ST. MARY UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF PROJECT MANAGEMENT

ASSESSMENT OF QUALITY MANAGEMENT PRACTICES OF CONDOMINIUM HOUSE PROJECTS IN ADDIS ABABA: THE CASE OF WASTEWATER MANAGEMENT IN MIKILILAND SITE

BY

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ID Nº SGS/0106/2009B

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A THESIS SUBMITTED TO ST. MARY'S UNIVERSITY, SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIRMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION IN PROJECT MANAGEMENT

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DECLARATION

I, the undersigned, declare that this thesis is my original work; prepared under the guidance of Chalachew Getahun (PhD). All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

Name

Bethelhem Zenebe Signature

St. Mary's University, Addis Ababa June, 2019

ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a university advisor.

Chalachew Getahun (PhD) _____

Advisor Signature

St. Mary's University June, 2019

Addis Ababa

Acknowledgement

My deepest thanks goes to Chalachew Getahun (PhD), my research advisor, whose constructive comments and suggestions were a guiding light having an immense contribution towards the successful completion of this paper.

My appreciation goes to a friend who remarkably supported and assisted me.

I would also like to appreciate official offices for their cooperation.

My admiration goes to my parents who were beside me throughout my endeavor with endless patients and continuous support.

Above all I would like to praise the almighty God for all his unspeakable gifts.

ABBREVIATIONS

AAHDA	Addis Ababa Housing Development Agency
AAWSA	Addis Ababa Water & Sewerage Authority
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
ES	Ethiopian Standards
FDRE	Federal Democratic Republic of Ethiopia
ISO	International Standard Organization
MCL	Maximum Concentrations limit
PMBOK	Project Management Body of Knowledge
PQM	Project Quality Management
QMS	Quality Management System
SD	Standard Deviation
WHO	World Health Organization

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ABSTRACT

General purpose of this research was mainly to assess wastewater quality management of condominium house projects practices and major quality management challenges. In order to achieve this objective, descriptive research method were employed and both primary and secondary data were used. Data collection tools used was questionnaires, interview, and document review. In addition clustered sampling techniques were employed.

The survey questionnaire was designed based on the literature and information collected through the document review of the wastewater treatment plant. These questionnaires were distributed to respondents from head office of AAWSA, sewerage treatment and reuse department and Mikililand condominium site sanitation committees. They were clustered by duties and responsibilities on onsite wastewater management, among all 40 distributed questionnaires 33 questionnaires were collected which represent a response rate of 82.5%. The data gathered through the questionnaire ware analyzed by Statistical Package for Social Science (SPSS). The generated data were analyzed using tables, frequency and percentage approaches.

The result of the study indicated that designing and constructing of the wastewater treatment facility at Mikililand condominium site hasn't fully employed all requirements of quality management process. Mikililand condominium wastewater management project was fully managed by AAHDA the owner instead of AAWSA which exclusively have an adverse effect on quality management. Inspection, process control chart and quality audits are found to be the major quality management tools and techniques used to control quality wastewater management. Qualified and experienced personnel, conformance to specification, processing time & weather patterns and quality of materials and equipment used while construction are identified as the major factors in the determinant of the quality of wastewater management. In the study it is examined that various quality assurance measures were taken starting from defining project objectives and to monitoring operation of the treatment plant by staffs from Mikililand condominium site sanitation committee with the assistance of AAWSA staffs. It was also identified that some barriers of quality management are; sewer line damaging, lack of quality management policy and strategy, in adequate management support, lack of waste management supervision and monitoring, and inefficient resources such as budget, repair & maintenance stuff, chemical dosing, labor were the major once.

Additionally the study recommends that AAWSA to have separate quality management policy in order to undertake complete quality management process, enhance management involvement, capacity building on project management skills for effective implementation of wastewater management.

Keywords: Quality, Quality Management, Quality Management Process, Wastewater Management, Wastewater Quality Management in Condominium House Projects

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Project Quality Management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It includes "all activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, quality control, quality assurance, and quality improvement, within the quality system (PMI, 2008). Quality management is a repetitive cycle of measuring quality, updating processes until the desired quality is achieved. Acknowledging the quality issues in wastewater management and increasing issues in environmental degradation, specific regulations to the implementation of the QMS have been framed (Metcalf and Eddy, 1991). The quality management has to provide the environment within which related tools, techniques and procedures can be deployed effectively leading to operational success for a project. This tool and process of quality management are used to relate critical success factors to company processes. This establishes the foundation on which the continuous quality management proceeds to conduct a gap analysis that identifies processes and steps within processes where improvement opportunities might be made (Robert, 2003).

Development of wastewater management system and implement quality management system through its operating period is the most essential for removing harmful chemicals and pollutants from water, sustain environmental protection and increase quality of life (Peavy, 1985). In the history of wastewater management, the main strengths have been to remove wastewater from users in order to prevent unhygienic conditions and to remove storm water to avoid damage from flooding. Mostly treated wastewater from the treatment plants is drained into surface water bodies such as rivers and the ocean. Although, if quality of the wastewater treatment plant isn't effective and efficient it leads to environmental (ground water contamination), decrease sea water quality and human health impacts (water-related diseases, such as cholera, dysentery, hepatitis, and typhoid) (Hutton, 2007).

ISO 140001, environmental management system describes aspects of what organization shall do to minimize harmful effects on the environment caused by its activities, conform to applicable regulatory requirements, and achieve continual improvement of its environmental performance. There is regional environmental policy established to improve and enhance the health and life

quality of all the people in the country and to promote sustainable social and economic development, without compromising the ability of the future generations to meet their own needs. The policy prohibits all acts causing environmental degradation, environmental pollution or environmental incidents and river water pollution.

In Ethiopia the effluent waste management was started in 1934. Before then residents of Addis Ababa used riversides and forests as a toilet. Then after, modern houses began to construct with septic tanks. Collected effluent waste was discharged around 'repi' and riversides before Kality catchment (wastewater treatment plant) constructed in 1984. Recently the effluent waste started to be connected by sewer lines and connected to 'repi' wastewater treatment plant. Population of Addis Ababa city is alarmingly increasing and both governmental and non-governmental organization's experiencing socio-economic and environmental problems due to population density. Hence high population density increases waste generation. Improper management of effluent harms and affects environmental, economic, social and human health. In order to safely manage and dispose the effluents deeply studied waste management construction is needed (Sisay, 2014).

Wastewater management is typically significant consideration for condominiums that are located in un sewer areas, where the condominium development must provide and manage its own wastewater collection, treatment, and disposal system. In order to be effective, sanitation systems not only need to perform a high quality treatment, but they also must be widely accessible and appealing, have to be affordable, low energy-demanding, relatively easy to maintain and operate, and convenient to use. Designing and implementing an appropriate waste management system in a particular place is only the beginning. Ensuring long-term viability and permanence of the system involves social considerations in addition to technological solutions (Bastidas, 2002).

Hence, role of quality management is to ensure products and services are consistent with their intended purpose and conformance to its requirements. In addition quality management is not an isolated activity, but intertwined with all the operational and managerial processes of the organization. The quality management system refers to quality planning, quality assurance and quality control (Philip, 1979). Therefore, this paper tries to assess quality management practices of wastewater management system of Mikililand site condominium house projects.

1.2 Study Site

Mikililand condominium site is found in peripheral side of Addis Ababa, Kolfe keranio sub city. This condominium site constructed between 2005/6-2008/9. In this site there are 123 blocks, 4,634 houses. Estimated population size to live in this site is 23,170 can be categorized as high population density. The constructed onsite wastewater treatment plant capacity is 3,000m^3 per day.

Fig 1.1 Mikililand Site Condominium Houses and Wastewater Treatment Plant

1.3 Statement of the Problem

Presently in Ethiopia, there is an increase in number of condominium house construction to address the basic need of the society. Besides residents of condominium houses are suffering from lack of sanitations in toilets, proper water supply as well as other infrastructures. There are frequent complains in almost all condominium sites related to the sanitation problems (Fekadu, 2014). General public health can be adversely affected by improper management of effluents waste. Proper collection, treatment and disposal of wastes is essential to communities wellbeing otherwise became sources of disease, pests and nuisance. Statistics data shows that more than 92.5% of the total effluent waste of Addis Ababa is not properly collected. This indicates that, the majority of the Ethiopian population is defecting in areas other than proper excreta disposal feces (Sisay, 2014).

There are few studies made on wastewater management particularly in Addis Ababa city context and most of these research concluded that Addis Ababa city wastewater management practice is

very weak and the rivers are extremely contaminated. Some of these research works are: Hamere (2017) studied contamination of rivers and water reservoirs and actions to combat it, Worku (2018) studied on how to create pollution free rivers and what action should be taken to correct them and Sisay (2014) studied assessment of liquid waste management practices. All this indicates that source of contamination are mainly from households, domestic, industries, commercial, etc. The polluted river produce heavy metals which are used by downstream residents to grow vegetables then which sold and consumed by inhabitants of the city which can cause health defects. Additionally a survey study from Merkabu (2014), titled "Assessment of the quality of construction of condominium housing projects in Addis Ababa", indicated problems in sanitation. It showed that the housing program gave little attention to issues like: the availability of basic services and facilities (i.e. waste management systems, green areas, and water provision problems etc… as incorporated in the housing program).

Quality management has to provide the environment within which related tools, techniques and procedures can be deployed effectively leading to operational success. Project quality management is the process of planning (identifying quality standards), assuring (planning to meet quality requirements) and controlling (steps taken to control results to see if they conform to requirements), (Hellstrom, Daniel, and Jonsson, 2006).

The study here focuses on quality of wastewater management system practice in condominium houses projects. Sisay (2014) indicated that management of condominium effluents waste poses a major problem in developing countries. The improper disposal of this waste cause serious environmental problem in terms of air, water and land pollution. Adopted wastewater management policies in developed countries to avoid wastewater management problems are constructing waste management system considering size, location, phasing, level of treatment, elimination of discharges, consolidation of facilities and monitoring onsite wastewater treatment systems. Main reason to conduct this proposed study is population in Addis Ababa are alarmingly increasing congruently condominium house projects are expanding. Thus it's necessary to assure the wastes are managed properly since large population density will lead to high waste generation.

Therefore, based on what has been done in other contexts and problems observed in wastewater management, this work aims to assess project management practices in relation to wastewater

quality management and identify major challenges of project quality implementation for condominium house projects in Addis Ababa at Mikililand site.

1.4 Research Questions

The research will focus on answering the following basic questions,

1. How is project management practiced in relation to wastewater quality management in Mikililand Condominium site in Addis Ababa?
2. What are the key factors challenging project quality implementation and wastewater management system in condominium house projects?

1.5 Objectives of the Study

1.5.1 General Objective

General objective of this study is to determine the quality of wastewater management system practice in condominium houses projects for Mikililand condominium site, Addis Ababa.

1.5.2 Specific Objective

- To assess project management practices in relation to wastewater quality management in Mikililand Condominium site in Addis Ababa
- To identify major challenges of project quality implementation and wastewater management for condominium house projects

1.6 Significance of the Study

Wastewater management is very critical in pollution reduction because improper management brings bad consequences in health, environmental, and sociological and economical aspects (Peavy, 1985). Thus this research paper tries to determine wastewater quality management practices in highly populated Mikililand condominium site as it contribute to the overall contamination of rivers. The study is significant as:

- The outcome of proposed study help AAWSA authorities to take better and appropriate measures in wastewater management activities at Mikililand condominium site.
- The study findings also are relevant input to the management of AAWSA in identifying the existing strength and weakness of quality management of wastewater management system in condominium houses in order to apply to the existing and similar projects in the future.
- The research could open the door for other researchers who are going to undertake further study in the area.

1.7 Scope and Limitations of the Study

This study is limited to quality management practices and challenges of wastewater management system in condominium house projects for Mikililand condominium site in Addis Ababa, developed by AAHDA. Generally, the study is limited to examining the nature of process quality management in the project management process thereby identifying the root causes of achieving project quality in wastewater management system for condominium house projects since its establishment. Although it describe practices of Mikililand condominium site only. Major limitations for this research work were availability of well-organized and sufficient documents.

1.8 Organization of the Study

This project is comprised of five chapters. The first chapter presented the background of the study, statement of the problem, research questions, and objectives of the study, significance of the study and scope and limitations of the study. The second chapter deals with review of theoretical, empirical and conceptual literature of important concepts that are relevant to the study. The third chapter discusses the research methodologies which include research approach, research design and research methods i.e., sampling techniques, target population and sample size, sources, instruments and procedures of data collection and data analysis method. Fourth chapter discuss data presentation, analysis and interpretation. In this section, the real practices and challenges while implementing the quality management in wastewater treatment plant for condominium houses projects for Mikililand site were well presented, analyzed, and interpreted. Finally, the last chapter includes conclusion of the results obtained from the research and provides appropriate recommendations.

CHAPTER TWO
LITERATURE REVIEW

This chapter includes conceptual, theoretical, and empirical literature reviews obtained from different scholars and authors that have been reviewed with respect to one of the knowledge areas of project management, quality management. It deals with the review of related literature gathered from different secondary sources such as published books, journals, articles and websites. The whole essence of this research is to study the key facts in treatment process, and quality management & associated factors. In order to get complete understanding of the theory and practice, various studies were analyzed and reviewed.

2.1 Conceptual and Theoretical Literature Review

Theoretical background of project, project management, quality, project quality management and process flow, tools and techniques, quality management implementation and challenges and relevant theories alone and with respect to waste water management has been described. Then conceptual framework has been established.

2.1 Theoretical Literature

2.1.1 Project and Project Management

2.1.1.1 Project

Artto, Martinsuo & Kujala (2006) used the following definition, a Project is a unique entity that aims at a previously defined goal, constitutes of complex, interrelated tasks and is limited by time, costs and its scope. Interrelation of the tasks means that the tasks in the project have to be carried out in a certain order. The tasks can be arranged as a logical whole by predecessor – successor relations. The dependency and the relations between the tasks build an essential part of the complexity of the project. The scope indicates that the project is producing a product, has to fill the requirements which founded on the needs and expectations directed at the project. The time indicates that a project has a previously defined schedule including a date for its beginning and its end. It means that the possibilities of using resources like labor, money or time are limited. The cost indicates that a project has to be carried out along a defined budget.

Project implementation and management focuses on three basic parameters: Quality, cost and time. A successfully managed project is completed at the specified level of quality, on or before the deadline, and within the planned budget (UNCRD, 2000).

2.1.1.2 Project Management

Project management is the process of managing, allocating, and timing resources in order to achieve a given objective in an expedient manner. The objective may be stated in terms of time (schedule), performance output (quality), or cost (budget). It is the process of achieving objectives by utilizing the combined capabilities of available resources. Project management covers the following basic functions Planning, Organizing, Scheduling, Controlling (Adedji B, 2004).

James P., Lewis (2002) defined Project management as the activities of planning, scheduling, and controlling of project to meet project objectives. There are many areas of project management, but these nine are the major components. What we manage in project management are work scope, time, costs, quality, human resources, communication, risk, procurement and integration. Hence this study envisages investigating the current practices and challenges of quality management in condominium houses projects of wastewater treatment system. Thus the following section describes quality management theories.

2.1.2 Quality Management

Over the past two decades, engineering industries have witnessed an unprecedented emphasis on quality in all aspects of the business. Quality has undergone conceptual change with process of evolution. Initially it was associated with inspection and later on covered the areas of process control, quality assurance, total quality management and strategic quality management. Hence it is less expensive to make things right first time than to make them over and do it right on the final try.

2.1.2.1 Quality

In olden days quality was considered synonymous with inspection. The definition of quality has seen a transformation with time which can be seen from definitions given below:

- Quality is about doing thing right first time, satisfying customers, minimizing costs, and maximizing profits
- The totality of features and characteristics of product, service and process, which bears on its ability to satisfy a given need (British Standard Definition)
- Quality as the totality of features and characteristics of a projects' product or service that bears on its ability to satisfy stated or implied needs (International Organization for Standardization, ISO)

- The total composite product and service characteristics of marketing, engineering, manufacturing and maintenance through which the product or service in use will meet expectations of the customer (Armand Feigenbaum)
- '… doing things right the first time….. every time.' W. Edwards Deming (1986)
- '…fitness for use, as judged by the user' Joseph M Juran (1989)
- '… conformance to requirements.' — Philip B. Crossby (1979)
- Other experts define quality based on conformance to requirements, meeting written specifications fitness for use and ensuring a product can be used as it was intended.

2.1.2.2 Quality Management

Quality management is a repetitive cycle of measuring quality, updating processes, until the desired quality is achieved. Quality management (QM) is not a separate, independent process that occurs at the end of an activity to measure the level of quality of the output. QM focuses on improving stakeholder's satisfaction through continuous and incremental improvements to processes, including removing unnecessary activities; it achieves that by the continuous improvement of the quality of material and services provided to the beneficiaries. It is not about finding and fixing errors after the fact, quality management is the continuous monitoring and application of quality processes in all aspects of the project (Crossby, 1979).

Quality system is based on quality management system, ISO 9001 and Environmental management system ISO 14001. ISO (International Standard organization) is the worldwide federation developed to harmonize national and international standards, developed by American National Standards Institute and American Society for Quality in 1987.

ISO 9001 is for quality management & it is:

- A family of standards and guidelines, that sets the requirements, for the assurance of quality and management's involvement in an organization.
- To ensure products and services are consistent with their intended purpose.
- Achieve customer satisfaction
- Continual improvement of performance and competitiveness
- Continual improvement of processes, products and services
- Comply with regulatory requirements

ISO 14001 is for environmental management this means what the organization does to:

- Minimize harmful effects on the environment caused by its activities,

- To conform to applicable regulatory requirements, and
- To achieve continual improvement of its environmental performance.

2.1.2.3 Project Quality Management

The main principle of project quality management is to ensure the project will meet or exceed stakeholder's needs and expectations. The project team must develop a good relationship with key stakeholders, specially the donor and the beneficiaries of the project, to understand what quality means to them. One of the causes for poor project evaluations is the project focuses only in meeting the written requirements for the main outputs and ignores other stakeholder needs and expectations for the project (PMI, 2008).

As scholars justify that project quality management as a process, according to Crawford the overall aim of quality management is to satisfy the customer, conform to requirements, ensure fitness for purpose, and to ensure the product for use. Project model looks at quality management as set of activities or tasks that are required to ensure the project satisfies all the needs for which it was undertaken based on documented in the state of work and includes a focus on quality management from the perspective of product, processes, and the people needed to make quality an effective and efficient aspect of successful project completion (Crawford, 2002).

PMBOK guide explains that "project quality management includes the processes and activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, quality control, quality assurance, and quality improvement, within the quality system activities conducted throughout, as appropriate" (PMI, 2008).

Project quality management consists of three main processes:

Quality Planning → Quality Assurance → Quality Control

2.1.3 Project Quality Management Process Flow

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project. Each process generally occurs at least once in every project phase (PMI, 2008). PMBOK guide explain project quality management process flows as follows:

2.1.3.1 Quality Planning

PMBOK guide defines quality planning as identifying which quality standards are relevant to the project and determining how to satisfy them. It is one of the key facilitating processes

during project planning and should be performed regularly and in parallel with the other project planning processes. For instance the desired project/product quality may require a detailed risk analysis of an identified problem.

Inputs to Quality Planning

A. **Quality Policy:** Quality policy is "the overall intentions and direction of an organization with regard to quality, as formally expressed by top management". The quality policy of the performing organization can often be adopted "as is" for use by the project. However, if the performing organization lacks a formal quality policy, or if the project involves multiple performing organizations (as with a joint venture), the project management team will need to develop a quality policy for the project. Regardless of the origin of the quality policy, the project management team is responsible for ensuring that the project stakeholders are fully aware of it.

B. **Scope Statement:** The scope statement is a key input to quality planning since it documents major project deliverables as well as the project objectives which serve to define important stakeholder requirements.

C. **Product description:** Although elements of the product description may be embodied in the scope statement, the product description will often contain details of technical issues and other concerns that may affect quality planning.

D. **Standards and regulations**: The project management team must consider any application-area-specific standards or regulations that may affect the project.

E. **Other process outputs**. In addition to the scope statement and product description, processes in other knowledge areas may produce outputs that should be considered as part of quality planning. For example, procurement planning may identify contractor quality requirements that should be reflected in the overall quality management plan.

Tools and Techniques of Quality Planning

A. **Benefit/cost analysis:** The quality planning process must consider benefit/cost tradeoffs. The primary benefit of meeting quality requirements is less rework, which means higher productivity, lower costs, and increased stakeholder satisfaction. The primary cost of meeting quality requirements is the expense associated with project quality management activities. It is axiomatic of the quality management discipline that the benefits outweigh the costs.

B. Benchmarking: Benchmarking involves comparing actual or planned project practices to those of other projects in order to generate ideas for improvement and to provide a standard by which to measure performance. The other projects may be within the performing organization or outside of it, and may be within the same application area or in another.

C. Flowcharting: A flowchart is any diagram which shows how various elements of a system relate. Flowcharting techniques commonly used in quality management include:

- Cause-and-effect diagrams, also called Ishikawa diagrams or fishbone diagrams, which illustrate how various causes and sub causes relate to create potential problems or effects.
- System or process flowcharts, which show how various elements of a system, interrelate.

D. Design of experiments: Design of experiments is an analytical technique which helps identify which variables have the most influence on the overall outcome. The technique is applied most frequently to product of the project issues. However, it can also be applied to project management issues such as cost and schedule trade-offs.

Output of Quality Planning

A. Quality management plan: The quality management plan should describe how the project management team will implement its quality policy. ISO 9000 terminology, describe the project quality system: "the organizational structure, responsibilities, procedures, processes, and resources needed to implement quality management". The quality management plan provides input to the overall project plan and must address quality control, quality assurance, and quality improvement for the project. The quality management plan may be formal or informal, highly detailed, or broadly framed, based on the needs of the project.

B. Operational definitions: are also called metrics in some application areas. It describes, in very specific terms, what something is, and how it is measured by the quality control process. For example, it is not enough to say that meeting the planned schedule dates is a measure of management quality; the project management team must also indicate whether every activity must start on time, or only finish on time; whether individual activities will be measured or only certain deliverables, and if so, which ones.

C. Checklists: A checklist is a structured tool, usually industry or activity-specific, used to verify that a set of required steps has been performed. Checklists may be simple or complex. They are usually phrased as imperatives ("Do this!") or interrogatories ("Have you done this?"). Standardized checklists used to ensure consistency in frequently performed activities.

D. Inputs to other processes: The quality planning process may identify a need for further activity in another area.

2.1.3.2 Quality Assurance

Quality assurance is all the planned and systematic activities implemented within the quality system to provide confidence that the project will satisfy the relevant quality standards. It should be performed throughout the project. Prior to development of the ISO 9000 Series, the activities described under quality planning were widely included as part of quality assurance.

Quality assurance is often provided by a Quality Assurance Department or similarly titled organizational unit, but it does not have to be.

Assurance may be provided to the project management team and to the management of the performing organization (internal quality assurance) or it may be provided to the customer and others not actively involved in the work of the project (external quality assurance).

Inputs to Quality Assurance

A. Quality management plan

B. Results of quality control measurements: are records of quality control testing and measurement in a format for comparison and analysis.

C. Operational definitions

D. Tools and Techniques to Quality Assurance

A. Quality planning tools and techniques: can be used for quality assurance as well.

B. Quality audits: quality audit is a structured review of other quality management activities. The objective of a quality audit is to identify lessons learned that can improve performance of this project or of other projects within the performing organization. Quality audits may be scheduled or random, and they may be carried out by properly trained in-house auditors or by third parties such as quality system registration agencies.

Outputs to Quality Assurance

A. Quality improvement: Quality improvement includes taking action to increase the effectiveness and efficiency of the project to provide added benefits to the project stakeholders. In most cases, implementing quality improvements will require preparation of change requests or taking of corrective action and will be handled according to procedures for overall change control

2.1.3.3 Quality Control

Quality control involves monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project. Project results include both product results such as deliverables and management results such as cost and schedule performance. Quality control is often performed by a Quality Control Department or similarly titled organizational unit, but it does not have to be.

The project management team should have a working knowledge of statistical quality control, especially sampling and probability, to help them evaluate quality control outputs. Among other subjects, they should know the differences between:

- Prevention (keeping errors out of the process) and inspection (keeping errors out of the hands of the customer).
- Attribute sampling (the result conforms or it does not) and variables sampling (the result is rated on a continuous scale that measures the degree of conformity).
- Special causes (unusual events) and random causes (normal process variation).
- Tolerances (the result is acceptable if it falls within the range specified by the tolerance) and control limits (the process is in control if the result falls within the control limits).

Inputs to Quality Control

A. **Work results:** Work results include both process results and product results. Information about the planned or expected results (from the project plan) should be available along with information about the actual results.
B. **Quality management plan**
C. **Operational definitions**
D. **Checklists**

Tools and Techniques of Quality Control

A. **Inspection:** Inspection includes activities such as measuring, examining, and testing undertaken to determine whether results conform to requirements. Inspections may be conducted at any level (e.g., the results of a single activity may be inspected or the final product of the project may be inspected). Inspections are variously called reviews, product reviews, audits, and walk-throughs.

B. Control charts: Control charts are a graphic display of the results, over time, of a process. They are used to determine if the process is "in control" (e.g., are differences in the results created by random variations or are unusual events occurring whose causes must be identified and corrected?). Control charts may be used to monitor any type of output variable. Although used most frequently to track repetitive activities such as manufactured lots, control charts can also be used to monitor cost and schedule variances, volume and frequency of scope changes, errors in project documents, or other management results to help determine if the "project management process" is in control.

C. Pareto diagrams: is a histogram, ordered by frequency of occurrence that shows how many results were generated by type or category of identified cause. Rank ordering is used to guide corrective action the project team should take action to fix the problems that are causing the greatest number of defects first. Pareto diagrams are conceptually related to Pareto's Law, which holds that a relatively small number of causes will typically produce a large majority of the problems or defects.

D. Statistical sampling: Statistical sampling involves choosing part of a population of interest for inspection (e.g., selecting ten engineering drawings at random from a list of 75). Appropriate sampling can often reduce the cost of quality control. There is a substantial body of knowledge on statistical sampling; in some application areas, it is necessary for the project management team to be familiar with a variety of sampling techniques.

E. Flowcharting. Flowcharting is used in quality control to help analyze how problems occur.

F. Trend analysis: Trend analysis involves using mathematical techniques to forecast future outcomes based on historical results. Trend analysis is often used to monitor:

- **Technical performance**—how many errors or defects have been identified, how many remain uncorrected.
- **Cost and schedule performance**—how many activities per period were completed with significant variances.

Outputs of Quality Control

A. Quality improvement: It is the systematic approach to the processes of work that looks to remove waste, loss, rework, frustration, etc. in order to make the processes of work more effective, efficient, and appropriate. Quality improvement refers to the application of methods and tools to close the gap between current and expected levels of quality by

understanding and addressing system deficiencies and strengths to improve, or in some cases, re-design project processes. A variety of quality improvement approaches exists, ranging from individual performance improvement to redesign of entire project processes. These approaches differ in terms of time, resources, and complexity.

B. Acceptance decisions the items inspected will be either accepted or rejected. Rejected items may require rework.

C. Rework is action taken to bring a defective or non-conforming item into compliance with requirements or specifications. Rework, especially unanticipated rework, is a frequent cause of project overruns in most application areas. The project team should make every reasonable effort to minimize rework.

D. Completed checklists when checklists are used, the completed checklists should become part of the project's records.

E. Process adjustments Process adjustments involve immediate corrective or preventive action as a result of quality control measurements. In some cases, the process adjustment may need to be handled according to procedures for overall change control

2.1.4 Wastewater Management

Waste must be properly managed to maintain a clean environment. Waste comes in three main forms: solid waste (garbage), human waste, and wastewater. People throughout the world have different methods to deal with these types of waste. Managing water and waste are increasingly challenging problems in the world today.

2.1.4.1 Wastewater

Wastewater comes in two forms: grey water and black water. Grey water is used domestic water, including used water from sinks, showers, and laundry, but not from toilets. Black water is wastes from toilets. Black water requires extensive, often expensive, treatment to be able to be reused and grey water is generally the only form of waste water reused (Ghunmi, 2011).

2.1.4.2 Wastewater Treatment Stages

Wastewater will go through any number of preliminary, primary, secondary, or tertiary treatment stages depending on its final purpose (Water UK, 2006). The amount of filtration required depends on the country's waste water reuse standards (WHO, 2006b). Under preliminary stages foreign objects and grits are removed. Grit is comprised of inorganic material such as sand, gravel, eggshells, etc. It is desirable to remove grit to prevent wear and

abrasion on pumps and other mechanical equipment (Keneck, Phil and David, 2001). Keneck, Phil and David (2001) on their handbook of wastewater management define the treatment stage as follows:

I. Primary Treatment

Primary treatment is a physical settling process that removes solids. Wastewater that enters the primary settling tank (or clarifier) is slowed down to enable the heavier solids to settle to the bottom. Lighter materials, such as grease, will float to the top of the tank. Settling tanks are designed with mechanisms to remove both the settled solids, as well as the floating solids. Primary clarifiers are either circular or rectangular. Both types work equally well when properly designed and maintained. Not all plants have primary treatment.

Primary treatment generates primary sludge. The sludge is removed and pumped to the solids treatment process for ultimate removal.

The wastewater still has solids remaining after primary treatment. These solids are either dissolved or suspended. Dissolved solids are very small solids (e.g. dissolving sugar in water). You cannot see the solids but they are there. Suspended solids can be likened to the same ends of a magnet. The solids repel each other. These solids are small, but are visible to the human eye. We remove these dissolved and suspended solids through the next phase of treatment secondary treatment.

II. Secondary Treatment

Secondary treatment is a biological treatment process used to stabilize the dissolved solids. Microorganisms (e.g., bacteria) feed on the organic solids (food) in the wastewater and convert the organics into a cellular or biological mass that can later be removed. The digestions systems are classified into aerobic and anaerobic. Aerobic digestion operates under the presence of oxygen, oxygen must be provided for aerobic organisms to work properly and efficiently. Anaerobic digestion is a collection of processes by which microorganism break down biodegradable material in the absence of oxygen. Anaerobic digestion is used as part of the process to treat biodegradable waste and sewage sludge.

Secondary treatment is intended to degrade organic compounds that consume oxygen when degraded and therefore increase the BOD and COD of the water. These microorganisms also bind less soluble fractions into floc particles that tend to settle to the bottom of the tanks.

Eventually the microorganisms also flocculate and settle so that the supernatant liquid can be discharged (Metcalf and Eddy 1991).

III. Tertiary Treatment

The final step in filtering water is tertiary treatment, where water is passed through sand filters, ponds, or wetlands to further clean the water. This step is only done where high quality water output is required, such as in places where plant life is particularly sensitive (Water UK, 2006; Sutherland, 2007). Tertiary treatment is the final stage to raise the effluent quality to the standard required before discharged. This phase usually includes different types of filtration, nutrient removal and chemical disinfection treatments (Metcalf and Eddy 1991). The large amounts of sludge that are generated in this process can be a problem. Although in theory the sludge can be composted, spread in fields as fertilizer or digested to produce methane, the scale of these operations often make them cost-prohibitive. Additionally, the sludge can have highly concentrated contents of heavy metals or other hazardous substances that were removed from the wastewater (Reynolds, 2002)

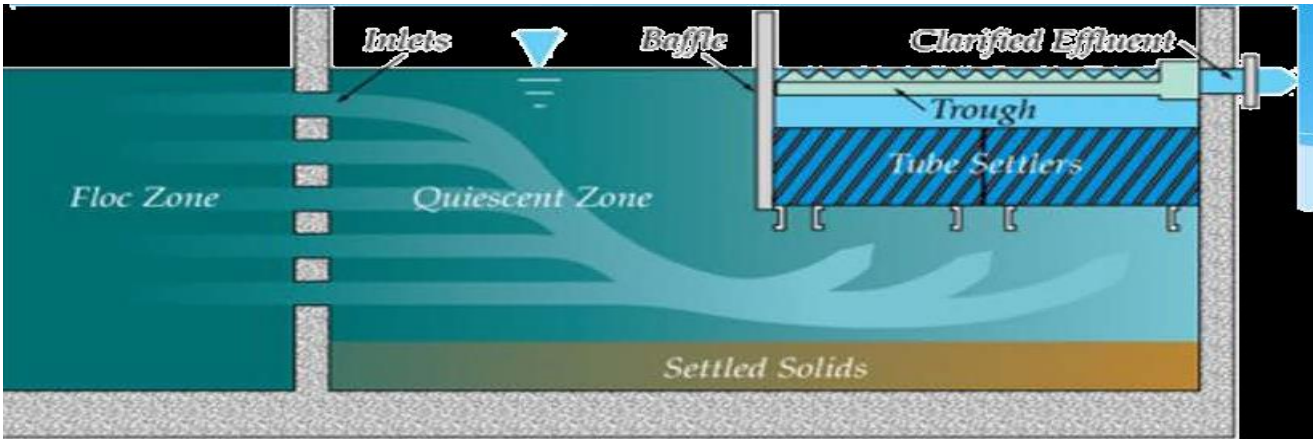

Fig 2.1 Overall Treatment Systems

2.1.4.3 Wastewater Management Policies

Mostly adopted water quality management plan by developed countries prepared by the Health and Environment control bureau of water classify and state wastewater management policies as:

A. Location, Sizing, Phasing, and Level of Treatment

The location and sizing of wastewater treatment plants and their accompanying collection lines are typically initiated by the designated management agencies. The management agency provides to the planning process its own decisions concerning the need to expand, consolidate,

and otherwise direct its own program. The need for phasing is determined by the management agencies and may be dependent on their local needs and ability to finance wastewater facilities. Phasing may necessary when additional quality of treatment is required by Environmental and Health control the provider needs time for engineering, financing, or technology development. Phasing may also be a result of postponing construction until the anticipated need for wastewater facilities actually exists. The minimum level of treatment is a determination of Environmental and Health Center. At the request of a committee, Environmental and Health Center will evaluate the location, size, and other technical information and make a decision concerning the quality of treated wastewater needed to maintain water quality standards. The results of the technical evaluation may be part of a Total Maximum Daily Load and ultimately included in any discharge permit issued by Environmental and Health Center.

B. Elimination of Discharges and Consolidation of Facilities

Health and Environment Center encourages, when possible and feasible, the consolidation of wastewater treatment facilities into regional treatment plants. The Plan may require that existing treatment plants be eliminated if continued operation threatens water quality or the systematic planned growth of a regional sewer system. Permits may be issued with conditions that require the facility to be eliminated. Any temporary facilities that would need to be eliminated in the future Plan. Factors such as location of the treatment facility, water quality benefits, and economics will guide the decision to approve or deny a request for a new wastewater facility or to recommend the elimination of an existing facility. These factors may also be evaluated during anti degradation review.

C. Onsite Wastewater Systems

Onsite Wastewater Systems, a wastewater treatment facility is considered to be accessible for connection when it adjoins the property in question, the sewer authority has granted permission for the connection and annexation or easements to cross adjacent property are not required for connection. Unless specifically granted an exception, in areas where centralized sewer is not currently accessible, Hygiene and Environmental Executive Committee requires public ownership of onsite wastewater systems serving more than one piece of deeded property.

2.1.5 PQM in Wastewater Management

Wastewater management is very essential to ensure that the receiving water into which the effluent is ultimately discharged is not significantly polluted, to meet the standards for the

quality of effluents from sewage works to be discharged to water bodies, to reduce contamination of ground water, to use treated sewage for gardening, irrigation, flushing, cooling systems, etc

2.1.5.1 Quality Planning in Wastewater Management

Wastewater collection systems (i.e., sewer networks) and centralized and decentralized treatment systems are designed and managed primarily to protect human and environmental health. Activities in planning include identifying sewer or nutrient management needs, estimating wastewater flows and loads, determining necessary levels of treatment; evaluating options, identifying sites; obtaining public input; designing and selecting treatment equipment, setting up the laboratories, quality assurance plan, providing routine and emergency operation and maintenance of wastewater, infrastructure etc. (Mihelcic, 2003).

The project management team also must consider environmental and health policies, sanitations regulations, taking action to ensure compliance with permits and approvals, collecting samples and conducting laboratory analyses to determine compliance with effluent or groundwater standards, and to assess off-site impacts, describing what all unit operations of wastewater treatment plant are and how it is measured by the quality control process etc. (Peavy, 1985). Additionally according to Chang typical quality plan contains most, if not all, of the following: brief description of the project, site layout plan, project quality objectives, list of contract document and drawings, project quality objectives, list(s) of materials and appliances used for the project, list(s) of materials and appliances used for the project, inspection and test plans, or list thereof, list of project-specific procedures, work instructions and inspection, frequency of updating the quality plan (Chang, 1999).

2.1.5.2 Quality Assurance in Wastewater Management

Quality assurance is done not only to the products and services delivered by the project but also to the process and procedures used to manage the project, that includes the way the project uses the tools, techniques and methodologies to manage scope, schedule, budget and quality. Quality assurance also includes the project meets any legal or regulatory standards (PMI, 2016).

Quality assurance factors are to have appropriate organization structure, clear lines of responsibility and communication, correct specifications and drawings, proper training, appropriate procedures, and ready access to necessary instructions, clear definition and

description of duties, to have the right resources, plant and materials; appropriate checking, measurement or testing of products and keeping proper records (Chang, 1999).

2.1.5.3 Quality Control in Wastewater Management System

It is the process that monitors specific project results to determine if they comply with relevant standards and identifies different approaches to eliminate the causes for the unsatisfactory performance. The goal of quality control is to improve quality and involves monitoring the project outputs to determine if they meet the quality standards or definitions based on the project stakeholder's expectations (Crossby, 1979). A good quality control system should have to consider; select what to control, set standards that provide the basis for decisions regarding possible corrective action, establish the measurement methods used, compare the actual results to the quality standards, act to bring nonconforming processes and material back to the standard based on the information collected, monitor and standardize measuring devices, include detailed documentation for all processes (Chang, 1999).

2.1.6 Factors Affecting Wastewater Quality Management

Quality can be assured by identifying and eliminating the factors that cause poor project performance Lepartobiko (2012). Studies shows that several quality factors were studied have impact on overall treatment process and performance of treatment plant. Most key factors studied having direct or indirect impacts are related to wastewater quality testing, unit operations and technical issues. Quality testing parameters are total dissolved salts (TDS), water temperature, environmental temperature, pH of water, concentration of suspended solids, dissolved oxygen in water, biological oxygen demand, chemical oxygen demand, color of water, quality of nutrients, and concentration of activated sludge, grease and oil in water. Technical issues include processing time, weather patterns, length and density of pipelines, equipment efficiency, and type of treatment, labor efficiency, and incoming water quality, availability of dosing chemicals and lack of knowledgeable and experienced operation personnel (Choudhury and Saha, 2017).

Good quality in the context of projects and programs as being to meet the customer requirement, meet the specifications, solve the problem, fit the purpose and satisfy the customer in this case the community who are served by the project. Most of the scholars agree that project quality in construction sector is affected by various internal and external factors (Turner, 2000).

2.1.7 Wastewater Quality Management Problems

Quality is one of the main concerns in project management depending on the nature of the project especially in developing countries including Ethiopia. Performance and efficiency of water treatment plant is affected by the capacity of water treatment plant and lack of monitoring, operations, repair and maintenance, human resource management, finance, service quality level, structural design, lack of waste management supervision, weak policies and institutional frameworks, sewer line construction, residents awareness, etc. (Mihelcic, 2003).

2.2 Empirical Review

This section will deal with a literature based on previous research evidence on condominium houses projects with perspectives of wastewater management system. It provides empirical evidences of quality management practices on onsite wastewater management project. Since Addis Ababa city population is alarmingly increasing one concern to give more attention to is handling waste in environmental friendly aspects otherwise its risk will lead to hazardous in human, animal and plant health, environmental effect, economic and social problems.

Accordingly quality management has increasingly been adopted by many organizations as an initiative to solve quality problems and to meet the needs of the final customer. Thus, this section is concerned with other studies conducted on other area in similar discipline. The first study selected for the empirical review is South Africa researchers' case study of water treatment plant and evaluation it's of performance. Through research, it was shown that performance and efficiency of water treatment plant were adversely affected by the capacity of water treatment plant and lack of monitoring. Additionally it included operations, repair and maintenance, human resource management, finance, service quality level, and consumer satisfaction. Through this research, it was shown that operations management has the greatest effect on the performance of water treatment plant (Makungo R, Odiyo JO, Tshidzumba N, 2011). Similarly, another research was conducted taking the case study of industrial-scale water treatment plants in Malaysia. Through this research, it was found that the structural design and operations of water treatment plant highly impacted the performance of water treatment plant. A group of researchers formulated a well-developed case study and showed the most important factors in evaluating the performance of wastewater treatment plants. Through their research, they highlighted that operational and maintenance factors must always be taken into consideration for improving the efficiency.

In order to assure wastewater treatment plant is performing efficiently three main criteria has been implemented generally operational efficiency, operational expenditure and environmental impact. Furthermore the alternatives, which are the main factors predicting the efficiency of water treatment plant include processing time, weather patterns, length and density of pipelines, equipment efficiency, type of treatment, labor efficiency, incoming water quality, and availability of dosing chemicals (Choudhury S, Saha,2017).

The other study conducted by Everline in his study on factors affecting the performance of construction projects in Kenya, identified four major factors that most important determinants in general construction projects; experience and qualification of personnel, quality of materials and equipments, conformance to specification and quality assurance training and meetings (Everline, 2014). In addition as Joy stated in his study on factors influencing quality of construction projects, the major factors that affect quality; material, labor, financial issues, conformance to codes and standards, top management support, management factors, selection of contractor, selection of designer design, co-operation of parties, contract documents and lack of communication (Joy, 2014). Further as stated by Agbenyega (2014) in his study in quality management practices of construction firms in Ghana, in solving the potential barriers are the main measures to be taken, namely: management commitment, communication between managers and employees, employee involvement, detailed and logical work program, regular inspection, quality audit report, lack of training and education of team members and review and analysis.

The study conducted on "Assessment of the Liquid Waste Management Practice of Condominium Houses" in Addis Ababa selected sites by Sisay in 2014 shows liquid waste management practice in the condominiums site, sewer line and vehicle is unsatisfactory because of the lack of waste management supervision of concerned bodies, weak policies and institutional frame works, slope of the constructed treatment plant, sewer line damaging due to road construction in the city, an adequate number of vehicle and carelessness of resident, therefore, the Addis Ababa City water and sewerage Authority and Addis Ababa Housing and construction Agency should develop the waste management supervision and strictly follow the National effluent Waste Management guideline (Sisay, 2014).

The problems identified by different researchers all shows there are difficulties in managing waste either in solid or liquid thus the quality management practice for all construction projects

have been in different sectors but not similar to this scenario. But contexts used in construction projects and principles used in wastewater management systems are used for this study. Accordingly, these variables are also considered in the study to consider in the context of the already in operation phase of condominium house construction projects with the aspects of wastewater management system.

Many other empirical studies had been conducted on similar topics all over the world besides above literature review. However all these researches were conducted in some particular context, geographical locations, and specific business sectors, and type of treatment processes. No specific research on this topic observed to analyze in one of project management body of knowledge areas of quality management practices in wastewater management system after establishment. Due to these reasons, there exists a wide scope for further studies, analysis & need for new research originated.

2.3 Ethiopian Environmental Policy

Ethiopia was approved by the Council of Ministers of the FDRE on April 2, 1997. The goal of this policy is to improve and enhance the health and life quality of all the people in the country and to promote sustainable social and economic development, without compromising the ability of the future generations to meet their own needs. The policy prohibits all acts causing environmental degradation, environmental pollution or environmental incidents and river water pollution. The policy, in general terms, regulates the responsibilities of industries and requires proper management of waste which affects City Rivers. It also deals with penalty schedule for breaking the law and adopts the Polluter Pays Principal (PPP), whereby the organization responsible for pollution or degradation of the environment must financially compensate for the damage. This financial punishment has a potential to discourage the polluting industries from further pollution if it is properly implemented and proportional to the extent of the pollution

The Regional State has established the Regional Hygiene and Environmental Executive Committee which has issued regional environmental sanitation regulations. As per the regulation, residents of the region and establishments/institutions must: construct and use latrines; not release liquid waste to flow onto roads, public places, running waters, wells, lakes, ponds and the like; not use open fields (instead of latrines); and not wash clothes and other similar things in unauthorized places. The environmental health inspectors, frontal health

workers, and sanitation agents are given the power to ensure full implementation of these regulations.

No	List Parameters Phyisco-Chemical Tests	Unit	WHO MCL (Max. Concentration Limit)
1	Color	-	Unobjectionable
2	pH	log 10	5-9
3	Total Suspended Solids	mg/l	200
4	Chemical Oxygen Demand	mg/l	200
5	Ammonia (NH_3)	mg/l	5
6	Total Phosphorus	mg/l	10
7	Total Nitrogen	mg/l	10
8	Oil & Grease	mg/l	100
Microbiological Analysis			
1	Biological Oxygen Demand	mg/l	100
2	Microbiology Analysis	cfu/100ml	<10

Table 2.1WHO/ES MCL of wastewater

2.4 Conceptual Framework

Lots of framework has been established to conduct quality management practices for different activities and objectives. For this study a similar framework has been followed for studying quality management practices of condominium house projects in managing wastewater system.

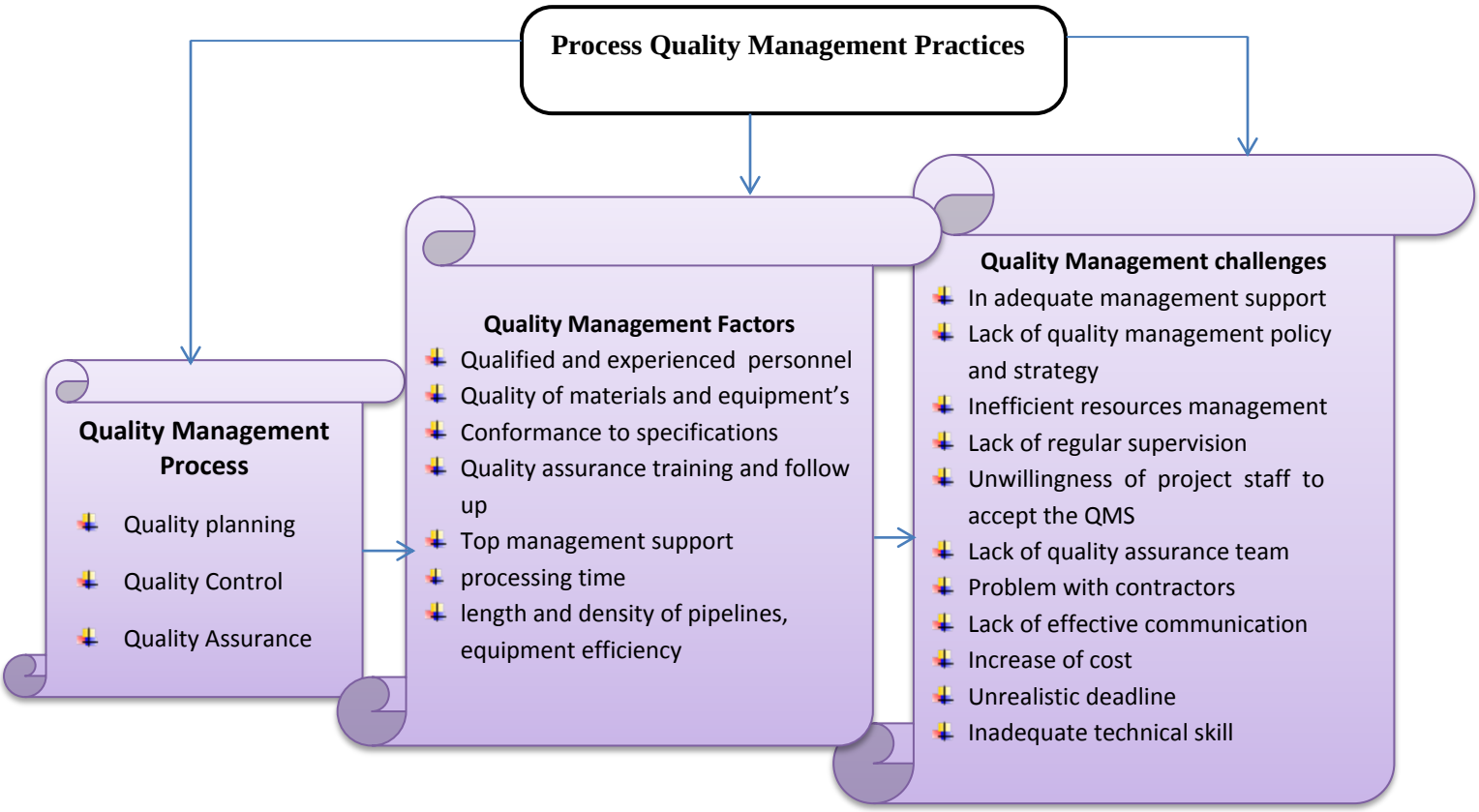

Fig 2.2 Conceptual Framework

Source: (Chang, 1999)

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGIES

This chapter deals with research design and methodologies. It specifies the type of research, the process of how the study is designed and the methods that are used to carry out the research. Generally it comprise research design, sampling techniques and sample size determination, data sources, data collection tools used, validity and reliability test, data analysis method and ethical considerations.

3.1 Research Approach

The study adopts mixed research approach qualitative and quantitative. According to Mark (2009), as cited in Aida (2015) mixing qualitative and quantitative approaches provides strengths that offset the weaknesses of both quantitative and qualitative research, provides more complete and comprehensive understanding of the research problem than either quantitative or qualitative approaches alone. This approach is used to provide more complete and comprehensive understanding on the basis of quality planning, quality assurance, quality control and quality management factors in wastewater management system.

3.2 Research Design

In any research undertaking, the methodology/research design to be followed is determined by the nature of the problem statement or more specifically by the research objectives. Here in this case study, the methodology followed is a descriptive research method. According to Creswell (2002), descriptive research method enables to easily be an instrument to analyze, tabulate and describe the context. While describing the collected data use the visual aids such as graphs and charts are used so as to make the reader understand the data. Moreover descriptive research helps to describe accurately the characteristics of individuals, group or situation also used to determine the frequency with which something occurs or with which it is associated to something else. Thus the research will describe the practices of Mikililand condominium site wastewater quality management system.

3.3 Research Methods

Research methods includes discussion of sampling techniques used, data sources and data collection tools used, data collection procedures and data analysis.

3.3.1 Sampling Techniques

Mugenda and Mugenda (2008) describe a sampling design as the process of selecting a number of individuals for a study in a way that the objects represent the characteristics of the population. Probability sampling method was chosen for this study as it makes each sample has an equal probability of being chosen and gives the probability that our sample is representative of a population. Under this method cluster random sampling was used by dividing the population into cluster that has deep insights on wastewater management i.e. operators from Mikililand site sanitation committees and AAWSA staffs in sewerage treatment and reuse department. This sampling method is chosen as it allows the researcher to focus on a limited number of informants that were clustered purposively to get the required information and optimal insight in carrying out the study. The cluster was designed based on their department, information and area of work they have about wastewater management implementation and challenges.

3.3.2 Target Population and Sample Size

The study focuses on Mikililnad condominium site currently practicing onsite wastewater management. Since successful quality management needs almost all members in the organization as they are involved directly or indirectly to the process. But population of this study is clustered by onsite staffs of Mikililnad condominium site wastewater treatment plant and head office staffs at AAWSA under department of in sewerage treatment and reuse as they have necessary information on the wastewater treatment plant. Therefore respondents of the study were mainly from the client or owner side of the project; AAWSA and condominiums site sanitation committees i.e. sewerage treatment and reuse leader, senior supervisors, junior supervisors, sewage engineers and operators/ assistances. The questionnaires were distributed with these participants. In addition interview was conducted with sewerage treatment and reuse supervisors. Thus, due to the above mentioned facts 33 samples of Mikililand site sanitation committees and AAWSA staffs team are included in the sample.

3.3.3 Sources, Instruments and Procedures of Data Collection

The study has employed both primary and secondary sources of data collection. To obtain sufficient and relevant data that helps to answer the research questions and achieve research objectives, both quantitative and qualitative data collection techniques were used from different primary and secondary sources. The primary sources of data were employees (professionals). Secondary data were also exploited to conduct the study. Documents review and analysis of

secondary data from various sources were used as useful source of information for the study. Relevant books, text books, journals, organization's past and current written documents on the relevant issues were used.

The researcher has selected questionnaires and interviews data instruments in order to collect relevant data. Interviews are considered as chosen instrument incase respondents misunderstand relevant questionnaires. These instruments were chosen considering research objective, costs, time, and data were analyzed and reduces basis since similar questions were distributed to each respondents. Additionally interviews are considered to assess the level of awareness about the risk exposure to waste and incase respondents misunderstand relevant questionnaires.

Procedures for the data collection contain the process flow of project quality management; quality planning, quality assurance, quality control and quality management factors. Based on these aspects questionnaires have been prepared to identify current practices and wastewater quality management problems encountered in Mikililand condominium site. And interviews were conducted to seek more information and make the data inclusive.

The first phase of data collection was the establishment of the study framework which includes the survey and secondary data. The survey framework includes the identification of all relevant documentation and formulation of questions for the interviews and questioners. The second phase pilot test done on the questioners by distributing questions to verify the clarity and include any comments before distributing to the total target. And the final version of questioner distributed to respondents and finally collected the data. Likewise interview were used in gather more of in-depth qualitative data from the key informant personnel's.

3.3.4 Data Analysis Method

Data processing is the collection of and manipulation of items of data to produce meaningful information. All collected data was analyzed both by quantitative and qualitative methods. The data obtained from the questionnaire used to assess the quality management practices and challenges were analyzed using SPSS (Version 20). After organizing, coding, and defining variables, responses of the cases were entered into the software. Then for analysis descriptive statistical methods were used presenting by frequencies, percent, mean and standard deviation as it enables us to present the data in a more meaningful and simpler interpretation of what the data was showing and results were presented using tables.

3.4 Validity and Reliability of the Instruments

Validity was enhanced by limiting the occurrence of systematic errors by use of simple understandable language Mutai (2000). Questionnaires and interview guidelines were prepared by the researcher to gather in depth respondent's opinions about wastewater treatment plant and its quality management in condominium house projects. The researcher checked the validity of questioners developed for this study. Before distributing the final questionnaires to the respondents, it's checked and commented by advisor of the researcher and pilots done to check the valid. The final version of the questioners was distributed after incorporating all the comments and feedbacks obtained.

Reliability analysis is carried out for internal consistency with regard to respondent's data on wastewater quality management rating using Cronbach's alpha and in principle cronbach's alpha of above 0.7 value is acceptable for internal consistency of data obtained from respondents. Therefore, reliability statistics checked based on the data process on SPSS is 0.82 for 74 items.

3.5 Ethical Considerations

The researcher takes utmost caution while administering the questionnaires. Authorization was obtained from the concerned office as well supporting letter from St. Mary University Student Support Office. Purpose of the study would be explained to the respondents to make them more comfortable to reply Respondents were give assurance regarding confidentiality and anonymous of the information obtained. The researcher approaches all participants to participate voluntarily in the data collection by collaborating in filling of the questionnaire. Thus the respondents were free to share their views. This study is not undermining any other personnel or previous or future researches. The purpose of study is made clear and simple to be easily understood by the readers to avoid any ambiguity at any end.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter of the study presents data presentation, analysis and interpretation of result and discusses that the data collected to answer the research questions derived from objectives of the study set to achieve. The data was mainly collected from the questionnaires and interviews from AAWSA staffs and Mikililand condominium site committee for the wastewater treatment plant. The result of the survey was discussed by triangulating the different source results: questionnaire results, interview and document review results.

The process of data analysis involved first cleaning and editing to exclude irrelevant materials to the study. The data analysis is grouped in to four major sections; these are personal information of the respondents, some secondary data related to the study, detail analysis regard to the questionnaire and interviews in a combined manner and finally discussion of the findings, because the content of the questionnaires, interviews and secondary data have the same objectives regarding to the research study.

The descriptive analysis was done in order to interpret raw data into useful information. Descriptive data was analyzed using qualitatively by frequencies to find the views of the respondents on wastewater quality management practices in Mikililand condominium site. The result of the analysis was presented in tables. The study further identified practices of quality management practiced in relation to wastewater management, the factors that influence quality of projects. The last section also assessed the challenges to quality management on wastewater treatment system.

4.2 Response Rate

A total of 40 questionnaires were distributed to the sewerage treatment and reuse teams in AAWSA and Mikililand condominium site sanitation committee. The respondents were professionals specifically assigned to control the wastewater treatment plant. The questionnaires directly focus on wastewater management staffs at head office of AAWSA and on the plant sites that have optimal insight in filling questionnaires. After the data had been collected, 33 out of the

targeted 40 questionnaires were responded to; therefore, 33 questionnaires were used in the analysis. This represented almost 82.5% response rate.

Table 4.1 Rate of Responses by Respondents

Questioner	**Mikililand Condominium sanitation committee & AAWSA**	
	Respondents	**%**
Returned	33	82.5
Not Returned	7	17.5
Total	40	100

Source: Survey Result, 2019

4.3 General Characteristics of Respondents

4.3.1 Gender Composition

The demographic statistics shown in the figure below show the distribution of respondents by gender. Participants were asked to indicate their gender by selecting the appropriate option provided (male or female). Accordingly they were eleven female and twenty two male respondents. This clearly indicates that the sample population was dominated by male respondents.

Table 4.2 Sex of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	11	33.3	33.3	33.3
	Male	22	66.7	66.7	100.0
	Total	33	100.0	100.0	

Source: Survey Result, 2019

4.3.2 Educational Background

The educational background of the respondents' analysis result shows that only 4 respondents (12.1%) have completed from high school, 8(24.2%) respondents have college diploma and the rest 21(63.6%) respondents have undergraduate degree. This profile shows that majority of the respondents have undergraduate degree.

Table 4.3 Educational Background of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School Completed	4	12.1	12.1	12.1
	College Diploma	8	24.2	24.2	36.4
	Bachelor Degree	21	63.6	63.6	100.0
	Total	33	100.0	100.0	

Source: Survey Result, 2019

4.3.3 Role and Experience of Respondents

Positions that respondents currently hold in the organizations are grouped into six major categories located in bureau and at site as sewerage treatment & reuse sub process leader, sewerage treatment & reuse sub process senior supervisor, sewerage treatment & reuse sub process junior supervisor, sewerage engineer's team leader, sewerage engineers and assistants.

Accordingly, 1(3.3%) hold leader position, 5(15.3%) were senior supervisors, 17(50.4%) were junior supervisor, 1(3.3%) team leader, 4(12.4%) were sewerage engineers and the rest 5(15.3%) were assistants.

Table 4.4 Positions of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sewerage Treatment & Reuse Sub process leader	1	3.3	3.3	3.3
	Sewerage Treatment & Reuse Sub process senior supervisor	5	15.3	15.3	18.6
	Sewerage Treatment & Reuse Sub process Junior supervisor	17	50.4	50.4	69
	Sewerage Engineers Team Leader	1	3.3	3.3	72.3
	Sewerage Engineers	4	12.4	12.4	84.7
	Assistant	5	15.3	15.3	100.0
	Total	33	100.0	100.0	

Source: Survey Result, 2019

In addition, the study chose to consider respondent's level of experience which is vital towards knowledge of wastewater quality management system. 8(42.4 %) of the respondents have 6-10 years, 11(30.3%) have less than 5 years, and 27.3% of them have above 10 years of experiences.

4.3.4 Mikililand Wastewater Treatment Plant

From the interview it's found that the responsible agency, AAWSA generally uses three mechanisms to solve the effluents problem in condominium houses of Addis Ababa. These mechanisms to remove effluents are by building septic tanks, connecting wastes to sewer lines, and built onsite wastewater treatment plant. Mikliland condominium site is the earliest site in having onsite wastewater treatment plant. Currently most condominium sites are constructed with onsite treatment plants and use latest technologies. Mikililand condominium site applies natural anaerobic reaction treatment system. Wastes from this site are both grey and black water. Capacity of treatment plant is 3000 m^3/day. Distance between houses and treatment plant is around 50m. It has 7 ponds which treat the waste by natural treatment process due to retention time. First preliminary treatment stage is carried out by the first pond, Grit chamber which is used to screen large solid particles. Then it transferred by gravity to the primarily treatment stage known as anaerobic pond system. It uses two ponds to receive wastes came from first stage. After 10days of retention time the wastes transferred to secondary treatment stage, faculation pond system. Finally it transferred to final tertiary treatment stage called as maturation pond system and it discharged to near river. The sludge also mostly discharged to near river and sometimes it's collected by solid waste collecting truck or burned by fire. Overall time needed to reach final stage is 31days. All this process passed to next stage by gravity.

Sanitation committee staffs at the site control and monitor continuous operation of the plant. And personnel's' from AAWSA periodically came to take samples for wastewater quality test, assist the staffs on the site, maintenance and repair, etc.

4.3.5 Wastewater Management Policies

Generally accepted wastewater management policies as briefly described in literature review are identifying location, sizing, phasing, and level of treatment, elimination of discharges and consolidation of facilities and optimal onsite wastewater systems. Although information obtained from AAWSA personal through interview doesn't indicate appropriate application of these policies.

For instance the treatment plant is located near the house; 50m which is not recommended. Although wastewater generated and capacity of the treatment plant doesn't much that leads weak treatment practices. At this site no treatment technologies were used the agency phasing strategy was based on geographical location, local availability of technologies and financial capability. There is no practice in elimination of discharges. Wastewater quality test reports showed that it's recommended to approve the level of treatment but no improvement hasn't made since now. There is no document available to decide the management agency has included the need to expand, consolidate or any suggestion but the respondent agreed the treatment plant requires improved technologies.

Wastewater quality testes are conducted for parameters available in local laboratories and the results are recorded. But there is no recommendation based on the values to assure the discharged effluents are within the maximum concentration level of wastewater quality standard or level of treatment required if it exceed.

4.4 Quality Management Process Flow

4.4.1 Quality Planning Practices

To describe quality management planning practice the researcher used agreement level of respondents for the quality planning variables recommended by Chung, (1999) and activities wastewater treatment planning process by Mihelcic, (2003). Majority of the responses are on the agreement level of the respondents rated from strongly agreed to strongly disagree. The following table describes the result of the findings.

Table 4.5 Content of Quality Planning

Quality Planning Activities	Response	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
Brief description of project	33	4 (12.1%)	17(51.5%)	9(27.3%)	2(6.1%)	1(3%)	2.36	0.895
List of contract documents and drawings	33	3(9.1%)	0	12(36.4%)	11(33.3%)	7(21.2%)	3.58	1.119
Project quality objectives	33	0	0	14(42.4%)	14(42.4%)	3(15.2%)	3.73	0.719
List(s) of materials and appliances used for the project,	33	12(36.4%)	13(39.4%)	1(3%)	7(21.2%)	0	2.09	1.128
Inspection and test plans, or quality test	33	1(3%)	23(69.7%)	9(27.3%)	0	0	2.24	0.502

list								
List of quality procedures and work instructions	33	1(3%)	0	6(18.2%)	18(54.5%)	8(24.2%)	3.97	0.847
Frequency (or provisional dates if possible) of internal quality audits	33	0	0	3(9.1%)	10(30.3%)	20(60.6%	4.52	0.667
Frequency of updating the quality plan	33	0	0	6(18.2%)	10(30.3%)	17(51.5%	4.33	0.777
Estimating wastewater flows and loads	33	0	0	9(27.3%)	19(57.6%)	5(15.2%)	3.88	0.650
Determining necessary levels of treatment	33	6(18.2%)	19(57.6%)	8(24.2%)	0	0	2.06	0.659
Designing and selecting treatment equipment	33	0	6(18.2%)	19(57.6%)	8(24.2%)	0	3.06	0.659
Emergency operation maintenance of waste water, infrastructure availability	33	11(33.3%)	16(48.5%)	6(18.2%)	0	0	1.85	0.712
Environmental and health policies and sanitation regulations	33	10(30.3%)	19(57.6%)	4(12.1%)	0	0	1.82	0.635

Source: Survey Result, 2019

Accordingly, mostly agreed variables that were included in quality planning of wastewater management are environmental and health policies and sanitation regulations (87.9%), emergency operation maintenance of wastewater, infrastructure availability (81.8%), and determining necessary levels of treatment or quality test list (75.8%). On other hand frequency of disagreed variables that weren't involved in quality planning of wastewater management are frequency (or provisional dates if possible) of internal quality audits (90.6%), frequency of updating the quality plan (81.8%) and list of quality procedures and work instructions (78.7%). Unlike the literature which recommend the content of the quality plan as listed in the above table the findings indicates partial inclusion of the content and there is no separate quality plan document for wastewater quality management.

From interview it's noted that designing and construction of the treatment plant were carried by AAHDA staffs who were less qualified and inexperienced personnel.

4.4.2 Quality Assurance Practices

This section of the study discusses the desirable measures for effective quality assurance practices in the surveyed wastewater treatment facility of Mikililand condominium site. To do this, the respondents were presented with 10 variables whether they consider it in their quality assurance system. These items are identified based on the literature from other similar projects and understanding quality assurance in wastewater management, the following table summarizes the responses of the target respondents for the question does the wastewater management system follow the following quality assurance activities.

Table 4.6 Content of Quality Assurance

Quality assurance activity	Response	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
Have appropriate organization structure	33	16(48.5%)	13(39.4%)	4(12.1%)	0	0	1.64	0.699
Clear lines of responsibility and communication	33	15(39.4%)	19(57.6%)	1(3%)	0	0	1.58	0.502
Correct specifications and drawings	33	0	0	12(36.4%)	15(45.5%)	6(18.2%)	3.82	0.727
Proper training	33	7(21.2%)	13(39.4%)	13(39.4%)	0	0	2.18	0.769
Appropriate procedures	33	6(18.2%)	12(36.4%)	5(15.2%)	10(30.3%)	0	2.58	1.119
Ready access to necessary instructions	33	0	8(24.2%)	0	10(30.3%)	15(45.5%)	3.97	1.212
Clear definition and description of duties	33	12(36.4%)	9(27.3%)	12(36.4%)	0	0	2.00	0.866
Have the right resources, plant and materials	33	2(6.1%)	18(54.5%)	4(12.1%)	6(18.2%)	3(9.1%)	2.70	1.132
Appropriate checking, measurement or testing of products	33	0	5(15.2%)	7(21.2%)	18(54.5%)	3(9.1%)	3.58	0.867
Keeping proper records	33	20(60.6%)	8(24.2%)	5(15.2%)	0	0	1.55	0.754

Source: Survey Result, 2019

The above table presents majority of agreed variables to assure quality ranked as first is clear lines of responsibility and communication (97%), then have appropriate organization structure

(87.9%), and third keeping proper records (84.8%). Consequently a mostly disagreed variable for assuring quality is ready access to necessary instructions (75.8%). This result illustrates that majority of the respondents confirmed more or less the bureau applies quality assurance techniques in organizational structure than in controlling the onsite quality of the wastewater.

Additionally the interview conducted shows that the bureau tries to conduct wastewater quality tests to determine the treatment facility is performing effectively and efficiently as per the standard. But it's shown that no improvements were made for the result that exceeds WHO MCL effluent standard. The sample are collected and conducted just to fulfill the requirements. Furthermore they don't have any maintenance schedule programmed for the sustainability of the operation instead assistance from the site report malfunctioned and assigned personnel from AAWSA head office will come for maintenance. Since its open pond system and outdated technology it needs more attention not to pollute the environment and cause communicable disease. Quality auditing is done by the internal sewerage and reuse leader but still improvement suggested hasn't applied to improve quality of the wastewater management system.

4.4.3 Quality Control Practices

Goal of quality control is to improve quality and involves monitoring the outputs to determine if they meet the quality standards. This section tries to describe practices of quality control in wastewater management system based on variables listed in literature section. The following table summarizes the responses of the target respondents for the question, does the Mikililand wastewater management system follow the following activities to control quality.

Table 4.7 Content of Quality Control

Quality control activity	Responses	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
Select operations or activities to control	33	3(9.1%)	21(63.6%)	4(12.1%)	5(15.2%)	0	2.33	0.854
Set standards that provide the basis for decisions regarding possible corrective action	33	0	4(12.1%)	20(60.6%)	8(24.2%)	1(3%)	3.18	0.683
Establish the measurement methods used	33	10(30.3%)	17(51.5%)	4(12.1%)	2(6.1%)	0	1.94	0.827
Compare the actual results to the quality	33	18(54.5%)	4(12.1%)	6(18.2%)	5(15.2%)	0	1.94	1.171

standards								
Act to bring nonconforming processes and material back to the standard	33	0	4(12.1%)	5(15.2%)	17(51.5%)	7(21.2%)	3.82	0.917
Monitor and standardize measuring devices	33	0	1(3%)	7(21.2%)	9(27.3%)	16(48.5%	4.21	0.893
Include detailed documentation for all processes	33	0	0	11(33.3%)	14(42.4%)	8(24.2%)	3.91	0.875

Source: Survey Result, 2019

The above table present majority of agreed variable to control quality ranked as first is establishment of measurement methods used (81.8%), select operations or activities to control (72.7%), and compare the actual results to the quality standards (66.6%). Consequently mostly disagreed variables for quality control are monitor and standardize measuring devices (75.8%), act to bring nonconforming processes and material back to the standard (72.7%), and include detailed documentation for all processes (66.6%).

Findings from questionnaires and interviews indicated that appropriate control system hasn't applied in this treatment facility. The engineers periodically review work results and data recorded to monitor the treatment plant is operating as per the specification based on the checklists and local government rules and regulations. But this review will just be recorded before decision made. Therefore the result shows that no improvement was made to Mikililand wastewater treatment site since establishment. This leads to discharge of wastes without proper treatment to environment. The consequences of this hazardous contamination bring adverse effects on social, economically, environmental, human and animal health.

4.4.4 Quality Management Tools & Techniques

In the table below a list of quality management tools and techniques were prepared based on the review of literatures. It is one of the objectives of the study to verify quality management tools and techniques are relevant in the context of wastewater quality management. The following table describes the result of the findings.

Table 4.8 Quality Management Tools and Techniques

Tools	Response	Count	Percent (%)	Mean	SD
Benefit Cost Analysis	Yes	12	36.4	1.64	0.489
	No	21	63.6		
Benchmarking	Yes	9	23.7	1.73	0.452

	No	24	72.3		
Flow Charting	Yes	23	67.7	1.30	0.467
	No	10	30.3		
Design of Experiments	Yes	23	67.7	1.30	0.467
	No	10	30.3		
Quality Audits	Yes	24	72.3	1.27	0.452
	No	9	23.7		
Process Control Charts	Yes	25	75.8	1.24	0.435
	No	8	24.2		
Inspection	Yes	26	78.8	1.21	0.415
	No	7	21.2		
Pareto Diagram	Yes	7	21.2	1.79	0.415
	No	26	78.8		
Statistical Sampling	Yes	12	36.6	1.64	0.489
	No	21	63.4		
Trend Analysis	Yes	5	15.2	1.85	0.364
	No	28	84.8		

Source: Survey Result, 2019

As can observe from the above most of the quality management tools and techniques might not be applicable since it might not be related to the process. Accordingly, inspection seems as the common practices which count for (78.8%) followed by process control charts (75.8%) and quality audits (72.3%).

Responses from the interview showed that experiment/laboratory test is used for conducting different parameters of wastewater quality tests i.e. pH, TSS, BOD, COD, faecals, etc. to verify whether the result meet the quality standard requirement of the discharging set by ES/WHO. Therefore, the others seems unrelated to wastewater quality management. Few quality management tools and techniques were revealed from the interview which were not highlighted in the literatures are periodic wastewater quality test reports, and treatment plant status reports. These reports are used as the monitoring tools of wastewater treatment performance.

4.5 Quality Problems in Wastewater Management

This section of the study assesses generally the problems in quality management for wastewater treatment system. The respondents were asked if they encounter problems as highlighted in the literatures for the implementation of wastewater quality management. To assess these variables were presented to rank from ‘great problems’ to ‘very less problems’ factors based on the literature. List of problems was as shown in table below. Problems which weren’t discussed in the literatures also identified by respondents and details for the feedbacks from the respondents are illustrated below.

Table 4.9 Problems in wastewater quality management

Description	Responses	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
Inadequate management support, lack of wastewater management supervision and monitoring	33	22(66.7%)	8(24.2%)	3(9.1%)	0	0	1.58	0.936
Lack of quality management policy and strategy	33	20(60.6%)	10(30.3%)	3(9.1%)	0	0	1.39	0.496
Inefficient resources (Budget, Repair & Maintenance stuff, chemical dosing, labor…)	33	11(33.3%)	19(57.6%)	0	3(9.1%)	0	1.85	0.834
Unwillingness of project staff to accept the quality management system	33	3(9.1%)	11(33.3%)	0	14(42.4%)	5(15.2%)	3.21	1.317
Lack of quality assurance team leading the process	33	16(48.5%)	11(33.3%)	2(6.1%)	4(12.1%)	0	1.82	1.014
Problems with contractors	33	0	3(9.1%)	4(12.1%)	10(30.3%)	16(48.5%)	4.18	0.983
Increase of cost	33	0	3(9.1%)	19(57.6%)	8(24.2%)	3(9.1%)	3.33	0.777
Lack of effective communication	33	10(30.3%)	18(54.5%)	2(6.1%)	2(6.1%)	1(3%)	1.97	0.951
Sewer line damaging	33	21(63.6%)	11(33.3%)	1(3%)	0	0	1.58	0.502

Source: Survey Result, 2019

From the above table, the first there major problems in the order of their rank were sewer line damaging(99%), lack of quality management policy and strategy (90.9%), lack of waste management supervision and monitoring(90.9%), and inefficient resources such as budget, repair & maintenance stuff, chemical dosing, labor (90.9%) ranked 1st, 2nd and 3rd respectively. However, the least ranked challenges to project quality in the wastewater quality management surveyed were problems with contractors (78.8%), and unwillingness of project staff to accept the quality management system ranked (57.6%). However, factors considered as less problematic

were found to affect even if the degree varies, since all the listed problems affect quality of wastewater management.

4.6 Perceived Factors Affecting Quality of Wastewater Management

This section of the study assesses the factors that influence the quality of wastewater management in condominium houses project for Mikililand condominium site. The respondents were presented with variables from the literatures to rank from 'great influence' to 'very less influence' for the question of quality management factors that affect performance of wastewater management;

Table 4.10 Perceived Quality Management Factors

Description	Responses	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
Processing time, weather patterns	33	20(60.6%)	7(21.2%)	6(18.2%)	0	0	1.58	0.792
Length and density of pipelines	33	4(12.1%)	16(48.5%)	6(18.2%)	7(21.2%)	0	2.48	0.972
Equipment efficiency	33	0	0	20(60.6%)	13(39.4%)	0	3.39	0.496
Incoming water quality	33	5(15.2%)	17(51.5%)	7(21.2%)	4(12.1%)	0	2.30	0.883
Availability of dosing chemicals	33	0	1(3%)	6(18.2%)	17(51.5%)	9(27.3%)	4.03	0.770
Lack of Qualified and experienced personnel	33	14(42.4%)	16(48.5%)	3(9.1%)	0	0	1.48	0.508
Quality of materials and equipment used in the project construction	33	2(6.1%)	17(51.5%)	4(12.1%)	8(24.2%)	2(6.1%)	2.73	1.098
Conformance to specifications	33	7(21.2%)	21(63.6%)	51(5.2%)	0	0	1.94	0.609
Quality assurance training and follow up	33	17(51.5%)	15(45.5%)	1(3%)	0	0	1.52	0.566
Top management support	33	5(15.2%)	16(48.5%)	4(12.1%)	8(24.2%)	0	2.45	1.064
Co-operation of stakeholders	33	0	0	1(3%)	15(45.5%)	17(51.5%	4.52	0.508

Source: Survey Result, 2019

From above table lack of qualified and experienced personnel (90.9%), conformance to specifications (84.8%) and processing time & weather patterns (81.8%) ranked 1st, 2nd, and 3rd respectively are estimated the three most important factors in the determinant of wastewater

quality management in condominium house projects undertaken. However, the least selected influential factor in terms of quality of projects undertaken by the survey was cooperation of stakeholder (97%) and availability of dosing chemicals (78.8%).

4.7 Consequences of Improper Wastewater Management

This section describes in pointing out major impacts of improper wastewater management activities. Thus it indicates impacts by ranking in having very bad consequences to no consequences. The following responses were collected for the questions of potential negative environmental impacts from Mikililand condominium treatment facility.

Table 4.11 Consequences of Improper Wastewater Management

Impacts	Respo nses	No bad Consequences	Moderately bad Consequences	Very bad Consequences	Not Applicable	Mean	SD
Local or regional water pollution	33	0	8(24.2%)	11(33.3%)	14(42.4%)	0.318	0.808
Aesthetic effects (noise, smell, …)	33	0	12(36.4%)	21(63.6%)	0	2.64	0.489
Soil or ground water contamination	33	1(3%)	15(45.5%)	5(15.2%)	12(36.4%)	2.85	0.972
Risk of severe accidents	33	0	27.3%	17(51.5%)	7(21.2%)	2.94	0.704

Source: Survey Result, 2019

Accordingly the result shows improper wastewater management system at Mikililand condominium site has high aesthetic effects (97.9%), local or regional water pollution (67.5%) and soil or ground water contamination respectively ranking as 1^{st}, 2^{nd} and 3^{rd}.

Consecutively questions were asked to know Mikililand wastewater treatment facility undertaken concrete actions to reduce the impacts. The result showed mostly non applicability of taken actions for the impacts listed in the above table. These responses shows high local or regional water pollution (84.8%), risk of severe accidents (72.7%), soil or ground water contamination (60.6%), and aesthetic effects (57.6%).

The offices haven't done any researches related to the impact of discharged wastewater from condominium site but the respondents fully agreed wastewater management practices in Mikililnad condominium site is very unsatisfactory. Partial research by Sisay (2014) for Mikililand condominium site show that effluent waste discharged from the treatment plant is totally hazardous and the sludge management system is also unsafe. This improper waste management will cause aesthetics effect such as bad odor come from the treatment plant to near

residents. Since it is open treatment system insects and scavengers exist in the ponds. These insects may cause communicable disease easily and other emergency problem. Also heavy metals form the treatment plant causes cancer diseases as the residents near used the river for agriculture purposes.

4.8 Discussion

In light of the data obtained through the three data collection tools (questionnaires, interviews and documents reviews), the following major points of discussions have been identified and discussed as follows.

In this study, efforts were made to triangulate the consistency and inconsistency of the results achieved through the above mentioned data collection tools. As stated under the data analysis section, in responding to the question concerning, how project quality planned and implemented, the finding has shown partially consistent results with some of the literature and various among variables.

It is found that there is no separate quality management policy separately in the organization unlike in the literature most studies recommend to have separate quality policy in the organization as guiding principle to undertake the whole process of quality management. But general concept of quality policy used in the organization is ISO environmental management system and Ethiopian environmental policy. Kerezen (2003) described quality policy is instrumental in creating the organization's standing and quality image since it is statement of principles stating what throughout the organization and across the project and Tonnen (2002) stated that the main advantages of this approach over conventional planning systems are that it combines strategic objectives with tactical daily management, covers all functions in a company and increases quality goals' consensus.

In literature section its described that quality planning in wastewater management activities are identifying sewer or nutrient management needs, estimating wastewater flows and loads, determining necessary levels of treatment; evaluating options, identifying sites; obtaining public input; designing and selecting treatment equipment, setting up the laboratories, quality assurance plan, providing routine and emergency operation and maintenance of wastewater, infrastructure (Mihelcic, 2003). But data collected from the interview shows that little consideration of these aspects were applied because lack of full participation and coordination of responsible institutions. The result also stated the planning process is initially based on the Ethiopian waste

discharging regulation standard and quality requirements but the practice don't comply. Unlike Liydia (2010) description of quality planning ensure that all relevant parties involved including consultants, subcontractors and suppliers are included in the task of quality planning for the project achievement. But the AAWSA sewerage treatment and reuse project team (62%) respond as they were not involved at all stage.

Chang (1999) identified quality assurance factors are to have appropriate organization structure, clear lines of responsibility and communication, correct specifications and drawings, proper training, appropriate procedures, and ready access to necessary instructions, clear definition and description of duties, to have the right resources, plant and materials; appropriate checking, measurement or testing of products and keeping proper records. The study is consistent with clear lines of responsibility and communication (97%), have appropriate organization structure (87.9%), and third keeping proper records (84.8%).

Quality management tools are important factors for the implementation of quality in the organization, where identification of quality standards, evaluation of overall project performance and quality control monitoring of specific project results in the quality management processes were defined by PMI (2000). Chang (1999) argue that, a good quality control system should have to establish the measurement methods used, compare the actual results to the quality standard to monitor and standardize measuring devices accordingly from about 10 major factors inspection and design of experiment/laboratory test as the major tools to control quality. In the study majority of the respondents agrees that there is performance measurement to control quality are clear establishment of measurement methods used (81.8%), select operations or activities to control (72.7%), and compare the actual results to the quality standards (66.6%) to make decision in wastewater management system.

Joy (2014) stated, quality management factors are the major factors that affect quality; material, labor, financial issues, conformance to codes and standards, top management support, management factors, selection of contractor, selection of designer design, co-operation of parties, contract documents and lack of communication. Consequently finding of this study shows that majority of the respondents identified qualified and experienced personnel (90.9%), conformance to specifications (84.8%) and processing time & weather patterns (81.8). Everline (2014) identified four major factors that most important determinants in general projects; experience and

qualification of personnel, quality of materials and equipments, conformance to specification and quality assurance training and meetings.

Major problems identified it this study is sewer line damaging (99%), lack of quality management policy and strategy (90.9%), in adequate management support, lack of waste management supervision and monitoring(90.9%), and inefficient resources such as budget, repair & maintenance stuff, chemical dosing, labor (90%). Partial with the research done by Beshah (2014) stated in his Fish-bone diagram, the root causes of quality problems which contributed to weak quality management practices are leadership problems, lack of policy and strategy, inefficient resources management, inefficient process management, lack of customer focus and weak business performance.

In addition to the problems which are similar with findings of other research most of the respondents and interview result showed that there are problems related with availability of latest technology as machine and technical capacity highly affect the quality of wastewater management, unavailability of quality control department willing to maintain quality as per the specification, and institutional coordination.

Chapter Five

Conclusion and Recommendations

This chapter has two sections. The first section presents conclusion of the study derived from findings and the second section deals with recommendation that were made on basis of the findings.

5.1 Conclusion

The study assessed quality management practices of condominium houses projects in wastewater management for Mikililand condominium site with the general objectives of assessing the wastewater quality management practices and major quality implementation challenges in wastewater management in condominium houses project.

On the basis of major findings of the study and as discussed in detail in the literature review part, effective wastewater quality management requires quality designing of treatment facility and sewer line installation, having organizational quality management policy and strategy, adequate management support, periodic waste management supervision and monitoring in the site, have sufficient resources such as budget, repair and maintenance staff, chemical dosing. Wastewater quality management also helps to achieve in meeting organizational objective, standards and regulations set by Ethiopian government to reduce environmental pollution. Project quality management is one of the nine core knowledge areas that project managers should be familiar and for the successful management of projects the organization has to undergo the quality management process. It involves estimating the planning process, quality assurance process, and quality controlling process based on the organizational quality policy and procedure.

Quality management practices remain important for achieving effective performance in every projects and organizations to achieve social and economic developments. The quality management process is partially undergoing with limitations of considering all the steps and parameters fully under consideration, similarly AAWSA doesn't have guiding for designing quality management at organizational level. Therefore, the project management process lacks standardization as per the literature on the process of quality management.

Mikililand site is an earliest almost a decade condominium house project built by Addis Ababa Housing and Development Agency. This site is fully occupied with a population of above 23,000. Capacity of treatment plant is 3000m^3/day. Wastewater quality management discussed form different authors described in literature review and findings of the study shows that

wastewater quality management is challenged by various factors mainly; lack of quality management policy and strategy for effective quality management, qualified and experienced personnel, and conformance to specifications, processing time & weather patterns. Additionally regular and periodic quality assurance site supervision and inspection were the most important measure to improve quality of wastewater management. The next important measure is implementing a comprehensive quality control mechanism starting from the planning phase and continuing into operation phases.

Consequences of improper wastewater management leads to Aesthetic effects (noise, smell, …), local or regional water pollution and soil or ground water contamination respectively. Since wastewater management system objectives is preserving environmental pollution for wellbeing of life, effective and efficient wastewater quality management system is significant as it avoid treatment performance deterioration throughout the process. Therefore, it may be concluded that, undertaking complete quality management process by developing quality management policy at organizational level and continuous wastewater management monitoring and supervision helps to improve the quality management related problems listed and working on the factors that affect the quality of projects.

5.2 Recommendations

Based on the findings of study it is recommended that AAWSA should consider the following areas of improvement in managing projects in general and onsite wastewater quality management in particular.

- There should be defined quality policy for wastewater management system since there are many condominium houses projects undertaken by AAHDA, AAWSA should define a quality policy for the emerging projects and assure quality for already operating facilities.
- Quality management of construction projects require stakeholders collaboration from clients and contractors sides on the basis on their respective roles and responsibilities defined. As such AAHDA should collaborate with AAWSA in planning process of wastewater management construction projects.
- AAWSA top management should work on identifying the gaps which require their strong support and strengthen on the quality focused activities since their guidance is critical for the success of the project.

- Assign quality management focal person at the treatment site is important to control overall quality of the wastewater management by application quality management skills and knowledge.
- AAWSA should assign qualified sanitation committee staffs at the treatment site to follow up use of good quality of materials and equipment to ensure conformances to specification and standard requirements.

Therefore, the bureau can make use of the results of this study to identify areas of improvements in order to manage its projects quality as per the standards of other literature which helps to manage in a more effective and efficient manner.

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APPENDICES I: Questionnaire

ST.MARY'S UNIVERSITY

PROJECT MANAGEMENT DEPARTMENT

M.A THESIS ON PROJECT MANAGEMENT

Dear respondent,

The purpose of this questionnaire is to collect data on Assessment of Quality Management Practices of Condominium House Projects in Wastewater Management System conducted for partial fulfillment of Masters of Art in project Management.

Believing that your frank and genuine responses will contribute vastly to the quality of the findings of this study, I would like to request you kindly to complete this questionnaire which will be kept confidentially for the study purpose. I would like to express my heartfelt thanks in advance for taking part in this endeavor.

Bethelhem Zenebe Tilahun 0910 62 21 33 or bethzenebe@gmail.com

Part I: General Information

Please put a "√" mark to all your responses in the circle provided beside each statement.

1. **Gender:** Male ☐ Female ☐

2. **Education background:**

High School completed ☐ College diploma ☐

Bachelor degree ☐ Master's Degree or above ☐

3. **What is your position/ role in Mikililand Condominium House Project?**_____

4. **Work Experience**?

Less than 5 years ☐ 6-10years ☐ Above 10 Years ☐

Part II: This part of questionnaire covers Quality management practices, Quality control tools and challenges in Condominium House Project in Wastewater Management System for Mikililand Site, Addis Ababa.

2.1 Quality Management and Process Flow

2.1.1 Quality Planning

1. Have you participated in any stages of wastewater treatment designing practices before?

Planning ☐ Implementation ☐ Controlling ☐ All stage ☐

2. Does the process involve quality management?

3. Does your quality plan for wastewater treatment plant contain the following activities?

Quality Planning Activities	**Strongly Agree**	**Moderately Agree**	**Slightly Disagree**	**Strongly Disagree**
Brief description of project				
List of contract documents and drawings				
Project quality objectives				
list(s) of materials and appliances used for the project,				
Inspection and test plans, or list thereof;				
list of quality procedures and work instructions				
frequency (or provisional dates if possible) of internal quality audits				
Frequency of updating the quality plan				
Estimating wastewater flows and loads				
Determining necessary levels of treatment				
Designing and selecting treatment equipment				
Emergency operation and maintenance of waste water, infrastructure availability				
Environmental and health policies and sanitation regulations				

2.1.2 Quality Assurance

1. Does the wastewater management system follow these activities to assure quality?

Quality assurance activity	**Strongly Agree**	**Moderately Agree**	**Slightly Disagree**	**Strongly Disagree**
Have appropriate organization structure				
Clear lines of responsibility and communication				
Correct specifications and drawings				
Proper training				
Appropriate procedures				
Ready access to necessary instructions				
Clear definition and description of duties				
Have the right resources, plant and materials				
Appropriate checking, measurement or testing of products				
Keeping proper records				

2.1.3 Quality Control

1. Does the wastewater management system follow these activities to control quality?

Quality Control Activity	Strongly Agree	Moderately Agree	Slightly Disagree	Strongly Disagree
select operations or activities to control				
set standards that provide the basis for decisions regarding possible corrective action				
establish the measurement methods used				
compare the actual results to the quality standards				
act to bring nonconforming processes and material back to the standard				
monitor and standardize measuring devices				
include detailed documentation for all processes				

Quality Management Tools & Techniques

1. Do you use any quality management tools? Yes ☐ No ☐

If Yes, Please Specify

Description	Yes	No	Comment
Benefit Cost Analysis			
Benchmarking			
Flow-charting(cause and effect/ Fishbone diagram)			
Design of Experiments			
Quality Audits			
Control Charts			
Inspection			
Pareto Diagrams			
Statistical Sampling			
Trend Analysis			
Any other Quality tools? Please mention			

Quality Management Factors in Wastewater Management

1. Please express your opinion on the following quality management factors that affect performance of wastewater management;

Description	Strongly Agree	Moderately Agree	Slightly Agree	Strongly Disagree
processing time, weather patterns				
length and density of pipelines				
equipment efficiency				
incoming water quality				
availability of dosing chemicals				
Qualified and experienced personnel				
Quality of materials and equipment used in the project construction				
Conformance to specifications				
Quality assurance training and follow up				
Top management support				
Co-operation of stakeholders				
Others please specify				

Quality Management Problems in Wastewater Management

1. What are the main challenges and obstacles of quality management in condominium house projects wastewater management system in your opinion?

Description	Strongly Agree	Moderately Agree	Slightly Disagree	Strongly Disagree
In adequate management support, lack of waste management supervision and monitoring				
Lack of quality management policy and strategy				
Inefficient resources (Budget, Repair & Maintenance stuff, chemical dosing, labor…)				
Unwillingness of project staff to accept the quality management system				
Lack of quality assurance team leading the process				
Problems with contractors				
Quality of the equipment i.e. pipelines, pump, fittings… types, efficiencies				

Increase of cost				
Lack of effective communication				
Inadequate technical skill				
Sewer line damaging				
If any other please mention				

2. Which practices have been established in your facility in order to implement environmental management?

	Yes	**No**
Written environmental policy	☐	☐
Environmental training program in place for employees	☐	☐
Carry out external environmental audits	☐	☐
Carry out internal environmental audits	☐	☐

Other practice (please specify) _____

3. Potential negative environmental impacts from your treatment facility?

Impacts	**No bad Consequences**	**Moderately bad Consequences**	**Very bad Consequences**	**Not Applicable**
Local or regional water pollution				
Aesthetic effects (noise, smell, …)				
Soil or ground water contamination				
Risk of severe accidents				
Other impact (please specify)				

4. Has your facility undertaken concrete actions to reduce environmental impacts described in the above which have associated with the following?

Impacts	**No bad Consequences**	**Moderately bad Consequences**	**Very bad Consequences**	**Not Applicable**
Local or regional water pollution				
Aesthetic effects (noise, smell, …)				
Soil or ground water contamination				
Risk of severe accidents				
Other impact (please specify)				

5. If your facility has undertaken significant technical measures which reduce the environmental impacts associated with its activities, which of the following most closely characterizes the nature of such measures? (Please tick only one box.)

Changes in production technologies ☐

Changes in product characteristics ☐

6. Does the Bureau solve these challenges? Yes ☐ No ☐
7. If yes, in what ways the organization solved these challenges? Please list mechanism

_____

_____

_____

8. How the organization's quality management practice look like

It is improved ☐ It is maintained ☐ It is decreasing ☐ is stopped ☐

9. Other, Please specify_____

Additional Comments

1. _____

_____

2. _____

_____

3. _____

_____

APPENDIX II: Interview Guidelines

Interview Questions/ Guidelines

Respondent Information

1. Would you tell me your current position in your organization, level and type of your education and experience on project management?
2. What is your general experience in your organization in project implementation and management with reference to time, budget and quality of outputs?

Wastewater Treatment Plant Information

1. Volume of wastewater generated per day from the condominium houses (m^3/day) _____
2. Capacity of treatment plant to treat per day (m^3/day)_____
3. Give brief descriptions of the operations at this facility?

   _____

   _____

   _____
4. Does the condominium house generate wastewater other than restrooms, cafeterias, kitchen areas? Yes ☐ No ☐ If yes, please explain,

   _____
5. Intended disposal method of treated water? _____
6. Required quality of treated water?_____
7. The space and electrical power required by the treatment plant?_____
8. Ethiopian government standard for discharging the wastes?_____
9. Does your facility perform laboratory tests of discharge? Yes ☐ No ☐
   If yes, please attach any recent data.
10. What are the mechanisms if the value of water test exceeds the limit to discharge?

    _____

Wastewater Management Policies

1. Describe Location and sizing of wastewater treatment plant designing process?
2. Does the planning process consider the need for expansion, consolidate, improvement of technologies?
3. Do you think additional quality of treatment technologies is required of this site?
4. Do your offices study the impacts of wastewater discharged to the environment?

Project Quality Management

3. Do you have project quality management system in your organization related to onsite wastewater management?
4. What are the policy and procedure of Condominium house projects in wastewater management concerning quality?
5. Do you have a quality manager separately? What are the major responsibilities? Or do other departments participate on the preparation of the quality plan? Other department staff responsible for contracts, purchasing, etc.
6. How do you control the quality of material and work? Who is responsible?
7. Does Addis Ababa city administration of Housing development team conduct regular supervision? How frequent?
8. Do you have training on project management? Especially on project quality management?
9. How do you see management commitment and priority for project Quality implementation and management?
10. How are projects quality maintained? What are the measures you take to control quality of projects?
11. How and in what ways are project quality related issues communicated?
12. What are the challenges you face in project quality implementation and management in your wastewater treatment plant?
13. What do you think must be fulfilled for successful project quality implementation and management in general?