-1
2	Monitoring means and methods	PB-2
3	scheduled performance evaluation	PB-3
4	Gap analysis on facility management	PB-4
5	Corrective measure (proactive action)	PB-5
6	documentation of result	PB-6
7	Continually improvement	PB-7

Table 14: AHP format of Performance based indicators

PEI	PB-1	PB-2	PB-3	PB-4	PB-5	PB-6	PB-7
PB-1	1						
PB-2		1					
PB-3			1				
PB-4				1			
PB-5					1		
PB-6						1	
PB-7							1

Table. 15 Socio-cultural indicators with acronyms

S.no	Socio-cultural indicator	SCI
1	appearance or view out of building	SC -1
2	aesthetic value	SC- 2
3	feeling of equality (cultural aspect)	SC- 3
4	integration with urban	SC- 4
5	location of the building	SC- 5
6	customer satisfaction with facility services	SC- 6
7	customer complaint on facility services(record)	SB- 7
8	occupancy turn of rate	SC- 8

Table 16: AHP format of socio-behavioural indicators

LMI	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8
SC-1	1							
SC-2		1						
SC-3			1					
SC-4				1				
SC-5					1			
SC-6						1		
SC-7							1	
SC-8								1

Table 17: Learning and management indicator with acronyms

S.no	Learning and management indicator	LMI

1	Learning and management	LM-1
2	managing the change	LM-2
3	understanding facility management professional practices	LM-3
4	understanding organizational structure and strategy	LM-4
5	develop facility management strategy (plan) in line with Organization structure	LM-5
6	Risk management (Assessment, control, mitigation and emergency preparedness)	LM-6
7	understanding Ethiopian laws (formal and informal laws)	LM-7
8	Good governance (no corruption)	LM-8
9	Rate of the response by concerned body	LM-9
10	consultancy services	LM-10

Table 18: AHP format of Performance evaluation and improvement indicators

LMI	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	LM-8	LM-9	LM-10
LM-1	1									
LM-2		1								
LM-3			1							
LM-4				1						
LM-5					1					
LM-6						1				
LM-7							1			
LM-8								1		
LM-9									1	
LM-10										1

Appendix V – Framework Validation

Frame work validation

Use the following scale of the agreement on the FMAT framework

Scale Refer	1 Entirely disagree	2 Mostly disagree	3 Somewhat disagree	4 Neutral	5 Somewhat agree	6 Mostly agree	7 Entirely agree

Category	Scale of agreement						
	1	2	3	4	5	6	7
Frame work is applicable in Hawassa city							
Frame work is drawn appropriately							
Frame work is can be effective when used in real life							
Frame work is can make responsiveness							
Frame work is user friendliness							

Any comment

Framework validation analysis using scale of agreement analysis

Category	Ex 1	Ext 2	Ex3	Ex 4	Ex 5	Mean value	Q1	Q3	Mdn	Level of agreement
Applicability	6	5	7	7	6	6.20	6	7	6	0.83
Appropriateness	6	6	5	6	6	5.80	6	6	6	1.00

Effectiveness	5	6	5	5	7	5.60	5	6	5	0.80
Responsiveness	7	6	6	5	6	6.00	6	6	6	1.00
User friendliness	6	7	5	4	6	5.60	5	6	6	0.83
					Average	5.84				0.89

Ex stands for Expert

Appendix VI – Questionnaire for assessment of current facility management

Section -1: Background of respondent

1. Sex

   Male☐ Female ☐

2. Level of your highest degree

BSc/B.A ☐ MSc/M.A ☐ Ph.D. ☐

3. Discipline of your highest degree ----------
4. Your experience year in organization

   1-5 years ☐ 5-10 years ☐ 10-15 years ☐ >15 years ☐

5. Story of building

G+1 ☐ G+2 ☐ G+3 ☐ G+4 ☐

Section -2: Please tick on provided section for the evaluation of current practice facility management in your organization using the following evaluation rate

1=excellent performance, 0.8=very good performance, 0.6=good performance, 0.4= low performance, 0.2=poor performance

Note that: all questions only concerned with your organization

S.no	Question	0.2	0.4	0.6	0.8	1
1	how do you think the practice of operating budget provision in your organization?					
2	how do you think the practice of occupancy budget provision in your organization?					
3	how do you think the practice of utility budget provision in your organization?					
4	how do you think the practice of building maintenance budget provision in your organization?					
5	how do you think the practice of capital budget provision in your organization?					
6	how do you think the practice of custodial &janitorial budget provision in your organization?					
7	how do you think the practice of facility condition survey budget provision in your organization?					
8	how do you think the practice of financial management(contract, procurement) in your organization?					
9	how do you think the practice of time value of money consideration in financial statement in your organization?					