ST. MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

MASTERS OF BUSINESS ADMINISTRATION

EFFECT OF FECAL SLUDGE EMPTYING AND TRANSPORT MANAGEMENT ON THE EFFICIENCY OF FECAL SLUDGE MANAGEMENT SERVICES IN HAWASSA TOWN, ETHIOPIA

BY: KASSAHUN BEDANE

ADVISOR: TESFAYE TILAHUN (Ph.D)

JULY, 2025

ADDIS ABABA, ETHIOPIA

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DECLARATION

I hereby declare that this thesis entitled “Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of Fecal Sludge Management Services in Hawassa Town, Ethiopia”, has been carried out by me under the guidance and supervision of Tesfaye Tilahun (Ph.D). The thesis is original and has not been submitted for the award of any degree or diploma to any university or institutions.

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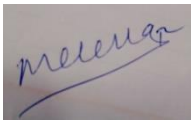
APPROVAL

The thesis entitled “Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of Fecal Sludge Management Services in Hawassa Town, Ethiopia” submitted by Kassahun Bedane is partial fulfillment requirements for the award of a Master Degree in Business Administration, in the Department of Business Administration, School of Business, St. Mary’s University supervision. Therefore, I hereby approve and recommend that it to be submitted to the Department for examination as the University Advisor.

Name: TESFAYE TILAHUN (Ph.D) Signature:  Date:_24/05/2025_

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By

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LIST OF ABBREVIATIONS/ACRONYMS

FSM	Fecal Sludge Management
HWSE	Hawassa Water and Sewerage Enterprise
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

ABSTRACT

This study aimed to assess the effect of fecal sludge emptying and transport management on the efficiency of Fecal Sludge Management services in Hawassa Town, focusing on key influencing factors such as financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges, and regulatory frameworks. A quantitative research design was adopted, incorporating both descriptive and explanatory approaches. Data were collected from a sample of 382 households selected through stratified random sampling across the town's 23 kebeles. Structured questionnaires were used to capture household experiences with FSM services. Descriptive statistics were used to assess the current state of service delivery, while correlation and regression analyses examined the relationships between independent variables and the efficiency of FSM services, measured through service reliability. Findings revealed that while private service providers are the primary actors in FSM service delivery, 33% of households have never emptied their sanitation facilities, citing cost, infrastructure, and lack of awareness as key barriers. Financial constraints, regulatory frameworks, and service provider capacity showed statistically significant effects on FSM service efficiency, while perceived cost of services and infrastructure challenges also contributed but with varying degrees of statistical support. Regression results confirmed that affordability and regulatory enforcement were the strongest predictors of service efficiency. The study concluded that the efficiency of FSM services in Hawassa was undermined by intersecting economic, institutional, and infrastructural barriers. Addressing these challenges requires improved regulatory coordination, investment in provider capacity and equipment, and targeted financial interventions for low-income households.

***Keywords**: Fecal sludge management, FSM efficiency, emptying services, transport, sanitation, Hawassa Town*

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Sanitation is a fundamental human right essential for public health and environmental protection. Approximately 4.2 billion people worldwide lack safely managed sanitation services, and 673 million still practice open defecation, leading to significant health and environmental risks (WHO & UNICEF, 2020). Fecal sludge management (FSM) is a critical component of urban sanitation systems, particularly in areas with pit latrines and septic tanks. Proper FSM involves systematic emptying, transportation, and treatment of waste to prevent environmental contamination and public health hazards. Inadequate FSM in many developing countries contributes to the spread of waterborne diseases like cholera and diarrhea (Yajima and Koottatep, 2010; Prüss-Ustün et al., 2019).

In sub-Saharan Africa, rapid urbanization has exacerbated FSM challenges. Most urban residents rely on on-site sanitation systems that require regular emptying to avoid overflow and contamination (Conaway et al, 2023; Peal et al., 2020). However, cities often face infrastructure shortages, limited service coverage, and weak regulatory frameworks, which, combined with high service costs and poor road infrastructure, limit access to FSM services (Lerebours, 2021; Nyakutsikwa, 2018). These challenges are compounded by weak institutional coordination and enforcement, resulting in the proliferation of informal and unsafe sludge disposal practices.

In Ethiopia, urbanization has outpaced sanitation infrastructure development, leading to significant FSM challenges. More than 60% of urban households rely on on-site sanitation facilities, but many struggle to access affordable FSM services (Ethiopian Ministry of Health, 2021). Although the government has introduced policies to address these issues, resource constraints, technical limitations, and weak stakeholder coordination hinder effective implementation (Sumita., 2024). The inefficiency of FSM, particularly in sludge emptying and

transport, remains a major obstacle to providing adequate sanitation services (Sumita, 2024; Heymans et al, 2017; Scot et al, 2016).

Hawassa, the capital of the Sidama Region, exemplifies the challenges of FSM in rapidly growing cities. Population growth has placed increasing pressure on the city's sanitation infrastructure. Most households rely on pit latrines or septic tanks that require frequent emptying. However, the availability and efficiency of FSM services are limited. The Hawassa Water and Sewerage Enterprise (HWSE) and private service providers manage FSM, but face operational challenges such as financial constraints, insufficient desludging equipment, and high service costs. Poor road conditions and a lack of coordination between service providers and regulatory authorities further exacerbate these issues (Scot et al, 2016). Weak regulatory enforcement has also led to the widespread use of informal sludge disposal practices, contributing to environmental pollution (Sumita, 2024; Heymans et al., 2017).

FSM inefficiencies manifest in frequent service delays, improper disposal practices, and high costs, disproportionately affecting low-income households. Additionally, infrastructural and logistical barriers, such as inadequate road networks and desludging vehicles, hinder effective FSM, leaving large parts of the city underserved. The illegal dumping of untreated waste poses significant health risks to residents (Sumita, 2024; Heymans et al, 2017; Scot et al, 2016).

Poor FSM in Hawassa has severe public health implications. The accumulation of untreated waste in residential areas increases the spread of diseases such as cholera and dysentery, particularly among low-income communities unable to afford desludging services (Sumita, 2024). Furthermore, unregulated sludge dumping, especially near Lake Hawassa, threatens water quality and local ecosystems. Addressing these challenges requires investment in FSM infrastructure, improved service coordination, and stricter regulatory enforcement. Without these interventions, the public health and environmental risks in Hawassa will continue to grow, complicating efforts to improve sanitation outcomes.

Hawassa’s FSM challenges reflect broader issues in rapidly urbanizing cities across sub-Saharan Africa. A coordinated approach involving investment in infrastructure, stakeholder collaboration,

and regulatory oversight is essential to improve FSM efficiency and meet the growing demands of urban populations.

1.2. Background of the Organization

The Hawassa Water and Sewerage Enterprise (HWSE) is the primary public institution responsible for managing water supply and sanitation services in Hawassa, the capital of the Sidama Region in southern Ethiopia. Established in the early 2000s, HWSE has played a critical role in providing clean water and ensuring safe sanitation services for the town's rapidly growing population (HWSE, 2022). However, as urbanization and industrialization have accelerated in Hawassa, the demand for efficient water and sanitation services, including fecal sludge management (FSM), has increased dramatically. HWSE is included in this section due to its institutional and regulatory importance. HWSE plays a central role in setting sanitation policies and regulating service provision, coordinating and supporting private FSM providers and influencing household-level service outcomes through infrastructure investment and policy enforcement. Therefore, understanding HWSE's background provides critical institutional context and helps explain how systemic and governance factors influence the efficiency of FSM services experienced by households in Hawassa Town.

The urbanization of Hawassa has put considerable pressure on the existing sanitation infrastructure. Most households in the town rely on on-site sanitation facilities such as pit latrines and septic tanks, which require regular emptying. HWSA, in collaboration with private service providers, is tasked with managing the collection, transportation, and treatment of fecal sludge (Heymans et al, 2017; Scot et al,2016). However, the organization faces numerous challenges in fulfilling these responsibilities, including financial constraints, inadequate desludging equipment, and logistical difficulties in reaching all parts of the city. These challenges have resulted in gaps in service provision, particularly in low-income and underserved areas (Sumita, 2024; Scot et al, 2016).

One of the critical issues facing HWSE is its limited capacity to manage fecal sludge effectively. Sumita (2024) and Heymans et al (2017) highlighted that the city's desludging equipment is insufficient to meet the needs of the growing population, and the high cost of services further

limits access for many households. This shortage of resources has led to frequent service delays and the proliferation of informal FSM service providers, who often dispose of sludge improperly, contributing to environmental pollution (Sumita, 2024). In addition, the city's poor road infrastructure makes it difficult for HWSE to access certain areas, further hampering effective service delivery.

To address these challenges, HWSE has partnered with various stakeholders, including international organizations and non-governmental organizations (NGOs), to implement projects aimed at improving the city's sanitation infrastructure and FSM services (Scot et al, 2016). Despite these efforts, significant challenges remain, particularly regarding regulatory oversight and enforcement. The lack of strong regulatory frameworks and inadequate institutional coordination between HWSE, private providers, and regulatory authorities has resulted in inefficiencies in service delivery and inconsistent compliance with sanitation standards (Sumita, 2024; Scot et al., 2016).

HWSE's commitment to improving urban sanitation is evident in its recent strategic initiatives, which prioritize upgrading infrastructure, expanding service coverage, and enhancing the capacity of service providers. However, without sustained investment and a stronger regulatory framework, the organization will continue to struggle with the rising demand for FSM services. Strengthening the regulatory environment, improving institutional coordination, and expanding HWSA’s operational capacity are essential steps for ensuring the long-term sustainability of sanitation services in Hawassa.

1.3. Statement of the Problem

Fecal sludge management (FSM) plays a critical role in ensuring urban sanitation, yet in many secondary towns like Hawassa, FSM services are inefficient, fragmented, and under-regulated. Current FSM models often overlook the contextual constraints of resource-limited urban environments, including financial barriers at the household level, inadequate provider capacity, poor infrastructure, and weak enforcement of FSM policies. These systemic challenges are not only theoretical but are reflected in the realities of urban residents who rely on on-site sanitation systems.

Empirical research on FSM service efficiency in the Ethiopian context particularly in Hawassa Town is limited. Most available studies focus broadly on urban sanitation without addressing how operational bottlenecks in emptying and transport affect service delivery at the household level. There is a lack of research data on how household financial constraints, service cost, capacity of service providers, awareness of regulations, and infrastructural barriers affect the efficiency of FSM services.

A preliminary investigation by the researcher indicated that the inefficiencies of FSM in Hawassa were evident through frequent service delays, improper sludge disposal, high service costs, and financial constraints that disproportionately affect low-income households. These inefficiencies have serious implications for both public health and environmental sustainability (Sumita, 2024; Heymans, 2017; Scot et al., 2016). However, despite the observable nature of these challenges, there remains a significant gap in systematically identifying and analyzing the root causes of FSM inefficiency particularly from the household perspective.

Households are the primary users and beneficiaries of FSM services. Their decisions regarding whether, when, and how to access these services critically shape the overall performance of the FSM system. Understanding household behaviors, financial capacities, perceptions, and awareness levels is essential to diagnosing systemic inefficiencies and developing targeted interventions. It is at the household level where critical decisions, whether and when to empty pits, which providers to use, and how to respond to service costs, are made. These decisions directly affect the functionality and sustainability of FSM systems. When households face financial barriers, lack awareness, or encounter infrastructural limitations, they are more likely to delay desludging, opt for informal providers, or avoid the service entirely. This contributes to irregular demand patterns, service backlogs, and increased environmental and public health risks due to unsafe disposal.

Moreover, the inability of households to access or afford reliable services weakens the operational and financial viability of both public and private FSM service providers, further reducing FSM service efficiency. Thus, household-level barriers are not just symptoms but root causes of broader FSM service inefficiencies. Addressing these challenges requires a clear

understanding of how socio-economic, infrastructural, and institutional factors at the household level interact to affect FSM service efficiency.

The study aims to fill the empirical gap by systematically evaluating the current state of FSM services in Hawassa Town and examining on how factors such as financial limitations, cost of services, service provider capacity, infrastructure, and regulatory frameworks affect FSM service efficiency from the end-user's perspective. Understanding these dynamics is critical to informing policy, improving operational practices, and ensuring equitable access to safe FSM services in Hawassa town.

1.4. Objectives of the Study

1.4.1. General Objective

The general objective of this study was to assess the effect of fecal sludge emptying and transport management on the efficiency of fecal sludge management services in Hawassa Town, Ethiopia.

1.4.2. Specific Objectives

The specific objectives of this study would be:

1. To evaluate the current state of fecal sludge emptying and transport services in Hawassa Town.
2. To analyze the effect of financial constraints on the efficiency of fecal sludge management services in Hawassa Town.
3. To assess the effect of capacity of service providers' on the efficiency of fecal sludge management services in Hawassa Town.
4. To analyze the effect of the cost of emptying services on the efficiency of fecal sludge management services in Hawassa Town.
5. To examine the effect of infrastructural challenges on the efficiency of fecal sludge management services in Hawassa Town.
6. To evaluate the effect of regulatory frameworks on the efficiency of fecal sludge management services in Hawassa Town.

1.5. Research Questions

1. What is the current state of fecal sludge emptying and transport services in Hawassa Town?
2. How do financial constraints affect the efficiency of fecal sludge management services in Hawassa Town?
3. How does capacity of service providers affect the efficiency of fecal sludge management services in Hawassa Town?
4. What is the effect of the cost of emptying services on the efficiency of fecal sludge management services in Hawassa Town?
5. How do infrastructural challenges affect the efficiency of fecal sludge management services in Hawassa Town?
6. How do regulatory frameworks affect the efficiency of fecal sludge management services in Hawassa Town?

1.6. Significance of the Study

The study on the "Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of Fecal Sludge Management Services in Hawassa Town, Ethiopia" will have significance for local communities, policymakers, service providers, and researchers. It was outlined as follow:

Public Health Improvement

Understanding the impact of fecal sludge management practices on FSM efficiency is critical for improving public health outcomes. Effective FSM practices help reduce the prevalence of sanitation-related diseases such as cholera, dysentery, and hepatitis by ensuring the safe collection, transport, and disposal of human waste, thereby preventing the contamination of water sources and the surrounding environment that typically facilitates disease transmission. By identifying and addressing the inefficiencies in fecal sludge emptying and transport, the study aims to contribute to the development of more effective sanitation solutions, thereby enhancing public health and reducing disease burden in Hawassa.

Environmental Protection

This study holds significance for environmental protection by highlighting how poor fecal sludge management practices contribute to contamination of local ecosystems and water bodies. Inefficiencies in sludge emptying and transport, such as limited equipment, poor road access, and unregulated disposal, often result in untreated waste being dumped inappropriately. By investigating the systemic and operational barriers that lead to such outcomes, the study provides evidence to inform sustainable sanitation strategies. Effective fecal sludge management not only safeguards environmental quality but also helps protect water resources and maintain local biodiversity.

Economic Benefits

This study provides insights into how inefficiencies in fecal sludge emptying and transport management increase the economic burden on both households and service providers. High service costs, affordability barriers, and underutilization of services contribute to irregular demand, operational delays, and unplanned expenditures by municipalities. By examining household-level financial constraints, service delivery inefficiencies, and cost-related decision-making, the study offers evidence-based recommendations to optimize resource allocation, promote cost recovery, and enhance the financial sustainability of FSM services. These findings are essential for guiding interventions that can reduce economic pressure on low-income households and improve the efficiency of HWSE FSM budgeting.

Policy and Regulatory Development

The findings of this study could inform policy and regulatory development related to sanitation services. By analyzing the effectiveness of existing regulatory frameworks and identifying gaps in policy implementation, the research could contribute to the creation of more robust and enforceable regulations. Enhanced regulatory frameworks can lead to better governance and improved service delivery in the sanitation sector.

Capacity Building and Service Improvement

The study provided valuable insights into the operational challenges faced by FSM service providers in Hawassa. By identifying issues related to service provider capacity, equipment, and

training, the research can contribute to the development of targeted capacity-building programs and improvements in service delivery. Enhancing the capabilities of service providers could lead to more efficient and reliable FSM services.

Contribution to Academic Knowledge

Finally, this study added to the academic body of knowledge on fecal sludge management and urban sanitation. It provides a case study of Hawassa, contributing to the understanding of FSM practices in Ethiopian and similar contexts. The research findings could be used by other researchers to explore related topics, compare findings with other studies, and develop new approaches to sanitation management.

By addressing these various aspects, the study on fecal sludge management in Hawassa would positioned to have meaningful contributions to public health, environmental sustainability, economic efficiency, policy development, service improvement, and academic research.

1.7. Scope of the Study

The study examined the following factors within the context of fecal sludge management in Hawassa Town: financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges, and regulatory framework. The study would be limited to Hawassa Town, located in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. In addition, it focused on fecal sludge emptying and transport management services. The study employed a quantitative method approach and used document analysis. The methodology confined to these data collection and analysis methods, excluding other potential research methods such as experimental or longitudinal studies. The research focused on data collected from the year 2025, encompassing current practices and effects of factors related to fecal sludge management services in Hawassa Town.

1.8. Limitation of the Study

While this study provided valuable insights into the effect of fecal sludge emptying and transport management on the efficiency of FSM services in Hawassa Town, the following limitations was

acknowledged. First, the study relied primarily on cross-sectional data collected through household surveys, which captured perceptions and service experiences at a single point in time. Second, the absence of disaggregated administrative data on FSM service users and non-users at the kebele level necessitated in-field identification during data collection. Third, the study focused solely on the household perspective, excluding direct inputs from FSM service providers, regulatory authorities, and other key stakeholders whose perspectives could have enriched the analysis.

1.9. Organization of the Study

The study on the "Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of Fecal Sludge Management Services in Hawassa Town, Ethiopia" was organized into five chapters, each serving a specific function in the research process.

Chapter 1 Introduction provided the background, detailing global, African, Ethiopian, and Hawassa-specific contexts of fecal sludge management, followed by an overview of the organization(s) involved. It identified the problem being studied, outlined the research objectives and questions, discussed the significance and scope of the study, and highlighted its limitations.

Chapter 2 Review of Related Literature examined both theoretical perspectives and empirical research findings related to fecal sludge management and sanitation efficiency, offering a conceptual framework based on the reviewed literature.

Chapter 3 Research Design and Methodology explained the study's research design and approach, focusing on the quantitative methods of data collection, sampling techniques, and data collection methods such as surveys and interviews. It also discussed data analysis techniques, ensuring the validity and reliability of the findings, and addressed ethical considerations.

Chapter 4 Results and Discussion described the findings from data collection presented, analyzed, and interpreted in light of the research objectives, followed by a discussion of the insights gained from the literature review.

Finally, Chapter 5 offered a summary of key findings, draws conclusions, and provided recommendations for policy, practice, and future research. The study concluded with references and appendices, which included the survey instruments and interview guides used in data collection.

CHAPTER TWO

REVIEW OF RELATED LITERATURES

The review of related literature provided a theoretical review, empirical review and conceptual framework of the research entitled “Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of FSM Service in Hawassa Town, Ethiopia.

2.1. Theoretical Literature Review

2.1.1. Definition

Fecal sludge management (FSM) refers to the process of safely collecting, transporting, treating, and disposing of fecal sludge from on-site sanitation systems such as pit latrines and septic tanks (Peal et al., 2020). FSM is integral to urban sanitation systems, particularly in cities where centralized sewer systems are lacking. It ensures that the health risks associated with untreated waste are mitigated through proper handling and disposal. FSM is a critical component of sustainable urban sanitation because it prevents environmental contamination and the spread of waterborne diseases (Gitonga et al.,2021),

Sanitation services, as defined by WHO and UNICEF (2020), are systems that ensure the safe disposal of excreta to protect public health and the environment. This includes both FSM and centralized systems. In the context of Hawassa, where on-site sanitation facilities dominate, FSM is the primary method of excreta management.

2.1.2. Concepts

The concept of Fecal Sludge Management (FSM) is rooted in the idea of ensuring safe sanitation in areas without centralized sewer systems, especially in urban and peri-urban settings. FSM encompasses various activities, including the collection, transport, treatment, and final disposal or reuse of fecal sludge from on-site sanitation systems such as pit latrines, septic tanks, and composting toilets (Strande et al., 2014). It is a vital component of urban sanitation strategies,

particularly in low- and middle-income countries where sewerage systems are not universally accessible (Peal et al., 2020).

A key concept in FSM is sustainability. This entails implementing solutions that not only manage waste efficiently but also minimize environmental impacts and promote resource recovery. Sustainable FSM systems aim to treat and reuse sludge in agriculture (as compost or fertilizer), biogas production, or other productive uses. Such an approach reduces reliance on landfill disposal and mitigates environmental pollution, contributing to circular economy goals (Jothinathan and Singh, 2023).

Another important concept is service delivery models. FSM service delivery involves both formal and informal providers, ranging from government institutions to private companies and local entrepreneurs (Peal et al., 2014). The service chain includes the technical processes of collection, transportation, and treatment, as well as the financial and institutional arrangements that support these processes. Effective service delivery models are characterized by clear regulatory frameworks, adequate financing, and community engagement (Bassan, 2014).

Public-private partnerships (PPPs) are increasingly recognized as a crucial concept in FSM. Given the resource constraints faced by governments in developing countries, PPPs enable collaboration between public agencies and private sector operators to provide FSM services more efficiently (Tillett et al., 2019). These partnerships ensure that both sectors share responsibilities, risks, and rewards, which can lead to improved service delivery and innovation in FSM technologies.

Another core concept is community engagement and awareness. The success of FSM systems depends heavily on the involvement and acceptance of local communities. Households need to understand the importance of regular emptying and proper disposal of fecal sludge for the system to function efficiently (Elis et al., 2021). Awareness campaigns and behavior change initiatives are thus crucial components of effective FSM programs, ensuring that households and businesses use the services provided responsibly.

2.1.3. Theoretical Frameworks of FSM

Systems Theory: FSM can be analyzed through the lens of systems theory, which views the sanitation service as a network of interdependent components, including infrastructure, regulatory frameworks, service providers, and users. Each component must function effectively for the system to deliver efficient services (Linda et al 2014). Failures in any part of the system—such as insufficient capacity or weak regulatory enforcement—affect the overall performance of FSM (Peal et al., 2014).

Institutional Theory: According to institutional theory, the rules, norms, and governance structures within which FSM operates shape its effectiveness (Bugalia, 2024; Scott,2004). Weak regulatory frameworks or enforcement mechanisms often lead to informal practices that compromise the efficiency of formal FSM services. This theory underscores the importance of strong institutions and regulations in ensuring sanitation service efficiency (Singh et al, 2021).

Resource-Based View (RBV) Theory: The RBV theory posits that an organization's ability to deliver services depends on its internal resources, including equipment, trained personnel, and financial capacity (Madhani, 2010). This theory applies to FSM, where the availability and capacity of service providers are directly linked to their resource base. Limited resources often lead to service delays and inefficiencies, particularly in resource-constrained settings like Hawassa.

2.1.4. Challenges of Fecal Sludge Emptying and Transport Management

2.1.4.1. Financial Constraints

Financial limitations at both the household and institutional levels are a major barrier to effective FSM. For households, the cost of formal emptying services often exceeds their capacity to pay, leading them to seek informal or unsafe alternatives (Bala., 2018). On the institutional side, underfunded FSM systems lack the resources needed for proper equipment, staffing, and infrastructure. Heymans et al. (2017) found that in Ethiopia, particularly in urban centers like Hawassa, financial constraints significantly impact the operational capacity of service providers, resulting in delayed services and inadequate coverage.

Moreover, financial constraints limit households' ability to access FSM services, particularly in low-income areas. This exacerbates public health risks, as households may resort to unsafe practices such as illegal dumping of fecal waste (Bala, 2018).

2.1.4.2. Capacity of Service Providers

The capacity of FSM service providers is crucial for ensuring timely and effective service delivery. Choge (2021) highlighted that service providers must have the necessary tools and equipment, such as desludging trucks and trained personnel, to meet the demands of growing urban populations. In Hawassa, the limited availability of service providers and their restricted capacity (e.g., insufficient desludging trucks) have been identified as major barriers to FSM efficiency (Ifill, S., & Kayaga, S., 2016).

Without adequate service providers, households face long delays in receiving services, and many are forced to turn to informal providers, who often do not follow safety protocols and this contributes to environmental pollution (Choge., 2021).

2.1.4.3. Cost of Emptying Service

The cost of emptying services significantly affects whether households opt for formal FSM services or seek cheaper, informal alternatives. Silumesii et al. (2024) pointed out that high costs of fecal sludge emptying service discourage households, particularly in low-income areas, from using formal services, leading to reliance on informal providers who often dispose of sludge unsafely.

The high cost of formal desludging services means that many households delay emptying their pits or use unregulated providers, both of which increase the risk of public health issues (Bala., 2018). Addressing the cost barrier is essential for encouraging the use of formal FSM services and improving sanitation outcomes.

2.1.4.4. Infrastructural Challenges

Infrastructural deficiencies are a major impediment to FSM efficiency. Inadequate road networks, particularly in densely populated informal settlements, make it difficult for service providers to reach all areas (Kennedy-Walker (2015). In addition, the lack of proper treatment facilities limits the capacity of service providers to process the collected sludge safely and efficiently.

Bala (2018) indicated that poor infrastructure not only delays service delivery but also increases operational costs for providers, who must navigate difficult terrain with inadequate equipment. This further reduces the accessibility and affordability of formal FSM services for the general population.

2.1.4.5. Regulatory Framework

Regulatory frameworks are vital for ensuring that FSM services meet safety and public health standards. Weak regulatory oversight leads to inconsistencies in service delivery and opens the door for informal providers to operate without following established safety protocols (Paladh et al, 2018; Ifill and Kayaga, 2016;). In Ethiopia, the regulatory environment for FSM is often weak, with limited enforcement of existing regulations, particularly at the local government level (Heymans et al., 2017).

The preliminary investigation in Hawassa showed that the lack of effective regulatory oversight has resulted in the proliferation of informal FSM providers who contribute to environmental pollution. Strengthening the regulatory framework and improving enforcement mechanisms are essential for ensuring that FSM services are safe, efficient, and accessible.

2.2. Empirical Review

Fecal sludge management (FSM) is a critical component of sanitation services, particularly in urban areas where centralized sewer systems are often lacking. Across different global contexts, the efficiency of FSM systems is influenced by several key factors: financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges, and

regulatory frameworks. This empirical review synthesizes findings from international, African, and Ethiopian contexts, with a particular focus on Hawassa Town, Ethiopia, to provide a coherent understanding of how these factors affect FSM efficiency.

2.2.1. Global Context

Financial constraints are a major barrier to accessing formal desludging services, especially in low- and middle-income countries. In Indian cities such as Bangalore, Murthy (2018) reported that high operational costs and the absence of targeted subsidies prevent low-income households from using formal FSM services, pushing them towards unsafe informal alternatives. Similarly, in Bangladesh, Bala (2018) found that affordability remains a significant concern, with formal services often priced beyond the reach of economically disadvantaged communities. As a result, many households resort to unregulated providers, contributing to unsafe sludge disposal, reduce FSM efficiency and results in public health risks.

Capacity limitations among service providers also hamper FSM efficiency globally. Choge (2021) highlighted that limited availability of desludging equipment and skilled personnel severely constrains the ability of providers to deliver timely and reliable services, particularly in peri-urban and hard-to-reach areas. In Thailand, Taweesan et al. (2017) observed that inadequate staffing and a lack of technical capacity led to frequent service delays, especially in densely populated neighborhoods. These challenges are compounded by infrastructural limitations, such as narrow roads or inaccessible areas, which restrict the mobility of service trucks and affect FSM efficiency.

The high cost of desludging services further deters households from seeking formal FSM solutions. Balal (2018) emphasized that in Bangladesh, many households opt for cheaper, informal services due to the prohibitive cost of formal ones. This not only undermines the financial sustainability of formal providers but also increases environmental and health risks due to unsafe disposal practices which results in FSM service inefficiency.

Infrastructural challenges also significantly impede FSM service efficiency. In many urban areas of developing countries, poor road conditions, informal settlements, and the lack of nearby

treatment facilities restrict provider access and operational capacity. Scott et al. (2016) reported that in Indonesia, such infrastructure-related constraints make it difficult to reach underserved communities, thus limiting service coverage and effectiveness.

Regulatory frameworks, play a crucial role in determining FSM outcomes. Weak regulatory enforcement often enables informal providers to operate unchecked. In Bangladesh, Singh (2021) found that the absence of strong monitoring and enforcement mechanisms led to widespread illegal dumping of fecal sludge, contributing to environmental degradation and undermining the efficiency of formal services. Conversely, well-defined and enforced regulations have been shown to improve service accountability, user safety, and provider performance in cities where such systems are in place.

2.2.2. African Context

Across Africa, financial constraints remain a significant barrier to accessing formal FSM services. In Uganda, Singh et al. (2022) found that high service costs, even with government subsidies, prevent many households from utilizing formal desludging services. This leads to delays in desludging, which results in FSM service inefficiency, environmental contamination and increased health risks. Similar findings were reported in Ghana, where Agboado (2015) noted that high service costs forced many households to rely on informal providers, whose unsafe practices compromised public health and sanitation outcomes.

The capacity of service providers in Africa is another key issue affecting FSM efficiency. In Kenya, for example, Choge (2021) found that the number of FSM service providers is insufficient to meet the growing demand for desludging services. This capacity constraint is exacerbated by inadequate infrastructure, such as a lack of desludging trucks and treatment facilities. Similarly, Heymans et al. (2017) reported that the combination of insufficient service provider capacity and poor infrastructure, particularly in informal settlements, creates delays in service delivery and reduces overall FSM efficiency.

Infrastructural challenges are a major constraint on FSM efficiency in African countries. Tilett et al. (2019) found that inadequate road networks and a lack of treatment facilities prevent FSM

service providers from delivering efficient services. These infrastructural deficiencies are particularly acute in informal settlements, where poor access to sanitation services exacerbates public health risks.

Regulatory frameworks in African countries are often weak, with inconsistent enforcement leading to widespread informal FSM practices. In Nigeria, Ogunkan (2022) reported that weak regulation allows informal providers to operate without oversight, resulting in unsafe sludge disposal, reduce FSM service efficiency and environmental contamination. Strengthening regulatory frameworks is necessary to improve FSM service efficiency and ensure compliance with safety standards.

2.2.3. Ethiopian and Hawassa Context

In Ethiopia, FSM services face numerous challenges, many of which are similar to those found in other African countries. Financial constraints are a significant barrier to formal service utilization. Sumita (2024) and Heymans et al. (2017) found that in Addis Ababa and Hawassa, the high cost of formal desludging services prevents many low-income households from accessing these services, forcing them to rely on informal providers or delay desludging. This reduces FSM service efficiency, increases the risk of environmental contamination and public health hazards.

The capacity of service providers in Ethiopia are limited, particularly in urban centers like Hawassa and other cities. Sumita (2024), reported that the number of desludging trucks and trained personnel is insufficient to meet the growing demand for FSM services in Hawassa and other cities. This capacity shortage leads to long service delays, particularly in informal settlements where access to sanitation services is already limited and resulted in FSM service inefficiency.

Infrastructural challenges are a major constraint on FSM services in Ethiopia. In Hawassa, poor road networks and a lack of treatment facilities limit the ability of service providers to deliver efficient desludging services. Sumita (2024) noted that inadequate infrastructure prevents service providers from accessing certain neighborhoods, particularly in informal settlements, which

leads to delays in service delivery and increased operational costs and reduce FSM service efficiency.

Regulatory frameworks in Ethiopia are weak, with limited enforcement of sanitation regulations. Sumita (2024) indicated that private emptying service providers operate in a somewhat uncoordinated manner and at present are not strongly regulated by the HWSA. NGOs and other non-state providers limit their role to providing communal or public latrines in low-income areas. They do not offer support for the operation, maintenance and servicing of these facilities Strengthening regulatory enforcement in Hawassa is crucial for improving FSM efficiency and ensuring that service providers adhere to safety standards.

2.3. Research Gaps

Despite significant research on FSM in Ethiopia and other African countries, several gaps remain. First, there is limited empirical evidence on the effect of financial constraints on FSM efficiency in a town like Hawassa. While studies found that affordability of FSM services affect FSM efficiency, it required to examine how these financial constraints affect service delivery in the town.

Second, capacity of service provider on FSM efficiency in urban centers like Hawassa, however, studies have identified capacity constraints, and there is a need for more detailed analysis of how these constraints affect service delivery.

Third, the cost of emptying services has been recognized as a barrier to formal service utilization, but few studies have examined how these costs influence household decision-making. Understanding the role of cost in determining household choices between formal and informal providers is critical for developing policies to improve service uptake.

Fourth, there is a need for more research on the effect of infrastructural challenges on FSM efficiency. While some studies have highlighted the importance of infrastructures in accessing the service, and there is a need for more detailed analysis of how these constraints affect service delivery for increasing service uptake in areas like Hawassa.

Lastly, there is insufficient focus on the regulatory frameworks governing FSM in Ethiopia. Existing research acknowledges the weakness of these frameworks, but there is a need for further exploration of how stronger regulatory enforcement could improve service efficiency and compliance with safety standards.

2.4. Conceptual Framework

The conceptual framework for this study was designed to examine the effect of fecal sludge emptying and transport management on the efficiency of FSM services in Hawassa Town, Ethiopia. This framework builds upon the five key factors identified in the empirical review, financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges and regulatory frameworks, which served as the independent variables. These factors influence the dependent variable, which is the efficiency of fecal sludge management services in Hawassa.

Independent Variables:

Financial Constraints: Financial barriers restrict households' ability to afford formal FSM services. Limited financial resources result in delayed desludging, improper disposal, or reliance on informal service providers, which lowers the overall efficiency of FSM (Heymans, 2017; Sumita, 2024).

Capacity of Service Providers: The ability of FSM providers to meet demand in terms of both availability and operational capacity directly impacts the efficiency of FSM services. Insufficient service providers or under-resourced operators (e.g., a lack of desludging trucks or personnel) result in delays and inadequate service coverage (Sumita., 2024).

Cost of Emptying Services: High costs of formal desludging services deter households from using these services, leading to a preference for informal providers or unsafe disposal practices. Lowering costs can increase service uptake and improve overall system efficiency (Heyman, 2017).

Infrastructural Challenges: Inadequate infrastructure, particularly poor road networks and limited treatment facilities, hampers service providers' ability to deliver efficient services. Good infrastructure is crucial for ensuring timely and widespread access to FSM (Sumita, 2024).

Regulatory Frameworks: Effective regulatory frameworks ensure that service providers follow safety standards and that services are delivered in a structured manner. Weak regulation leads to inefficiencies, such as informal providers operating without proper oversight (Sumita, 2024).

Dependent Variable:

Efficiency of fecal sludge management services: The efficiency of fecal sludge management services in Hawassa measured by the timely and effective emptying and transport of fecal sludge like reliability and satisfaction of the service. A highly efficient system should reduce environmental pollution, minimize public health risks, and ensure adequate service coverage (Sumita, 2024; Heyman, 2017).

Conceptual Model:

The conceptual framework could be visually represented as follows:

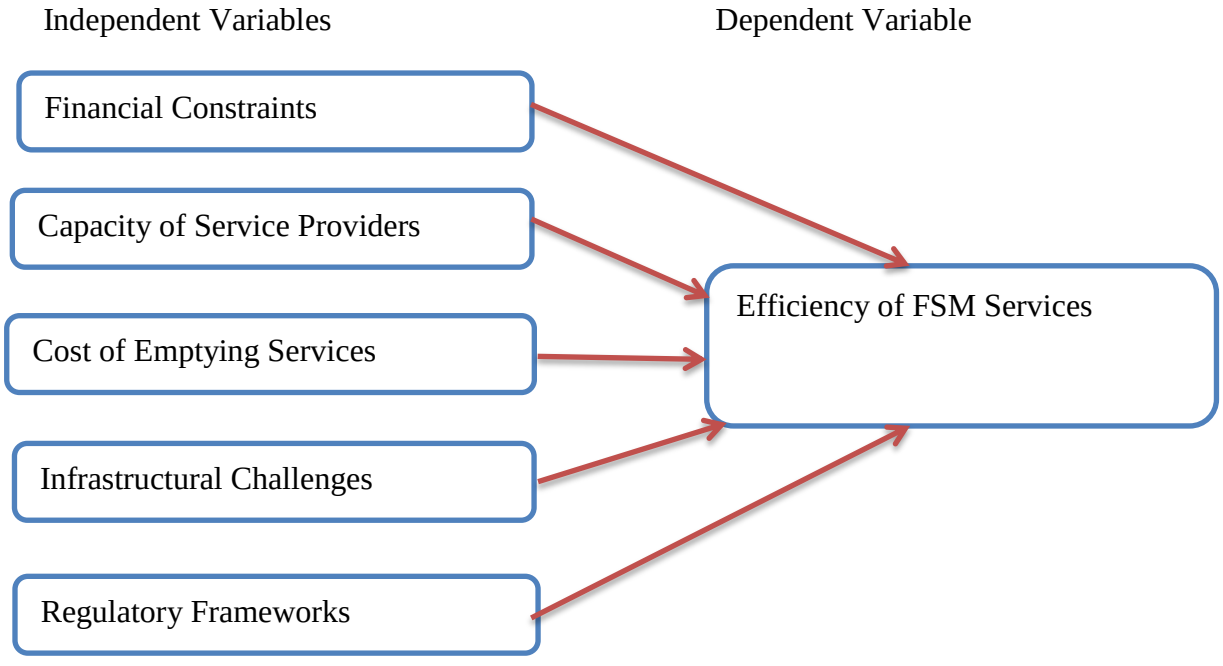

Fig.2.1. Conceptual Framework (Source: Own, 2024)

This model illustrated that the independent variables, financial constraints, service provider capacity, cost of emptying services, infrastructural challenges, and regulatory frameworks, interact to influence the efficiency of FSM services. Each independent variable exerts a direct or indirect effect on the efficiency of fecal sludge management, which included emptying and transport processes.

2.5. Research Hypothesis

The following hypotheses are derived from theoretical perspectives and supported by empirical studies reviewed in the preceding sections. They are structured as null hypotheses (H_0) and alternative hypotheses (H_1) for each specific research objective.

H1: Financial Constraints and FSM Efficiency Previous research highlights financial barriers as a significant determinant of FSM service efficiency. Murthy (2018) and Bala (2018) found that in low-income urban areas of India and Bangladesh, affordability constraints prevent households from accessing formal emptying services, contributing to environmental and public health hazards. According to the resource-based theory, access to essential financial resources determines a household's ability to utilize services. In Hawassa, similar affordability issues may lead to infrequent desludging or reliance on informal providers.

$H_0$1: Financial constraints have no significant effect on the efficiency of fecal sludge management services in Hawassa Town.

$H_1$1: Financial constraints have a significant negative effect on the efficiency of fecal sludge management services in Hawassa Town.

H2: Capacity of Service Providers and FSM Efficiency The capacity of FSM providers including availability of trucks, personnel, and technical capabilities—has been shown to influence service efficiency. Choge (2021) and Taweesan et al. (2017) reported that insufficient operational resources lead to service delays and limited reach, especially in peri-urban settings. This aligns with the systems theory, which posits that weak subsystems (e.g., service delivery) hinder overall system functionality.

H_o2: The capacity of fecal sludge service providers has no significant effect on the efficiency of FSM services in Hawassa Town.

$H_1 2$: The capacity of fecal sludge service providers has a significant positive effect on the efficiency of FSM services in Hawassa Town.

H3: Cost of Emptying Services and FSM Efficiency High desludging costs discourage households from using formal services. Balal (2018) showed that in Bangladesh, households prefer unregulated service options due to pricing, which undermines the effectiveness of formal FSM systems. This hypothesis builds on the institutional theory which highlights how economic rules and incentives shape service utilization.

H_o3: The cost of emptying services has no significant effect on the efficiency of FSM services in Hawassa Town.

$H_1 3$: The cost of emptying services has a significant negative effect on the efficiency of FSM services in Hawassa Town.

H4: Infrastructural Challenges and FSM Efficiency Inadequate infrastructure such as poor road access and lack of treatment facilities hinders timely FSM operations. Scot et al. (2016) emphasized that infrastructural bottlenecks restrict provider mobility and access, especially in informal settlements. This perspective aligns with systems theory, which views infrastructure as a foundational component of service networks.

H_o4: Infrastructural challenges have no significant effect on the efficiency of fecal sludge management services in Hawassa Town.

$H_1 4$: Infrastructural challenges have a significant negative effect on the efficiency of fecal sludge management services in Hawassa Town.

H5: Regulatory Framework and FSM Efficiency Weak enforcement of FSM policies allows informal providers to flourish, reducing overall service quality and consistency. Singh (2021) reported that inadequate regulation in Bangladesh led to widespread illegal sludge dumping.

Institutional theory underscores the role of governance structures and enforcement mechanisms in determining system outcomes.

H_o5: Regulatory frameworks have no significant effect on the efficiency of fecal sludge management services in Hawassa Town.

$H_1 5$: Regulatory frameworks have a significant positive effect on the efficiency of fecal sludge management services in Hawassa Town.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

This study investigated the effect of fecal sludge emptying and transport management on the efficiency of FSM services in Hawassa Town, Ethiopia. The research design was structured to achieve the study's objectives by employing a methodologically sound approach to data collection, analysis, and validation.

3.1. Research Design

This study employed a research design of using a combination of descriptive and explanatory (causal) research designs. The descriptive design was used to assess the current state of fecal sludge management (FSM) services in Hawassa Town, including service usage patterns, provider types, and perceptions of service quality and reliability. This helped to establish a factual baseline regarding household engagement with emptying and transport services.

The explanatory design was applied to examine the relationships between selected independent variables, financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges, and regulatory frameworks, and the dependent variable, the efficiency of FSM services. Statistical tools such as correlation and regression analysis were used to test hypotheses and determine the direction and significance of these relationships.

This dual design enabled the study not only to describe the existing conditions of FSM service delivery but also to explore the factors that influence service efficiency, thereby producing findings that are both empirically grounded and actionable for policy and practice.

3.2. Research Approach

This study employed a quantitative research approach to generate objective, measurable, and statistically analyzable data related to the efficiency of fecal sludge management (FSM) services in Hawassa Town. The quantitative approach was appropriate given the study's focus on

identifying patterns, measuring relationships, and testing hypotheses concerning factors affecting FSM service efficiency.

Data were collected through structured household surveys using a standardized questionnaire. This tool was designed to capture numerical information on key variables such as financial constraints, service cost, provider capacity, infrastructure challenges, regulatory frameworks, and household experiences with FSM service delivery. The use of a quantitative approach enabled the application of statistical techniques including descriptive analysis, correlation, and regression to identify significant trends and causal relationships.

Overall, this approach provided a robust empirical foundation for assessing both the current state of FSM services and the underlying factors influencing their operational efficiency.

3.3. Data to be Collected

To address the research objectives of this study, titled "Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of Fecal Sludge Management Services in Hawassa Town," both primary and secondary data were collected.

Primary data were collected through structured household surveys using a quantitative instrument designed to generate data on the study's key variables. These included independent variables, financial constraints, cost of emptying services, capacity of service providers, infrastructural challenges, and regulatory frameworks, and the dependent variable, efficiency of FSM services, measured through indicators such as service reliability and user satisfaction. Households were selected as the primary respondents because they are the direct users and decision-makers regarding fecal sludge management (FSM) services. Their lived experiences, perceptions, and behavioral choices significantly affect the efficiency of FSM service delivery. For example, households determine the frequency of pit emptying, their willingness or ability to pay for formal services, and whether to engage licensed or informal service providers. These decisions directly affect demand patterns, service timelines, and safe disposal practices. Therefore, collecting data from households was essential to understanding the real-world constraints and drivers of FSM service performance from the end-user perspective. This

approach ensured that the analysis was grounded in the practical realities of service engagement and provided evidence for policy and operational improvements tailored to household needs.

The quantitative data enabled statistical analysis of the relationships between these variables, supporting hypothesis testing and model development. In addition, secondary data were gathered from institutional reports, policy documents, and administrative records, particularly from the Hawassa Water and Sewerage Enterprise and the Hawassa Health Bureau. These data provided contextual background on service coverage, operational performance, and urban sanitation infrastructure. The combined use of primary and secondary data enhanced the study's comprehensiveness and analytical depth, ensuring that findings were grounded in both field-level evidence and broader institutional context.

3.4. Population, Sample Size, and Sampling Technique

3.4.1. Population

The population for this study comprised urban and peri-urban households across the 23 kebeles of Hawassa Town, totaling 63,847 households, based on the 2023 population record from the Regional Plan and Development Bureau. These households were considered eligible for fecal sludge management (FSM) services, regardless of whether they had previously accessed such services.

Households were selected as the study population because they are the primary end-users of on-site sanitation systems (e.g., septic tanks, pit latrines) that require regular emptying and transport services. Their experiences, behaviors, perceptions, and constraints are central to evaluating the efficiency of FSM service delivery. The independent variables explored in this study financial constraints, cost of emptying, service provider capacity, infrastructural challenges, and regulatory frameworks are all factors that households interact with directly. For example, households assess affordability, determine when and how to request emptying services, and experience firsthand the reliability and quality of services received. As such, their knowledge and experiences are vital to measuring the dependent variable, efficiency of FSM services.

Although the Hawassa Water Supply and Sewerage Enterprise (HWSE) is the primary institution mandated with coordinating and regulating FSM services in the town, the actual service outcomes are shaped significantly by household-level behavior and access. Understanding how households engage with, perceive, and are affected by FSM services offers critical insights that complement the institutional perspective of HWSE. Thus, targeting households as the study population ensured that the data captured the real-world factors influencing FSM efficiency from the demand side.

To ensure the study adequately captured both service uptake and access barriers, the population was conceptually included two distinct subgroups of FSM service users and non-users. Stratified sampling is appropriate when the population includes known subgroups that differ in characteristics relevant to the research objectives (Creswell & Creswell, 2018; Kothari, 2004).

Including non-users was methodologically significant for understanding the full scope of FSM service efficiency. While users provided insights into the quality, reliability, and satisfaction with existing services, non-users helped reveal critical barriers such as financial constraints, lack of awareness, and infrastructural challenges, factors directly linked to the study's independent variables. This approach ensured the study addressed not only service performance but also accessibility and demand-side limitations. Furthermore, capturing the perspectives of non-users supports more inclusive and evidence-based policy recommendations by identifying the underlying reasons for service avoidance or inaccessibility. Therefore, the inclusion of both users and non-users enhanced the representativeness and validity of the findings by reflecting the diverse experiences and decision-making dynamics within the FSM landscape of Hawassa Town.

3.4.2. Sample Size

The sample size for this study was determined using Cochran's (1977) formula for calculating sample sizes for proportions, at a 95% confidence level and a 5% margin of error. To ensure maximum variability and a conservative estimate, a population proportion of 50% ($p = 0.5$) was assumed. This resulted in an initial sample size of 384 households for an infinite population.

However, since the total number of urban and peri-urban households across the 23 kebeles in Hawassa Town is finite (N = 63,847 households), a finite population correction was applied.

After adjustment, the final required sample size was approximately 382 households. This sample size was deemed adequate to ensure statistical reliability and representativeness, enabling the study to provide meaningful insights into the effect of fecal sludge emptying and transport management on the efficiency of fecal sludge management services in Hawassa Town.

Sample Size Determination Formulas

According to Cochran (1977), the sample size for a finite population is calculated using the following formulas:

1. Initial Sample Size for an Infinite Population (n_0):

   $n_0 = (Z^2 \times p \times (1 - p)) / e^2$

   Where:

   Z = Z-value for the desired confidence level (e.g., 1.96 for 95%)

   p = estimated population proportion (use 0.5 if unknown)

   e = margin of error (e.g., 0.05 for 5%)
2. Adjusted Sample Size for Finite Population (n):

   $n = n_0 / (1 + (n_0 - 1) / N)$

   Where:

   N = total population size

Step-by-step calculation:

$n_0 = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 = (3.8416 \times 0.25) / 0.0025 = 0.9604 / 0.0025 = 384.16$

$n = 384.16 / (1 + (384.16 - 1) / 63{,}847) \approx 384.16 / 1.006 \approx 381.5$

Final sample size ≈ 382 households

3.4.3. Sampling Technique

This study employed a stratified random sampling technique to ensure proportional and representative inclusion of households across the 23 kebeles of Hawassa Town, which together comprise a total of 63,847 urban and peri-urban households, as reported by the Hawassa Town Plan and Development Bureau (2023). Each kebele was treated as a separate stratum, allowing for proportional allocation of the sample size to reflect the geographic distribution of households across the town.

The final sample size of 382 households was proportionally allocated to each kebele based on its share of the total household population. Within each kebele, simple random sampling was employed to select participating households.

It was found that precise user data per kebele were not available. As such, the study included both FSM service users and non-users, identified during field data collection through self-reported responses. This approach ensured balanced representation of both service uptake and access-related barriers.

The use of stratified random sampling, combined with proportional allocation and in-field identification of service-use status, ensured that the sample was both geographically representative and analytically inclusive. This method is widely recommended in applied research when population subgroups are known but unevenly distributed, and when subgroup status can be reliably determined during data collection (Creswell & Creswell, 2018; Kumar, 2014; Bhattacherjee, 2012).

3.5. Data Collection Methods

To achieve the research objectives, this study employed a quantitative research approach to collect primary data from households in Hawassa Town, using structured questionnaires designed to capture measurable data relevant to the efficiency of FSM services The data collection was carried out using a structured household questionnaire, which was administered digitally through the mWater application, a mobile data collection tool designed for efficient, accurate, and real-time data capture.

The questionnaire was structured to gather information on key variables related to fecal sludge management, including service frequency, cost, accessibility, satisfaction levels, and perceived efficiency of emptying and transport services. The use of mWater enhanced data quality by minimizing manual entry errors, ensuring consistency across enumerators, and facilitating secure data storage.

A stratified random sampling technique was employed to ensure geographical representativeness across the 23 kebeles of Hawassa Town. This approach allowed for the inclusion of households from various sub-cities and kebeles, thereby increasing the generalizability and reliability of the findings. The use of a structured tool via mWater for quantitative data collection contributed to generating scientifically valid and policy-relevant insights aligned with the research objectives.

3.6. Data Analysis

The data collected through the household surveys were subjected to quantitative analysis using statistical software of SPSS. The analysis was conducted in two main stages: descriptive and inferential statistics.

Descriptive analysis was first conducted to summarize the socio-demographic characteristics of respondents and to provide an overview of the current state of FSM services. This included the use of frequencies, and percentages to describe household experiences, service use patterns, and perceptions of FSM service efficiency.

To examine the relationships between variables, inferential statistical techniques were employed. Correlation analysis was used to explore the strength and direction of associations between independent variables such as financial constraints, cost of emptying services, capacity of service providers, infrastructural challenges, and regulatory frameworks and the dependent variable, efficiency of FSM services.

To further assess the predictive influence of the independent variables on FSM service efficiency, regression analysis was conducted. This allowed for the identification of statistically significant determinants of service efficiency and enabled the testing of research hypotheses concerning the causal relationships among the study variables.

Overall, the data analysis approach was designed to align with the explanatory nature of the study and to provide evidence-based insights into the operational and systemic factors influencing FSM service delivery in Hawassa Town.

3.7. Validity and Reliability

3.7.1. Reliability

Reliability represents the accuracy and precision of a measurement procedure (Kothari, 2004). To assess the internal consistency of the measurement scales used in this study, a reliability analysis was conducted using Cronbach's Alpha. This statistical test determines how closely related a set of items are as a group and is considered an indicator of scale reliability. According to widely accepted guidelines, an alpha value of 0.70 or higher is generally regarded as acceptable for research purposes (Zikmund et.al (2010). As summarized in the Table 1 below, all constructs used in this study demonstrated acceptable levels of internal consistency:

Table 3.1. Reliability analysis test results of survey instrument

Variable	Number of Items	Cronbach's Alpha	Remark
Financial Constraint	4	0.88	Acceptable
Cost of Emptying Service	3	0.77	Acceptable
Capacity of Service Provider	5	0.76	Acceptable
Infrastructural Challenge	4	0.83	Acceptable
Regulatory Framework	4	0.75	Acceptable
Efficiency of FSM Service	5	0.83	Acceptable
Average		0.80	

Source: Survey primary data, 2025

The computed Cronbach Alpha for all the measurement scale was stood at 0.80. While, the reliability analysis revealed that all variables achieved alpha values ranging from 0.75 to 0.88, indicating good to high internal consistency across all constructs. The financial constraint variable recorded the highest reliability score ($\alpha = 0.88$), suggesting a strong correlation among the items measuring this construct. Similarly, the constructs measuring infrastructural challenge ($\alpha = 0.83$) and efficiency of FSM service ($\alpha = 0.83$) also demonstrated strong internal consistency. The remaining variables cost of emptying service ($\alpha = 0.77$), capacity of service

provider (α = 0.76), and regulatory framework (α = 0.75), all surpassed the 0.70 threshold, confirming their reliability for subsequent statistical analyses such as correlation and regression.

Overall, the reliability test confirmed that the measurement instruments used in this study were consistent and suitable for further analysis, thus strengthening the validity of the study's findings.

3.7.2. Validity

To ensure the validity of the analysis, the study applied multiple strategies. Content and face validity were established through expert review of the questionnaire, ensuring that items accurately represented the intended constructs. Construct validity was supported by designing multi-item scales for key variables and confirming expected relationships through correlation and regression analyses. A pilot test was conducted to refine the clarity and structure of questions, while the use of the mWater platform during data collection enhanced internal validity by minimizing entry errors and enforcing logical consistency. Together, these steps ensured that the tools and analysis accurately captured and reflected the research objectives.

3.8. Model Specification

To analyze the effect of key factors on the efficiency of fecal sludge management (FSM) services, this study employed an ordinal logistic regression model. This approach was appropriate because the dependent variable, efficiency of FSM services was measured on an ordered categorical scale (e.g., low, moderate, high), which violates the assumptions of ordinary least squares (OLS) regression (Agresti, 2010). The ordinal logistic regression estimates the probability that the response variable falls into a given category or below, relative to the higher categories. Agresti (2010) formally defined the ordinal logistic regression model equation using the cumulative logit (log-odds) approach.

The general form of an ordinal logistic regression model is:

$$\log(P(Y \leq j)) = \alpha j - (\beta 1X1 + \beta 2X2 + \ldots + \beta kXk)$$

where:

- $P(Y \leq j)$ is the cumulative probability of the outcome being at or below category j,

- αj is the threshold (cut point) for category j, between different levels of perceived reliability.
- β = regression coefficients,
- X1, X2,....., Xk = independent (predictor) variables.

3.9. Ethical Considerations

The study adhered to ethical research principles, including obtaining informed consent from all participants, ensuring confidentiality, and minimizing any potential harm. Ethical approvals were obtained from the relevant institutions before the commencement of data collection.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

This chapter presented the analysis of data collected from structured questionnaires of the research questions from the respondents focused on Effect of Fecal Sludge Emptying and Transport Management on the Efficiency of FSM services in Hawassa Town, Ethiopia. It included descriptive statistics to summarize the demographic characteristics of respondents, inferential statistics to explore relationships and examine effect of fecal sludge emptying and transport management on the efficiency of FSM services.

4.1. Response Rate

The response rate for the study was notably high, with 100% of the 382 questionnaires filled and returned. This strong engagement from participants suggested a significant level of interest and involvement in the research topic. Besides, this rate happened as a result of regular monitoring and data management tool of mWater software application in mobile. The high response rate not only underscored the reliability of the data collected but also provided a robust foundation for analyzing Effect of fecal Sludge Emptying and transport Management on the Efficiency of FSM services in Hawassa Town It helped ensure that diverse household perspectives of both service users and non-users were captured, thereby reducing non-response bias and supporting reliable statistical analysis and interpretation.

Table 4.1. Response rate of respondents

No	Questionnaire status	Frequency	Percent
1	Issued	382	100
2	Filled and Returned	382	100
3	Unreturned	0	0
	Total	382	100

Source: Survey primary data, 2025

4.2. Demographic and Socioeconomic Characteristics of Respondents

This section presented an analysis and interpretation of the demographic and socioeconomic characteristics of respondents, including household size, age distribution, gender, education level, income, and sanitation facility information. These factors provide critical insights into the population's capacity to access and utilize fecal sludge management (FSM) services.

4.2.1. Household Size, Children under 5 Years, Age, Gender, Education and Income of the Respondents

The household size indicated that most households (34.3%) have nine or more members, followed by 3-5 members (33.5%) and 6-8 members (29.6%), while only 2.6% have 1-2 members. This indicated that large households are common, potentially influencing the demand for sanitation facilities and emptying services.

In terms of Children under 5 Years the data showed that 41.1% of households have no children under five, 24.9% have one child and 22.3% have 2-3 children. This suggested that households with young children may require more frequent fecal sludge management services due to increased hygiene demands, waste accumulation from childcare practices, and the need to minimize health risks for vulnerable members of the household.

Regarding to the age distribution, the age distribution showed that 48.2% of household heads were between 31–45 years and 37.7% were between 46–60 years, indicating that 85.9% of FSM-related decisions were made by individuals in the middle-adult age group. These age groups are generally considered economically active, socially responsible, and more likely to be engaged in household planning and financial decisions. Their role as primary decision-makers means they are most likely to assess, prioritize, and act upon sanitation service needs, including when and how to access fecal sludge management services. In contrast, the minimal representation of younger and older age groups implies that they play a smaller role in FSM decision-making.

The findings of gender illustrated that the majority of respondents were male representing 69.4%, while females accounted for 30.6%. This suggested that a gender disparity dimension in sanitation decision-making.

The educational profile of household heads showed that a majority had at least secondary education, with 38.2% completing secondary school and 33.8% attaining tertiary education. Meanwhile, 16.8% had only primary education and 11.3% had no formal education. This relatively high proportion of educated respondents suggests a potentially greater level of awareness about sanitation practices, understanding of FSM service benefits, and capacity to navigate service access procedures. As a result, higher education levels may contribute to more informed decision-making regarding when and how to use formal FSM services, and may also be associated with a greater likelihood of rejecting unsafe or informal alternatives.

Table 4.2. Household size, Children under 5 years, Age, Gender, and Education of the respondents

Description	Category	Frequency	Percent
Household Size	1-2	10	2.60%
	3-5	128	33.50%
	6-8	113	29.60%
	9 or more	131	34.30%
Children under 5 years of age	none	157	41.10%
	1	95	24.90%
	2-3	85	22.30%
	4 or more	45	11.80%
Age of head of the household	under 30	2	0.50%
	31-45	184	48.20%
	46-60	144	37.70%
	61-100	52	13.60%
Gender	Male	265	69.40%
	Female	117	30.60%
Education	no formal education	43	11.30%
	primary education	64	16.80%
	secondary education	146	38.20%
	tertiary education	129	33.80%

Source: Survey primary data, 2025

Lastly, the analysis of monthly income of the household showed that a substantial portion of households (35.3%) earned 5,001-10,000 ETB, followed by 32.5% earning more than 10,000 ETB. However, low-income households (<3,000 ETB) accounted for 11.8%, which might indicate affordability challenges in accessing FSM services.

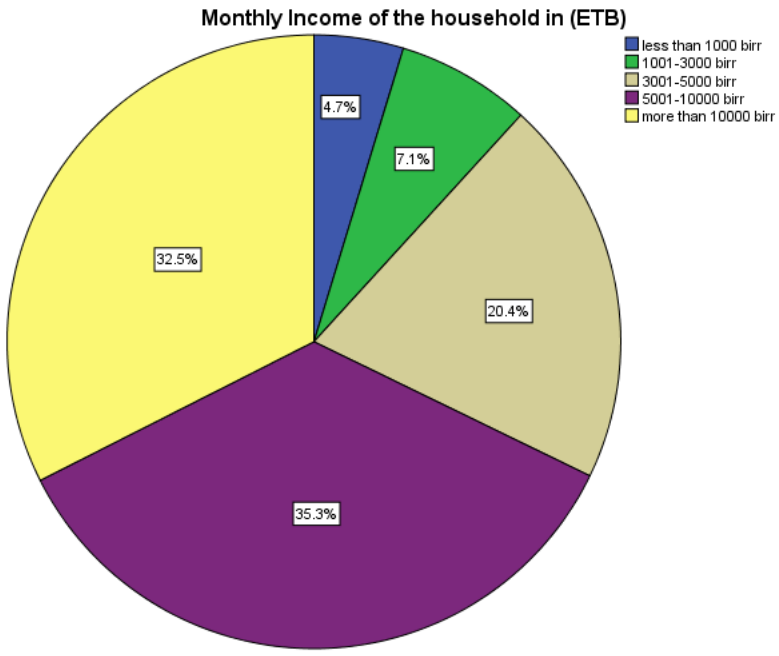

Fig 4.1. Monthly income of the Household (*Source: Survey primary data, 2025)*

4.2.2. Sanitation Facility Information

Table 4.3 depicted that the most common type of sanitation facility utilized by the respondents were a pit latrine with a slab (56.8%), followed by VIP latrines (13.4%) and flush toilets connected to a septic tank (13.4%). However, 15% use pit latrines without slabs, and 1.3% rely on public toilets, while 0.3% still practiced open defecation. This suggested that most of the households accessed and used improved sanitation facility and contributed to improve FSM services while the rest was not improved and has an effect on FSM services.

In terms of ownership of sanitation facility the majority (52.6%) of households owned their sanitation facilities, while 26.2% shared with 2-3 households and 21.2% shared with 4 or more households. This implied that shared facilities might pose hygiene and maintenance challenges and contributed to an effect on FSM services.

Regarding to the condition of facilities, the majority of sanitation facilities were rated as good (54.5%) or excellent (30.4%), but 13.6% were in fair condition, and 1.6% were in poor condition. This suggested that potential FSM services delivery concerns and might pose hygiene challenges in the households.

Table 4.3. Type, Ownership and Condition of Sanitation Facility of respondents

Description	Category	Frequency	Percent
Type of sanitation facility	pit latrine without a slab	57	15.00%
	pit latrine with a slab	217	56.80%
	VIP latrine	51	13.40%
	flush toilet connected to a septic tank	51	13.40%
	public toilet	5	1.30%
	open defecation	1	0.30%
Ownership of sanitation facility	privately owned by the household	201	52.60%
	shared with other households (2-3 households)	100	26.20%
	shared with multiple households (4 or more)	81	21.20%
Condition of sanitation facility	excellent (clean well maintained)	116	30.40%
	good (clean but requires maintenance)	208	54.50%
	fair (some damage but functional)	52	13.60%
	Poor (severe damage not fully functional)	6	1.60%

Source: Survey primary data, 2025

4.3. Descriptive Analysis

Descriptive analysis was utilized to summarize and describe the main features of the data collected from the respondents. These main features aligned with the specific objectives of the study. Frequencies and percentages used for the descriptive analysis of the study because it match with the study categorical type of data, more interpretable and better suited for informing findings in WASH/public health research (Babbie, 2020 and UNICEF & WHO, 2021).

4.3.1. Descriptive Analysis of the Current State of Fecal Sludge Emptying and Transport Services in Hawassa Town

This section presented an analysis of the frequency, quality, availability, and challenges of fecal sludge management (FSM) services, service provider emptying and reasons not emptying the service in Hawassa Town. The findings highlight key trends in FSM services utilization and the factors influencing service efficiency.

4.3.1.1. Frequency of FSM Service Use

The frequency of FSM services use findings showed that the majority of respondents (56%) replied that their sanitation facilities were emptied every 8-13 years, followed by 25.9% empty every 2-7 years, while only 9.2% empty once a year, 6% every six months, and 2.9% every three months. This implied that the long intervals between emptying indicated low service utilization, which may be due to financial constraints, lack of awareness, or reliance on alternative disposal methods. In addition, the low percentage of frequent emptying (every 3-12 months) suggested inefficiencies in FSM services delivery and affordability concerns.

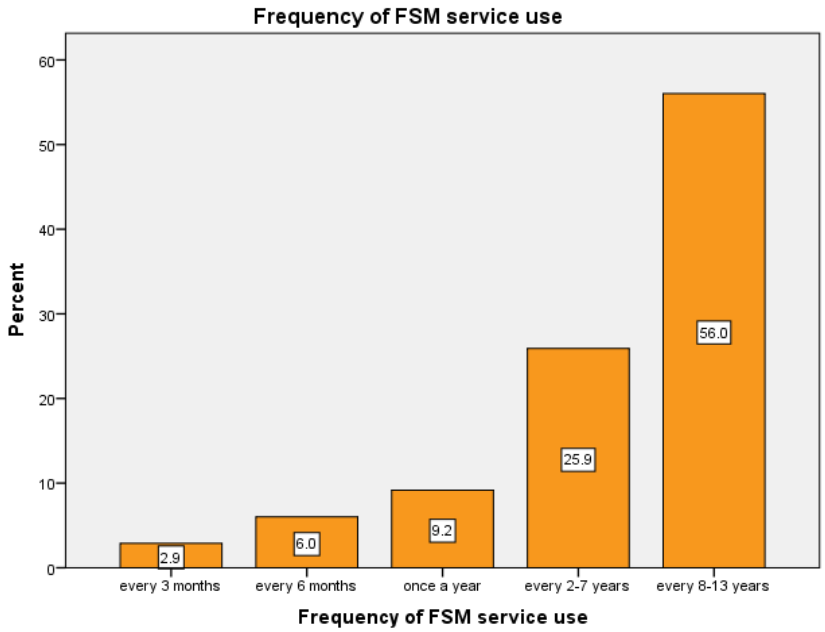

Fig 4. 2. Frequency of FSM Service Use (*Source: Survey primary data, 2025)*

4.3.1.2. Quality, Availability, Problems and Types of Problems Encountered of FSM Services Use

Table 4.4 showed that from the quality of FSM Services, 38.7% of respondents rated FSM services as good, while 12.8% rated it as fair. Despite of this, 9.7% rated it as poor, and 0.8% rated as very poor. Meanwhile, 32.2% of respondents have never received FSM services as they were non-users of the service, highlighting a significant service gap. This indicated that one-third of respondents have never used FSM services suggested accessibility challenges or lack of awareness. Moreover, some respondents rated service quality as good, the presence of poor and very poor ratings indicated inconsistencies in service delivery.

The availability of FSM services findings indicated that, 31.9% responded that FSM services were usually available, while 23% stated the services were sometimes available. However, 6.3% reported rare availability, and 2.1% informed that services were never available. Additionally, 31.4% of respondents were unsure about service availability which suggested that a lack of awareness or reliance on alternative methods. The findings indicated that the mixed responses on availability suggested FSM services were not uniformly accessible, potentially due to capacity of service providers, financial, or logistical challenges.

In terms of problems encountered with FSM service use, a significant 74.1% of respondents reported experiencing problems with FSM servicess, while 25.9% did not encounter any issues. The high percentage of households facing FSM-related problems reflected serious inefficiencies in service provision. Moreover, these problems might contribute to low service utilization, as seen in the frequency of emptying data.

Regarding to the types of problems encountered with FSM Services, the most frequently reported problem was high cost (36.7%), followed by poor service quality (20.8%) and delays in service (15.1%). The other challenges included limited availability of service providers (9.6%), health and environmental concerns (13.5%), and road infrastructure issues (3.9%). Only 0.4% of respondents cited low income as a problem suggested that cost-related concerns may be linked to perceived service value. These findings indicated that the high costs might reduce FSM services utilization, leading to inefficiencies in emptying frequency and sludge management. Besides, dominance of cost-related complaints highlights the need for affordable FSM services or

subsidies. Service delays and poor quality suggested a lack of operational efficiency among providers, which may discourage regular service use.

Table 4.4. Respondents' data on Quality, Availability, Problems and Types of Problems Encountered of FSM Services Use

Description	Category	Frequency	Percent
Quality of FSM service	excellent	22	5.80%
	good	148	38.70%
	fair	49	12.80%
	poor	37	9.70%
	very poor	3	0.80%
	never received such services	123	32.20%
Availability of FSM service	always available	20	5.20%
	usually available	122	31.90%
	sometimes available	88	23.00%
	rarely available	24	6.30%
	never available	8	2.10%
	I don't know	120	31.40%
Encountered problems with FS	yes	283	74.1
emptying services	no	99	25.9
Types of problems encountered	High cost	206	36.70%
with FS emptying services	delays in service	85	15.10%
	poor quality of service	117	20.80%
	limited availability of service providers	54	9.60%
	difficulty accessing service due to poor road infrastructure	22	3.90%
	health or environmental concerns	76	13.50%
	low income	2	0.40%

Source: Survey primary data, 2025

4.3.1.3. Service provider empties sanitation facility and reasons for not emptying and using FSM services

Out of the 382 households surveyed, the majority representing (43.7%) reported that their sanitation facilities were emptied by private service providers. The Hawassa Town Water and Sewerage Enterprise, a public service provider, was the second most utilized, serving 22.5% households. A smaller number of households, 1.8%, relied on informal, non-licensed service providers for fecal sludge emptying, while only 0.3% household reported practicing self-emptying. While 33.8% of the households indicated that their sanitation facilities had never been emptied. The analysis indicated that private service providers were the primary actors in fecal sludge emptying services, accounting for 43.7% of the households surveyed. This suggested a significant role of the private sector in sanitation service delivery, possibly due to factors such as flexibility, availability, or quicker response times. The Hawassa Town Water and Sewerage Enterprise, a public utility, served 22.5% of the households. This reflected a moderate reliance on government-led service provision. Only a small percentage of households (1.8%) reported using informal, non-licensed service providers, and even fewer (0.8%) practiced self-emptying. The low engagement with informal and self-service methods might indicate regulatory control or awareness of health risks associated with unsafe practices. Moreover, the finding showed that 33.8% of households had never emptied their sanitation facilities and not uses FSM services.

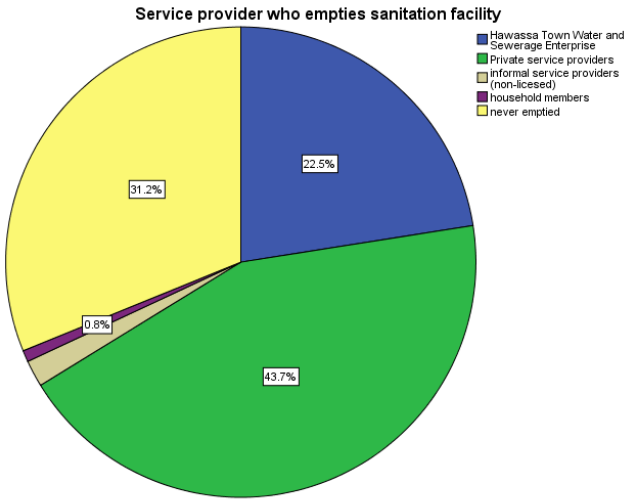

Fig 4.3. Service Provider empties sanitation facility (*Source: Survey primary data, 2025)*

Regarding to the reasons for not emptying and using FSM services among the households indicated that the most commonly cited reason was lack of awareness about the service, which accounted for 32.2% of the responses. The second most frequently reported reason was that services were too expensive, noted by 29.3% households. Other reported reasons include financial constraints, cited by 15.9%, and inaccessibility due to poor infrastructure, mentioned by 11.7%. Additionally, 11.0% households indicated they relied on alternative methods such as informal providers or self-emptying practices.

The findings indicated that the most significant barriers to accessing FSM services were information-related and cost-related. The leading reason, lack of awareness (32.2%) suggested that a considerable proportion of the population might not know about the availability, benefits, or procedures for accessing FSM services. This reflected a critical gap in community outreach, education, and public communication strategies. The second major constraint, high perceived cost (29.3%) revealed that many households find FSM services financially burdensome. This aligned with the 15.9% who cited general financial constraints, indicating that economic limitations were a widespread challenge to service uptake. A smaller, yet meaningful portion of households face physical access barriers (11.7%), likely due to poor road infrastructure or service vehicle inaccessibility. The use of alternative methods (11.0%) implied that some households might bypass formal FSM systems entirely, possibly risking unsafe practices that could affect public health and environmental safety.

Table 4.5. Respondents' data on reasons not emptying and using the FSM services

Description	Category	Frequency	Percent
Reasons for not emptying and using FSM services	Services are too expensive	83	29.30%
	Lack of awareness about the service	91	32.20%
	Inaccessible due to poor infrastructure	33	11.70%
	Alternative methods (informal providers, self-emptying)	31	11.00%
	Financial constraints	45	15.90%

Source: Survey primary data, 2025

4.3.2. Descriptive Analysis of the Effect of Financial Constraints on the Efficiency of FSM Services in Hawassa Town

This section examined how financial constraints affect the efficiency of fecal sludge management (FSM) services in Hawassa Town. The findings highlighted the affordability of FSM services, cost-related barriers, alternative coping mechanisms, and the overall impact on service efficiency.

4.3.2.1. Affordability of FSM Services

Affordability of FSM services findings indicated that 70.4% of respondents described FSM services were expensive, 2.1% very expensive, 27.2% considered FSM services affordable and 0.3% very affordable. This indicated that the high perceived cost suggested that affordability was a major barrier to FSM services utilization. In addition, households that found services too expensive might delay emptying, affecting the overall efficiency of FSM operations.

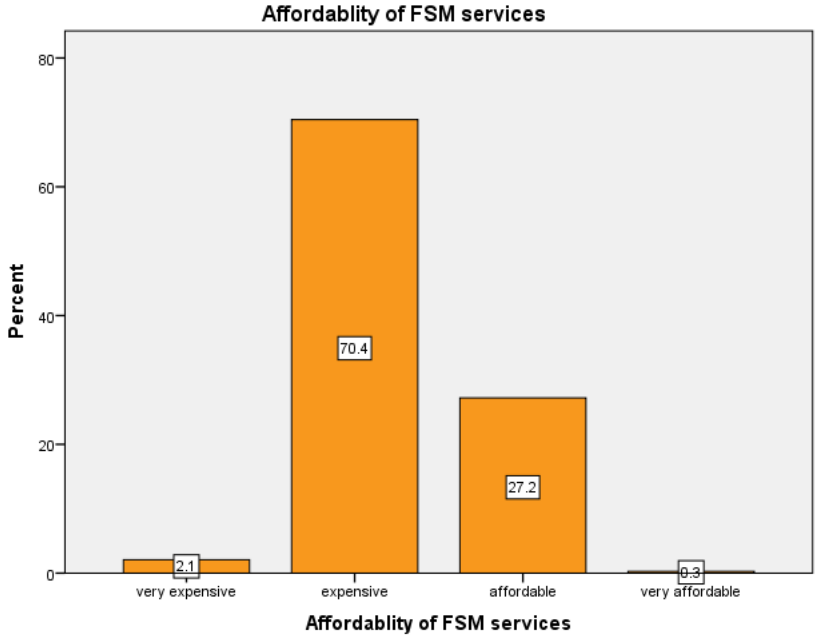

Fig 4.4. Affordability of FSM services (*Source: Survey primary data, 2025)*

4.3.2.2. Cost prevention, impacts of financial constraints, health problems, Cost Alternatives and Effects of Financial constraints on FSM Efficiency

The finding of cost prevention on FSM Service use showed that 20.2% of respondents often avoid FSM services due to cost, 39.8% sometimes avoid, 25.7% reported that cost did not prevent them from using FSM services. In terms of impact of financial constraints on FSM Service access, 75.4% of respondents stated that financial constraints limit their access to FSM services, 23.8% reported no financial impact on access and 0.8% was unsure. This indicated that a high percentage of respondents avoid FSM services due to cost, indicated a direct link between financial constraints and inefficiency in FSM services use.

Regarding to health problems due to financial constraints, 31.41% of respondents reported health problems due to financial constraints affecting FSM services use, 41.1% did not report any health issues, while 27.49% were uncertain. This indicated that health risks associated with poor FSM access highlighted potential sanitation crises in financially strained households.

Cost alternatives to formal FSM services revealed that respondents stated alternative strategies for managing fecal sludge to cope with financial constraints. Accordingly, 45.5% relied on informal service providers (unregulated, possibly unsafe), 24.6% delay emptying, increasing risks of overflow, 18.1% borrow money to afford FSM services and 11.3% manage on their own, likely using unsafe or informal methods. This implied that reliance on informal providers and delays in emptying indicated inefficiencies, as FSM services were not being used optimally. Moreover, borrowing money for FSM services suggested financial strain and the need for cost-reduction mechanisms and managing on their own raises concerns about sanitation safety and environmental risks.

Lastly, the analysis of effects of financial constraints on FSM efficiency showed that the major financial effects on FSM efficiency, 33.7% of respondents stated an inability to afford timely service, 28.2% relied on informal or cheaper providers, and 28.2% experience service delays due to financial barriers, 6.2% reported quality impacts and 3.7% mentioned health risks. This finding suggested that delays, reliance on informal providers, affordability issues all contributed to FSM inefficiencies and affecting service quality and regulation. In addition, financial

constraints reduce the frequency and quality of FSM services utilization and undermining sanitation infrastructure which contributed to FSM inefficiencies.

Table 4.6. Respondents' data on Cost prevention, impacts of financial constraints, health problems, Cost Alternatives and Effects of Financial Constraints on FSM Efficiency

Description	Category	Frequency	Percent
Cost prevention on FSM service use	yes often	77	20.20%
	yes sometimes	152	39.80%
	rarely	55	14.40%
	no	98	25.70%
health problems due to financial constraints	yes	120	31.41%
	no	157	41.10%
	I don't know	105	27.49%
Impacts of financial constraints on access to FSM emptying services	yes	288	75.40%
	no	91	23.80%
	I don't know	3	0.80%
Cost Alternatives to formal FSM service use	use informal service providers	174	45.5
	borrow money for the service	69	18.1
	delay emptying	94	24.6
	manage on your own	43	11.3
	I don't know	2	0.5
Financial effects on FSM services	inability to afford timely service	227	33.70%
	reliance on informal or cheaper service provider	190	28.20%
	delays in service	190	28.20%
	impacts on service quality	42	6.20%
	health or sanitation concerns	25	3.70%

Source: Survey primary data, 2025

4.3.3. Descriptive Analysis of the Effect of Capacity of Service Providers on the Efficiency of FSM Services in Hawassa Town

This section analyzed how the capacity of fecal sludge management (FSM) service providers, including their availability, skills, equipment, and overall sufficiency, affects the efficiency of FSM services in Hawassa Town.

4.3.3.1. Service Provider Availability

The availability of FSM services providers findings showed that the majority of respondents (46.5%) replied that providers were available most of the time, 4% of responded that FSM services providers were always available, 36.8% occasionally available, 11.7% rarely found FSM services providers and 1% of respondents never available were unsure about FSM services availability. This indicated that the limited availability of FSM providers (only 4% always available) suggested inefficiencies in service provision. Moreover, FSM services may be inconsistent or geographically imbalanced, affecting timely sludge management.

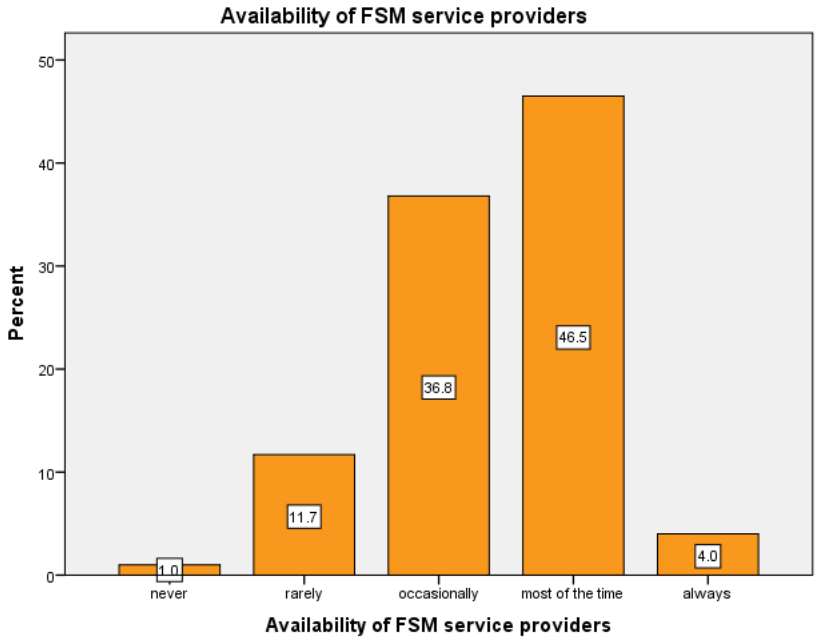

Fig 4.5. Availability of FSM Service Providers (*Source: Survey primary data, 2025)*

4.3.3.2.Skills, Adequacy of Equipment and Effect of FSM Providers Shortage on FSM Efficiency

The findings of skills of FSM services providers indicated that 34% FSM services providers had the necessary skills, 19.1% disagreed and 46.9% were unsure about provider skills, suggested limited user engagement. Thus, the low confidence in service provider skills (only 34%) suggested that there might be training gaps and which potentially leading to inefficient FSM operations. On the other hand, high percentages of respondents (46.9%) were uncertain about provider skills, which could indicate lack of direct experience with FSM services.

In terms of adequacy of FSM equipment and resources, 31.2% stated that FSM services providers had adequate equipment, 28.8% disagreed, indicated a lack of sufficient trucks and tools, 40.1% were unsure about equipment adequacy, again reflected possible transparency issues in FSM operation. This suggested that insufficient equipment reduces FSM efficiency by causing delays or incomplete services and the high uncertainty about equipment might suggest inadequate communication between providers and users regarding service capacity.

Regarding to sufficiency of service providers (Trucks, Staff, and Resources), 25.7% responded that FSM providers had sufficient resources, while 46.1% disagreed, reporting insufficient trucks, staff, or other capacity issues and 27.7% were unsure, again pointing to a lack of awareness or engagement with FSM services. This implied that a significant portion (46.1%) of respondents reported insufficient FSM capacity, which can directly cause service inefficiencies. As a result of insufficient trucks and staff limit service coverage, increase waiting times, and reduce response efficiency. Moreover, FSM services providers need investment in equipment and workforce expansion to improve service effectiveness.

Lastly, the effect of FSM provider shortage on FSM efficiency showed that 62.8% of respondents responded no effect, possibly because they had not engaged with FSM services, 15.7% informed the shortage causes delays in service delivery, 12.3% indicated that it increases costs, 3.1% thought that it might lead to environmental health risks and the remaining 6% were unsure of the effects. This indicated that service provider shortages caused delays and increased costs which negatively impacting FSM efficiency. Delays in emptying services may lead to overflows, sanitation crises, and reduced public health standards. Moreover, environmental risks

may be underreported but remain a significant long-term impact of inefficiencies in FSM services.

Table 4.7. Respondents' data on Skills, Adequacy, Sufficiency and Effect of Shortage of Service Providers

Description	Category	Frequency	Percent
Skills of FSM service providers	yes	130	34.00%
	no	73	19.10%
	I don't know	179	46.90%
Adequacy of appropriate equipment	yes	119	31.20%
	no	110	28.80%
	I don't know	153	40.10%
Sufficiency of service providers	yes	98	25.7
	no	176	46.1
	sometimes	2	0.5
	I don't know	106	27.7
Effect of shortage of service providers	no	240	62.8
	causes delays in service delivery	60	15.7
	increases costs	47	12.3
	leads to environmental health risks	12	3.1
	I don't know	23	6

Source: Survey primary data, 2025

4.3.4. Descriptive Analysis of the Effect of Cost of Emptying Services on the Efficiency of FSM Services in Hawassa Town

This section examined how the cost of emptying services affects the efficiency of fecal sludge management (FSM) services in Hawassa Town. The analysis focused on affordability, delays due to cost, alternative coping strategies, and the overall impact on FSM efficiency, including health and sanitation concerns.

4.3.4.1.Cost of Emptying Service

The findings of cost of emptying price showed that 22.5% of respondents paid 3500 ETB for their last emptying service, 17% paid 4500 ETB, while 5.8% paid more than 5500 ETB, and 32.7% had never used FSM services. The fact that one-third of households had never emptied their sanitation facilities indicated that lack of awareness or potential financial barriers or reliance on informal methods which would have a major inefficiency in FSM services. The high costs of emptying (often exceeding 3500 ETB) might discourage households from using formal FSM services, leading to delays or alternative disposal methods.

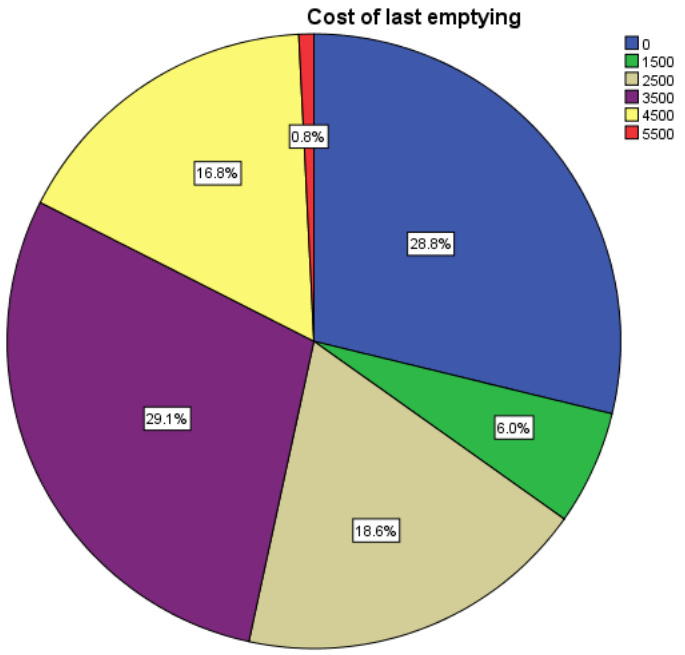

Fig 4.6. Cost of last emptying (*Source: Survey primary data, 2025)*

4.3.4.2. Affordability, Delays, Alternative Solutions, Unfair Costs and Health and Sanitation Issues Related to FSM Costs

The finding of affordability of FSM Services showed that 75.7% of respondents could not afford FSM services, while 23.8% considered the costs affordable. The high percentage of respondents who find FSM services unaffordable suggested that cost is a major barrier to service access.

Delays due to cost revealed that 25.9% of respondents never experience delays due to cost, 29.1% occasionally delays, 11% frequently delays, 3.7% always delay and 30.4% were unsure

which possibly indicated a lack of direct experience with FSM services. This result indicated that delays in emptying due to cost reduce the efficiency of FSM services, leading to sludge accumulation, overflow, and hygiene risks. Furthermore, households that experience frequent delays were more likely to rely on informal methods or unsafe disposal practices which further lowering FSM efficiency.

In terms of alternative solutions when costs were unaffordable, households adopt alternative strategies and accordingly respondents replied that 34.8% delay or postpone emptying, increasing sanitation risks, 25.9% use informal service providers, which may be cheaper but less reliable, 15.3% seek financial help to cover emptying costs, 13.1% share service costs with neighbors, indicated community-based coping mechanisms and 10.9% empty the pit or tank themselves, posing environmental and health risks. This finding indicated that delaying emptying and using informal providers reflected FSM inefficiencies caused by high costs, self-emptying poses serious health and environmental risks, highlighting the need for affordable FSM solutions. Moreover, financial constraints push some households to seek external financial help or share costs, suggested that cost-sharing program could enhance service uptake.

Regarding to unfair costs, households identified several reasons why FSM services costs were perceived as unfair and responded that 36% high costs, reinforcing affordability concerns, 21.6% poor service quality, 19.8% complained about slow response times, 13.3% additional fees, 9.4% mentioned lack of reliability or consistency in service delivery. The finding suggested that high cost was the primary reason for dissatisfaction, contributing to low service utilization and inefficiencies in FSM operations. Additionally, slow response times and additional fees discourage households from using FSM services regularly which might be leading to poor sanitation outcomes.

Lastly, health and sanitation issues related to FSM costs, due to delays in FSM services use, households responded sanitation problems of 37.3% experienced persistent odor, 25.7% increased health risks, 17.8% faced overflow or leakage, 15.4% noticed pest attraction, leading to further hygiene concerns and 3.8% experienced structural damage. This indicated that delays in emptying due to cost contribute to poor sanitation conditions, increasing health risks and environmental hazards and also the presence of persistent odor and overflow indicated a sign of poor sludge management including inadequate sludge containment and lead to FSM inefficiency.

Table 4.8. Respondents data on Affordability, Delays Due to Costs, Alternative Solutions, Unfair cost and Sanitation Issues

Description	Category	Frequency	Percent
Affordability of the cost of FSM service	yes	91	23.80%
	no	289	75.70%
	I don't know	2	0.50%
Delays due to cost	never	99	25.90%
	occasionally	111	29.10%
	frequently	43	11.30%
	always	14	3.70%
	I don't know	116	30.40%
Alternative solutions costs unaffordable	delay or postpone emptying	109	34.80%
	use informal service provider	81	25.90%
	empty the pit or tank myself	34	10.90%
	share service costs with neighbors	41	13.10%
	seek financial help	48	15.30%
Reasons for unfair costs	poor service quality	60	21.60%
	slow response time	55	19.80%
	high cost	100	36.00%
	hidden or additional fees	37	13.30%
	lack of reliability or consistency in service delivery	26	9.40%
Health or sanitation issues	over flow or leakage	74	17.80%
	persistent odor	155	37.30%
	increased health risk	107	25.70%
	attraction of pests	64	15.40%
	structural damage	16	3.80%

Source: Survey primary data, 2025

4.3.5. Descriptive Analysis of the Effect of Infrastructural Challenges on the Efficiency of FSM Services in Hawassa Town

This section examined how infrastructural challenges such as accessibility, equipment adequacy, service disruptions, and physical barriers affect the efficiency of fecal sludge management (FSM) services in Hawassa Town.

4.3.5.1. Accessibility of FSM Emptying Services

The finding of accessibility of FSM Emptying Services showed 5% of respondents stated FSM emptying services were easily accessible, 63.4% reported moderate accessibility, 19.9% found FSM servicess poorly accessible and 11.8% not accessible at all. This informed that a small portion of households experience easy access to FSM services, which suggested that infrastructure issues, road conditions, or service coverage gaps affected accessibility. Over 30% of respondents (poorly accessible and not accessible at all) struggle with FSM access, which might reduce service efficiency and increased sanitation risks. Moreover, moderate accessibility indicated that services exist but may be delayed due to infrastructural constraints.

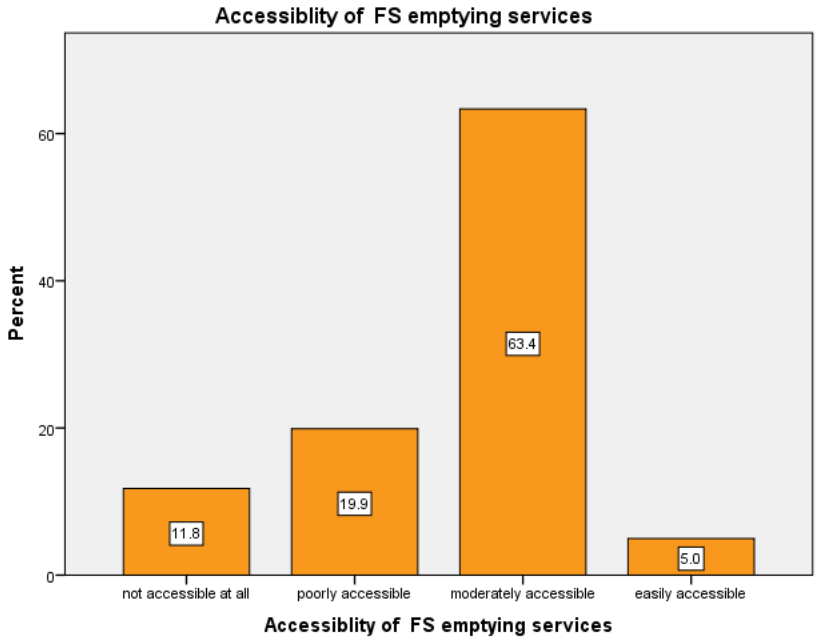

Fig. 4.7. Accessibility of FS emptying services (*Source: Survey primary data, 2025)*

4.3.5.2.Adequacy, FSM Service Disruptions, Reasons for Inaccessibility and Types of FSM Service Interruptions

Adequacy of FSM equipment and tools findings showed that 18.8% of respondents explained that FSM services providers were well-equipped, 40.8% providers have equipment, but it was outdated or inadequate, 17.8% service providers often lack necessary equipment and 22.5% of respondents were unsure about equipment adequacy. This illustrated that over half (59.1%) of respondents believed FSM providers lack adequate or modern equipment, which can cause inefficiencies in sludge emptying and transport. Limited equipment capacity can lead to delays, service cancellations, or reliance on informal service providers. Moreover, FSM efficiency can be improved by investing in modern, reliable emptying and transport equipment.

In terms of frequency of FSM services disruptions due to infrastructure problems, 27.5% of respondents described that never experiencing FSM services disruptions, 31.9% occasionally experienced disruptions, 6.5% frequently, 1% always disrupted and 33% of respondents were unsure or unaware of service disruptions. This indicated that almost 40% of respondents (occasional, frequent, or always) experienced FSM services delays due to infrastructure problems, demonstrating that poor infrastructure was a major challenge to service efficiency. Uncertainty (33%) about disruptions may suggest lack of awareness among some households.

Regarding to FSM inaccessibility among respondents who faced FSM inaccessibility, the key reasons were 39.8% cited poor road conditions, making it difficult for vacuum trucks to reach households, 34.7% stated that their distance from service providers was a major barrier, 25.4% reported a lack of available FSM services providers in their area. The finding suggested that poor road conditions (39.8%) were the most common infrastructure-related barrier, affecting FSM efficiency by increasing transport delays and costs. Distance from service providers (34.7%) highlights the need for decentralized FSM services stations to reduce response time. In addition, a lack of FSM providers in some areas (25.4%) suggested that infrastructure investments should be paired with service expansion strategies.

Lastly, the types of FSM service interruptions due to infrastructure, 47% of respondents described that experiencing service delays due to infrastructure issues, 23.7% experienced service cancellations because FSM providers could not access their location and 29.3% stated increased wait times, meaning they had to wait longer than expected for services. This indicated

that service delays (47%) reduced FSM efficiency, as waste accumulates beyond safe containment limits. Service cancellations (23.7%) indicated that FSM providers were sometimes unable to deliver services due to poor infrastructure, creating major sanitation challenges. Furthermore, increased wait times (29.3%) suggested that even when services were available, infrastructure limitations caused inefficiencies in response time.

Table 4.9. Respondents' data of Adequacy, FSM Service Disruptions, Reasons for Inaccessibility and Types of FSM Service Interruptions

Description	Category	Frequency	Percent
Adequacy of tools and equipment	yes they are well equipped	72	18.8
	have equipment but it is outdated or inadequate	156	40.8
	no often lack the necessary equipment	68	17.8
	I don't know	86	22.5
Services disruption	never	105	27.5
	occasionally	122	31.9
	frequently	25	6.5
	always	4	1
	I don't know	126	33
	Total	382	100
Reasons for inaccessibility	lack of service providers	30	25.42
	poor road conditions	47	39.83
	distance from service providers	41	34.74
Types of Interruptions	service delay	135	47.00%
	service cancellation	68	23.70%
	increased wait times	84	29.30%

Source: Survey primary data, 2025

4.3.6. Descriptive Analysis of the Effect of the Regulatory Framework on the Efficiency of FSM Services in Hawassa Town

This section analyzed how regulatory policies, enforcement mechanisms, and awareness of FSM regulations influence the efficiency of fecal sludge management (FSM) services in Hawassa Town.

4.3.6.1. Awareness of FSM Regulations, Effectiveness of Enforcement and Impact of Regulatory Policies

The findings of awareness of FSM regulations and policies showed that 66% of respondents were not aware of FSM regulations or policies, 12.3% were sometimes aware, 15.2% were aware but unsure of the details and 6.5% of respondents well informed about FSM policies. This indicated that a lack of awareness about FSM regulations weakens compliance and service efficiency, as households and service providers may not adhere to best practices. Even among those who are aware, many were unsure of the details (15.2%), indicated gaps in information dissemination. Moreover, low regulatory awareness reduced the effectiveness of FSM policies in ensuring safe, timely, and regulated service delivery.

In terms of effectiveness of FSM regulations enforcement, 7.6% of respondents responded FSM regulations were very effective, 36.4% were moderately effective, 17.5% were slightly effective, 9.2% found FSM regulations completely ineffective and 29.3% were unsure of the effectiveness of FSM regulations and 7.6% of respondents found FSM regulations very effective, indicated weak enforcement mechanisms. This indicated that moderate effectiveness suggested partial enforcement, but significant gaps remain. Regulatory uncertainty highlights a lack of communication between regulatory bodies and FSM stakeholders. In addition, weak enforcement may lead to service delays, unregulated pricing, and poor sanitation standards, reducing FSM efficiency.

Regarding to impact of regulatory policies on FSM services quality, 19.9% of respondents responded FSM regulations greatly improve service quality, 27.2% stated somewhat improve quality, 25.9% reported little impact on quality, 3.4% stated regulations reduce service quality and 28.5% were unsure of regulatory impact on FSM services quality. This suggested regulatory framework contributed to FSM efficiency when effectively implemented, as seen by 47.1% of

respondents acknowledging improvements in service quality. However, 23.6% of respondents were unsure of the regulatory impact, reflecting gaps in awareness and policy implementation. Moreover, the presence of respondents (25.9%) who see little impact suggests that FSM regulations may not be effectively enforced in practice.

Table 4.10. Respondents' data on Awareness of FSM regulations, effectiveness of enforcement and impact of regulatory policies

Description	Category	Frequency	Percent
Awareness of government regulations	yes well informed	25	6.50%
	sometimes aware	47	12.30%
	aware but unsure of details	58	15.20%
	not aware at all	252	66.00%
Effectiveness of FSM regulations enforcement	very effective	29	7.60%
	moderately effective	138	36.10%
	slightly effective	68	17.80%
	not effective at all	49	12.80%
	I don't know	98	25.70%
Impact of regulatory policies	reduce service quality	13	3.4%
	have little impact on quality	99	25.9%
	somewhat improve quality	104	27.2%
	greatly improve quality	76	19.9%
	I don't know	90	23.6%

Source: Survey primary data, 2025

4.3.7. Descriptive Analysis of the Efficiency of FSM Services in Hawassa Town

This section analyzed the efficiency of fecal sludge management (FSM) services in Hawassa Town by assessing efficiency score, service reliability, satisfaction levels, key hindrances to efficiency, and the broader impacts of inefficiencies.

4.3.7.1. Descriptive Analysis of FSM Efficiency Score

A descriptive analysis was conducted to assess the overall efficiency of fecal sludge management (FSM) services in Hawassa Town from the perspective of service users. The efficiency score was computed by averaging two core indicators: Reliability of FSM services and Satisfaction with FSM services quality. Each indicator was measured on a 4-point Likert scale. The resulting composite score was used solely for descriptive analysis to provide a general overview of perceived service efficiency across the study population.

According to Boone (2012) and Sullivan (2013), the composite efficiency scores were categorized into five levels to facilitate interpretation: Low Efficiency (1.00–1.99), Moderate-Low Efficiency (2.00–2.49), Moderate Efficiency (2.50–2.99), High Efficiency (3.00–3.49) and Very High Efficiency (3.50–4.00). The analysis was based on data from 256 respondents who had utilized FSM services.

Table 4.11. Distribution of FSM Efficiency Scores (n = 256)

Efficiency Category	Score Range	Frequency (n)	Percent (%)
Low Efficiency	1.00 – 1.99	24	9.40%
Moderate-Low Efficiency	2.00 – 2.49	32	12.50%
Moderate Efficiency	2.50 – 2.99	85	33.20%
High Efficiency	3.00 – 3.49	89	34.80%
Very High Efficiency	3.50 – 4.00	26	10.20%
Total	—	256	100%

Source: Survey primary data, 2025

The findings indicated that a majority of the households (68%) perceived FSM services to be operating at either a moderate or high level of efficiency. 34.8% perceived high efficiency (scores between 3.00 and 3.49), 33.2% of respondents described moderate efficiency (scores between 2.50 and 2.99) and a smaller proportion of users (10.2%) rated the services as very highly efficient, indicated consistent satisfaction and reliability in their experiences. However, a significant minority expressed concerns about service delivery, 12.5% of users rated FSM efficiency as moderate-low, and 9.4% reported it as low, suggested that 21.9% of respondents experienced inefficiencies or gaps in reliability and satisfaction. This distribution implied that

while the overall perception of FSM services efficiency was favorable, there remains a substantial portion of the population facing challenges, possibly related to affordability, provider availability, infrastructure, or regulatory performance.

4.3.7.2 Reliability of FSM Services

Reliability of FSM services findings showed that 5.3% of respondents responded FSM services very reliable, 66.9% rated them as mostly reliable, while 22.9% found them often reliable, 4.9% stated FSM services were completely unreliable. The findings indicated that a small percentage (5.3%) considered FSM services very reliable, indicated room for improvement in service consistency and quality. The fact that 66.9% found services mostly reliable is positive, but achieving full efficiency requires addressing the remaining inefficiencies.

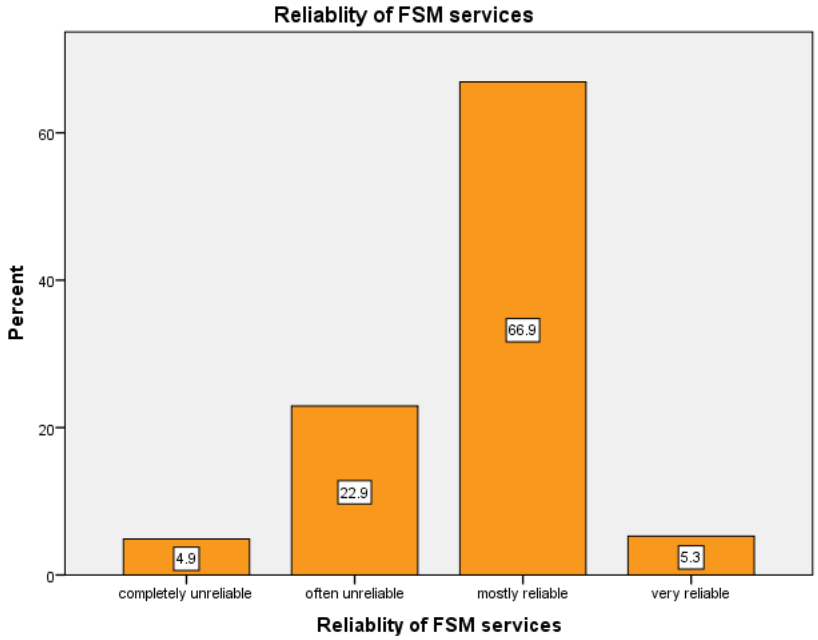

Fig 4.8. Reliability of FSM Services (*Source: Survey primary data, 2025)*

4.3.7.3.Satisfaction with FSM services quality, Factors Hindering FSM Service Efficiency and Impact of Inefficient FSM Services

The findings of satisfaction with FSM services quality indicated that 1.3% of respondents were very satisfied with FSM services, 46.6% were satisfied, 20.4% were dissatisfied, 2.1% were very dissatisfied and 29.6% were unsure. The findings showed satisfaction levels were mixed, with a notable 20.4% dissatisfaction rate. The high percentage of respondents unsure suggested FSM services may be underutilized or inconsistently available. Moreover, for FSM efficiency to improve, addressing dissatisfaction through better service quality, affordability and accessibility is crucial.

In terms of factors hindering FSM service efficiency respondents described several challenges affecting FSM efficiency, financial constraints (24%) were the most significant barrier, lack of community awareness (22.3%) affected FSM services demand and compliance, lack of service providers (19.6%) led to delays and reduced coverage, high cost of emptying services (13.9%) discouraged regular use, poor infrastructure (11%) made access to FSM services difficult, and weak regulatory framework (9.2%) contributed to poor service monitoring and enforcement. The findings indicated that financial constraints and high costs (combined 37.9%) were the biggest barriers to FSM efficiency, suggesting that affordability is a key issue. In addition, a lack of service providers (19.6%) and poor infrastructure (11%) reduced the availability and accessibility of FSM services, making timely sludge management difficult. Weak regulations (9.2%) and lack of awareness (22.3%) suggested that better policy implementation and public education could enhance FSM efficiency.

Regarding to impact of inefficient FSM services, the findings of FSM inefficiencies had major consequences for public health, the environment, and community well-being, of which health risks (34.3%) were the most frequently reported impact, including disease outbreaks and sanitation-related illnesses, environmental pollution (29.4%) was another major issue, likely due to improper waste disposal and overflow, increased expenses (23.5%) were a significant consequence, as inefficiencies lead to higher service costs and social or community conflicts (12.8%) arose due to sanitation-related disputes. The findings indicated that health risks and environmental pollution together account for over 63% of the reported impacts, highlighting the

urgency of improving FSM efficiency. Higher service costs (23.5%) resulted from inefficiencies, as delays and lack of providers force households to seek more expensive alternatives. Moreover, community conflicts (12.8%) indicated that inefficient FSM services affect social cohesion, particularly in areas with shared sanitation facilities.

Table 4.12. Respondents' data on Satisfaction with FSM services quality, Factors Hindering FSM Service Efficiency and Impact of Inefficient FSM Services

Description	Category	Frequency	Percent
Satisfaction with FSM services quality	very satisfied	5	1.3
	satisfied	178	46.6
	dissatisfied	78	20.4
	very dissatisfied	8	2.1
	I don't know	113	29.6
Factors Hindering Service Efficiency	financial constraints	262	24.00%
	lack of service providers	214	19.60%
	high cost of emptying service	152	13.90%
	poor infrastructure	120	11.00%
	lack of community awareness	243	22.30%
	weak regulatory framework	100	9.20%
Impact of Inefficient FSM Services	health risks	348	34.30%
	increased expenses	239	23.50%
	environmental pollution	298	29.40%
	community conflict	130	12.80%

4.4. Correlation Analysis

Correlation analysis is a fundamental and practical measure of association between variables, providing insight into the direction and strength of their relationship (Geoffrey et al, 2012). This involves calculating correlation coefficients to quantify the extent to which changes in one variable correspond to changes in another. This study used Spearman's rank-order correlation because it is appropriate for assessing the strength and direction of association between two ordinal or non-normally distributed variables (Laerd Statistics, 2015). Given that many of the study variables such as reliability levels, financial constraints, and service provider capacity were measured on Likert-type scales, Spearman's correlation is suitable for evaluating monotonic relationships without assuming linearity or normal distribution.

In this study, the value of Spearman's correlation coefficient (r_s) is used to interpret the strength and direction of the relationship between independent variables (e.g., financial constraints, service provider capacity) and the efficiency of FSM services. The coefficient ranges from -1 to +1, where +1 indicates a perfect positive monotonic relationship, -1 indicates a perfect negative monotonic relationship, and 0 indicates no monotonic relationship.

Cohen (1988) and Mukaka (2012) stated that the strength of the correlation is interpreted as follows: 0.00–0.19 (Very weak), 0.20–0.39 (Weak), 0.40–0.59 (Moderate), 0.60–0.79 (Strong) and 0.80–1.00 (Very strong). This interpretation helped assess how strongly factors like cost or infrastructure associated with the perceived efficiency of FSM services.

In order to run the Spearman correlation for this study, three assumption tests conducted. These assumption tests were:

1. Both variables are ordinal and/or continuous.
2. The variable values are pairs (have two measurements for every sample case, one for each variable).
3. The relationship between the variables is monotonic (increasing or decreasing).

Accordingly, the study data set checked and satisfied with the three assumption tests and it was also obtained that there was no linearity and normal distribution in the data set. Thus, Spearman

correlation was appropriate to conduct correlation analysis between independent and dependent variables of the study.

In this study, reliability of FSM services was selected as the sole dependent variable for both the ordinal regression and Spearman correlation analyses. This choice was grounded in theoretical and methodological considerations. Reliability directly captures the consistency, trustworthiness, and efficiency of FSM services delivery, and thus serves as a fundamental and representative indicator of overall service efficiency (Tilley et al., 2014). While "Satisfaction with FSM Service Quality" was also measured in the survey, satisfaction encompasses a broader range of factors such as cost affordability, customer service experience, and user expectations, which extend beyond operational efficiency.

Statistically, reliability is measured on an ordinal scale, making it suitable for ordinal logistic regression modeling (Laerd Statistics, 2015). Furthermore, selecting a single dependent variable rather than including both reliability and satisfaction ensures model simplicity, avoids redundancy, and minimizes multicollinearity risks. In Spearman correlation analysis, the use of reliability alone as the dependent variable aligns with best practices for examining monotonic relationships involving ordinal data (Laerd Statistics, 2015).

Accordingly, focusing on reliability as the core outcome measure enabled a consistent, interpretable, and methodologically sound assessment of how financial, regulatory, and service delivery factors affect the efficiency of FSM services in Hawassa Town. Therefore, reliability was chosen to ensure the models remained focused, parsimonious, and clearly aligned with the study’s objective of analyzing the operational efficiency of FSM services delivery.

Table 4.13 depicted that the correlation between independent and dependent variables.

Table 4.13. Correlation between Independent and Dependent Variables

Correlations

			Affordablity of FSM services	Cost prevention on FSM service use	health problems due to financial constraints	Impacts of financial constraints on access to FSM emptying services	cost of emptying	Affordablity of the cost of FSM service	Delays due to costs	Accessiblity of FS emptying services	Equipped adequacy of tools and equipment to perform FS emptying	Frequency of FSM services disruption or delayed due to infrastructure problems	Availability of FSM service providers	Skills of FSM service providers	Adequacy of appropriate equipment	Awareness of regulations	Effectiveness of FSM regulations enforcement	Impact of regulation
Spearman's rho	Reliablity of FSM services	Correlation Coefficient	.311**	-.251**	-.184**	-.290**	-.324**	.290**	.386**	.396**	-.490**	.228**	.396**	.386**	.412**	.321**	.352**	.712**
		Sig. (2-tailed)	.000	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		N	266	266	258	264	266	264	255	266	257	255	261	194	193	266	255	266

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey primary data, 2025

4.4.1. Correlation Analysis for Effect of Financial Constraints on the Efficiency of FSM Services in Hawassa Town

This section presented the relationships between financial constraints and the efficiency of FSM services measured by service reliability using Spearman's correlation coefficients to measure strength and direction. All relationships are tested at the 0.01 significance level.

Affordability of FSM services showed a positive and statistically significant correlation with reliability ($r = 0.311$, $p < 0.01$). This indicated that households who consider FSM services affordable were more likely to perceive them as reliable.

Cost prevention on FSM services use showed a negative and significant correlation with reliability ($r = -0.251$, $p < 0.01$). This suggested that households who delayed or avoided services due to cost perceive FSM services as less reliable.

Health problems due to financial constraints was negatively and significantly correlated with reliability ($r = -0.184$, $p < 0.01$). This showed that financial hardship leading to sanitation-related health issues was associated with lower perceptions of reliability.

Impacts of financial constraints on access to FSM services showed a negative and significant correlation with reliability ($r = -0.290$, $p < 0.01$). This suggested that households who experience access challenges due to financial issues tend to view FSM services as less reliable.

4.4.2. Correlation Analysis for Effect of Capacity of Service Providers on the Efficiency of FSM Services in Hawassa Town

This section explored the correlation between service provider capacity: availability, skill level, and adequacy of equipment and the efficiency of fecal sludge management (FSM) services in terms of reliability. Spearman's rank correlation coefficient was used to evaluate the strength and direction of the relationships.

Availability of FSM services providers showed a moderate positive and significant correlation with reliability ($r = 0.396$, $p < 0.01$). This indicated that households with better access to FSM providers tend to perceive the services as more reliable.

Skills of FSM services providers demonstrated a moderate positive and significant correlation with reliability ($r = 0.386$, $p < 0.01$). This indicated that technically competent providers contribute to improved perceptions of FSM services reliability.

Adequacy of appropriate equipment showed a moderate positive and significant correlation with reliability ($r = 0.412$, $p < 0.01$). This indicated that availability of proper equipment helped providers offer more consistent and timely services, enhancing reliability.

4.4.3. Correlation Analysis for Effect of Cost of Emptying Services on the Efficiency of FSM Services in Hawassa Town

This section presented the relationships between cost-related variables and the efficiency of FSM services in terms of reliability. Spearman's rho was used due to the ordinal and non-normally distributed nature of the variables.

Cost of Emptying Services showed a moderate negative and statistically significant correlation with FSM service reliability ($r = -0.324$, $p = 0.000$). This indicates that higher actual fees paid for the last emptying service are associated with lower perceptions of reliability among users. The

financial burden may contribute to service delays, dissatisfaction, or reluctance to use the service again.

Affordability of FSM services demonstrated a positive and significant correlation with reliability ($r = 0.290$, $p < 0.01$). This indicated that households that find the cost of services affordable were more likely to view the services as reliable.

Delays due to cost showed a moderate positive and significant correlation with reliability ($r = 0.386$, $p < 0.01$). This indicated that those who delayed service due to cost sometimes perceive the service as more reliable, possibly due to increased effort in selecting quality providers when eventually using the service.

4.4.4. Correlation Analysis for Effect of Infrastructural Challenges on the Efficiency of FSM Services in Hawassa Town

This section presented the correlation analysis between infrastructural challenges and the efficiency of FSM services, measured by service reliability. Spearman's rank correlation coefficient (rho) is used due to the ordinal nature of the variables.

Accessibility of FSM emptying services showed a moderate positive and significant correlation with reliability ($r = 0.396$, $p < 0.01$). This indicated that households with better access to FSM services tend to perceive them as more reliable.

Adequacy of tools and equipment for performing FSM showed a moderate positive and significant correlation with reliability ($r = 0.490$, $p < 0.01$). This indicated that FSM services supported by adequate tools and equipment were seen as more dependable by users.

Frequency of service disruption or delay due to infrastructure displays a weak positive and significant correlation with reliability ($r = 0.228$, $p < 0.01$). This indicated that while service disruptions were linked to infrastructure issues, the relationship with perceived reliability was weak, possibly due to user expectations already being adjusted to infrastructural limitations.

4.4.5. Correlation Analysis for Effect of Regulatory Framework on the Efficiency of FSM Services in Hawassa Town

This section presented the correlation analysis between regulatory framework variables such as awareness, enforcement, and perceived impact of regulations and the efficiency of FSM services measured through service reliability. Spearman's rank correlation coefficients were used due to the ordinal nature of the data.

Awareness of FSM Regulations demonstrated a moderate positive and statistically significant correlation with reliability ($r = 0.321$, $p = 0.000$). This suggests that households with better knowledge of sanitation regulations are more likely to perceive FSM services as reliable, possibly due to increased accountability and user engagement.

Effectiveness of FSM Regulation Enforcement exhibited a moderate positive and statistically significant relationship with service reliability ($r = 0.352$, $p = 0.000$). This finding underscores the importance of strong regulatory enforcement mechanisms in improving public trust and consistency in FSM service delivery.

Perceived Impact of Regulatory Policies presented a strong positive and statistically significant correlation with reliability ($r = 0.712$, $p = 0.000$). This indicates that when users believe that existing regulations have a real impact on service quality and delivery, they tend to report much higher reliability in FSM services.

4.5. Regression Assumption Tests

Ordinal logistic regression is a type of regression analysis used when the dependent variable is ordinal that is, it has a natural order but the intervals between values are not necessarily equal (e.g., reliability levels such as "very unreliable," "reliable," "very reliable"). It estimates the probability of the dependent variable falling into one of the ordered categories based on one or more independent variables. It is commonly used to model relationships between a set of predictors (which can be continuous or categorical) and an ordinal outcome (Hosmer et al, 2013, William 2006, McCullagh, P., 1980).

This study used ordinal logistic regression because the dependent variable, efficiency of FSM services, is measured on an ordinal scale, such as levels of service reliability (very unreliable to very reliable). The aim is to understand how multiple independent variables like financial constraints, provider capacity, and infrastructural challenges influence the likelihood of FSM services being rated at various efficiency levels.

Laerd Statistics. (2015) and O'Connell, A. A. (2006) described that there are three ordinal regression assumption tests. Accordingly, the following key assumptions were checked before applying ordinal logistic regression in this study.

1. Ordinal Dependent Variable: The outcome variable (e.g., FSM services efficiency or reliability) is ordinal, satisfying the main requirement for this model. The dependent variable in the analysis is "Reliability of FSM services" which measured on an ordinal scale—likely based on perceptions such as "very unreliable" to "very reliable." This met the requirement for applying ordinal logistic regression, where the outcome variable must be categorical with a meaningful order, but not necessarily equidistant between levels.

2. No Multicollinearity: Multicollinearity test stated that there is no important multi-collinearity (the independent variables are not strongly correlated with each other). Independent variables were tested for multicollinearity (e.g., using VIF or correlation matrix), ensuring that predictors are not highly correlated with each other. Multicollinearity was assessed using Tolerance and Variance Inflation Factor (VIF) values and it requires that VIF<10 and tolerance>0.1 to satisfy multicollinearity test. Accordingly, Table 14 indicated that the VIF values in the resultss range from 1.191 to 6.207, with Tolerance values mostly above 0.1.Therefore, the values observed here indicated that multi-collinearity was not severe and generally within acceptable limits for ordinal logistic regression.

Table 4.14. Multicollinearity test

Coefficients[a]		
	Collinearity Statistics	
	Tolerance	VIF
(Constant)		
Impacts of financial constraints on access to FSM emptying services	0.163	6.137
Cost prevention on FSM service use	0.161	6.207
health problems due to financial constraints	0.613	1.632
Cost of emptying services	0.612	1.633
Delays due to costs	0.402	2.485
Accessibility of FS emptying services	0.765	1.306
Equipped adequacy of tools and equipment to perform FS emptying	0.43	2.324
Frequency of FSM services disruption or delayed due to infrastructure problems	0.601	1.665
Availability of FSM service providers	0.622	1.608
Skills of FSM service providers	0.425	2.355
Adequacy of appropriate equipment	0.352	2.84
Awareness of regulations	0.798	1.254
Effectiveness of FSM regulations enforcement	0.839	1.191
Impact of regulation	0.52	1.922
a. Dependent variable: Reliability of FSM services		

Source: Survey primary data, 2025

3. Proportional Odds/Parallel Lines Assumption: The relationship between each pair of outcome groups is assumed to be the same. This was tested using Test of Parallel Lines, if the p-value is greater than 0.05, the assumption holds.

Test of parallel lines: One of the main assumptions of proportional odds model (the ordinal logistic regression) here was that the effects of the predictors on the odds of falling into a higher

(versus lower) category on the dependent variable is the same across categories. A non-significant test (in the table of Test of Parallel lines) resulted suggested the assumption of proportional odds was met, meaning the effects of the independent variables on the cumulative probability of falling into a higher category did not vary across categories on the dependent variable. In our output, that appears to be the case as p=1.000. Since the p>0.05, therefore, this indicated that it satisfied the proportional odds assumption and checked and accepted to run ordinal logistic regression.

Table 4.15. Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	0			
General	.000[b]	0	62	1

Source: Survey primary data, 2025

4.6. Regression Analysis

In this study, ordinal logistic regression was employed to analyze the effect of fecal sludge emptying and transport management on the efficiency of FSM services because the dependent variable, efficiency (measured through reliability), was ordinal in nature. Accordingly, model evaluation and interpretation were based on outputs appropriate for ordinal regression. Specifically, the Model Fitting Information was used to assess the overall goodness of fit of the model, Pseudo R-Square statistics (such as Nagelkerke R^2) were used to estimate the proportion of variance explained by the predictors, and the Parameter Estimates table was employed to interpret the direction, magnitude, and statistical significance of each independent variable's effect on the dependent variable. Unlike traditional linear regression, where outputs such as the ANOVA table, R-Square, and standardized coefficients are suitable for continuous dependent variables, ordinal regression requires outputs that align with the ordinal scaling and the proportional odds assumption. Therefore, in general, use Model Fitting Information instead of ANOVA, use Pseudo R-Square (Nagelkerke, etc.) instead of classical R^2, use Parameter Estimates instead of traditional linear regression coefficients, because the dependent variable is ordinal, not continuous. This approach followed the methodological guidance provided by Laerd

Statistics (2015), Field (2018), and Peng, Lee, & Ingersoll (2002), ensuring that the analysis and reporting were consistent with the statistical requirements of ordinal outcome modeling.

4.6.1. Pseudo R-Square

The Pseudo R-Square statistics provide additional insight into the explanatory power of the ordinal regression model. The Cox and Snell value was 0.805, the Nagelkerke value was 0.997, and the McFadden value was 0.992. Among these, the Nagelkerke R-Square, which adjusts Cox and Snell's value to allow for a maximum value of 1, suggested that the model explained approximately 99.7% of the variance in FSM services efficiency. Similarly, the very high McFadden R-Square value of 0.992 indicated an excellent model fit. These results collectively demonstrated that the independent variables included in the model account for a very large proportion of the variability in the efficiency of FSM services, confirming the model's strong predictive ability.

Table 4.16. Pseudo R-Square

Pseudo R-Square	
Cox and Snell	.805
Nagelkerke	.997
McFadden	.992
Link function: Logit.	

Source: Survey primary data, 2025

4.6.2. Model Fitting Information

The model fitting information for the ordinal regression analysis indicated that the final model provides a statistically significant improvement over the intercept-only model. The difference between the intercept-only model and the final model was substantial, with a Chi-Square value of 263.544 ($df = 30$, $p < 0.001$). This highly significant result suggested that the independent variables included in the model collectively contributed to explaining variations in the efficiency of FSM services. Therefore, the final model was considered a good fit for the data and appropriate for interpreting the effects of the predictors on FSM services efficiency.

Table 4.17. Model Fitting Information

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	263.544			
Final	0.000	263.544	30	.000
Link function: Logit.				

Source: Survey primary data, 2025

4.6.3. Parameter Estimates

The Parameter Estimates table provided detailed insights into the individual effects of each predictor on the likelihood of perceived efficiency of FSM services. Table 4.18 showed that significant predictors were identified at the 0.05 significance level, highlighting the key drivers influencing service reliability perceptions. In this analysis, unstandardized beta coefficients (Estimates) were used to assess the direction and statistical significance of each predictor's relationship with FSM services reliability. These values reflected the actual unit change in the dependent variable for a one-unit change in the predictor. (Table 4.18 and Annex 2).

Among financial constraint variables, the cost prevention on FSM services use (Estimate = 10.533, p = 0.014) was a statistically significant positive predictor, suggested that higher cost-related barriers substantially increased perceptions of reduced service reliability. Conversely, impacts of financial constraints on access (Estimate = -9.847, p = 0.001) demonstrated a significant negative association, indicating that when financial barriers were reported, the perceived reliability of FSM services notably decreased.

Regarding cost-related factors, delays due to costs (Estimate = -4.223, p = 0.014) were significantly associated with reduced perceived efficiency. Households facing service delays due to high costs expressed lower reliability ratings for FSM services.

For capacity of service providers, the availability of FSM services providers (was highly significant, with estimates of -3.910 and -3.639 (both p = 0.004 across different threshold levels).

These results revealed that lower availability of service providers negatively impacted perceptions of reliability.

Within the regulatory framework variables, awareness of FSM regulations (Estimate = -2.247, p = 0.038), effectiveness of FSM regulations enforcement (Estimate = -7.778, p = 0.010), and impact of FSM regulation (Estimate = -7.482, p = 0.003) had a significant negative relationship. Each of these findings indicated that weak awareness, poor enforcement, and perceived low impact of regulations significantly contributed to lower perceived reliability of FSM services.

Meanwhile, several infrastructural challenge variables (e.g., accessibility to services, adequacy of equipment, service disruptions) and some cost-related variables (e.g., general delays) did not achieve statistical significance ($p > 0.05$), suggesting their limited direct effect on user perceptions within this model.

The thresholds (cut points) further confirmed that as the reliability rating increases, the probability of respondents transitioning to higher levels of perceived FSM services efficiency shifts based on the predictor effects modeled through the logit link function. These results highlighted that financial barriers, service provider availability, and regulatory factors were critical in shaping users' perceptions of FSM services reliability.

Table 4.18. Significant Predictors of FSM Service (Parameter Estimate)

Predictor Variable	Estimate (β)	p-value
Cost prevention on FSM service use	10.533	0.014
Impacts of financial constraints on access	-9.847	0.001
Delays due to costs	-4.223	0.014
Availability of FSM service providers	-3.910, -3.639	0.004
Awareness of regulations	-2.247	0.038
Effectiveness of FSM regulation enforcement	-7.778	0.01
Impact of regulation	-7.482	0.003

Source: Survey primary data, 2025

Standardized beta coefficients used in a separate ranking Table 4.19 to compare the relative strength and importance of each significant predictor, as they are scale-independent and allow for cross-variable comparison. Table 4.19 depicted that the regression analysis identified several significant predictors influencing the reliability of fecal sludge management (FSM) services in Hawassa Town.

Based on the standardized beta coefficients, the impact of regulation emerged as the strongest predictor ($\beta = 0.524$), indicating that households who perceived regulations to have a strong, positive impact also described higher reliability of FSM services. This was closely followed by the impact of financial constraints on access to FSM services ($\beta = 0.510$), showing that minimizing financial barriers substantially enhances service reliability.

The third most influential factor was cost prevention on FSM services use ($\beta = 0.440$), where financial barriers that prevent timely emptying negatively impacted perceptions of reliability. Availability of FSM services providers ($\beta = 0.205$) also demonstrated a moderate positive effect, suggested that consistent availability of providers supports more reliable service delivery. Furthermore, awareness of FSM regulations ($\beta = 0.156$) and the effectiveness of FSM regulations enforcement ($\beta = 0.123$) showed positive but moderate influences, highlighting that improved communication and enforcement of regulations contributed to better reliability outcomes.

Overall, regulatory strength, financial accessibility, and service provider availability were the most critical drivers of FSM services efficiency as perceived by users, suggesting that interventions targeting these areas could significantly improve service reliability across Hawassa Town.

Table 4.19. Ranking of Significant Predictors of FSM Service Reliability

Rank	Predictor	Standardized Beta Coefficient (β)	Strength	Direction
1	Impact of Regulation	0.524	Strongest	Positive
2	Impacts of Financial Constraints on Access to FSM Services	0.51	Very Strong	Positive
3	Cost Prevention on FSM Service Use	0.44	Strong	Negative
4	Availability of FSM Service Providers	0.205	Moderate	Positive
5	Awareness of Regulations	0.156	Moderate	Positive
6	Effectiveness of FSM Regulations Enforcement	0.123	Moderate	Positive

Source: Survey primary data, 2025

4.6.4. Ordinal Logistic Regression Model Equation

An ordinal logistic regression equation models the relationship between one or more independent variables (IVs) and an ordinal dependent variable (DV). Agresti (2010) formally defined the ordinal logistic regression model equation using the cumulative logit (log-odds) approach.

The general form of an ordinal logistic regression model is:

$$\log(P(Y \leq j)) = \alpha j - (\beta 1X1 + \beta 2X2 + \ldots + \beta kXk)$$

where,

- $P(Y \leq j)$ is the cumulative probability of the outcome being at or below category j,
- αj is the threshold (cut point) for category j, between different levels of perceived reliability.
- β = regression coefficients,
- X1, X2,....., Xk = independent (predictor) variables.

In this study using only significant predictors ($p < 0.05$) from the Parameter Estimates, Table 4.20 presented the key independent variables that showed a statistically significant effect ($p < 0.05$) on the perceived reliability of fecal sludge management (FSM) services in Hawassa Town. Positive estimates indicated predictors that improve reliability, whereas negative estimates indicated predictors that reduce reliability.

Table 4.20. Significant Predictors of FSM Service Reliability (Ordinal Logistic Regression)

Predictor Variable	Estimate (β)	p-value	Direction of Effect
Cost prevention on FSM service use	10.533	0.014	Positive
Impacts of financial constraints on access	-9.847	0.001	Negative
Delays due to costs	-4.223	0.014	Negative
Availability of FSM service providers	-3.91	0.004	Negative
Awareness of regulations	-2.247	0.038	Negative
Effectiveness of FSM regulation enforcement	-7.778	0.01	Negative
Impact of regulation	-7.482	0.003	Negative

Source: Survey primary data, 2025

Thus, based on the parameter estimates (β), the ordinal logistic regression model predicting FSM services efficiency (measured through service reliability) can be summarized as follows:

$$\text{Logit}(\text{FSM Service Reliability}) = \alpha + (10.533 \times \text{Cost Prevention on Service Use}) - (9.847 \times \text{Impact of Financial Constraints}) - (4.223 \times \text{Delays Due to Costs}) - (3.910 \times \text{Availability of Service Providers}) - (2.247 \times \text{Awareness of Regulations}) - (7.778 \times \text{Effectiveness of Regulation Enforcement}) - (7.482 \times \text{Impact of Regulation})$$

where:

- α represents the model intercepts (thresholds),

- Each coefficient reflects the direction and magnitude of the variable's contribution to changes in FSM services reliability.

Positive coefficients increase the log-odds of higher service reliability ratings, while negative coefficients decrease it. This model highlights financial constraints, regulatory factors, and service provider availability as critical influences on perceived FSM services efficiency.

The ordinal logistic regression model indicated that cost prevention on FSM services use had a strong positive association with FSM services reliability. In contrast, greater impacts of financial constraints, more frequent delays due to costs, limited availability of FSM services providers, low awareness of regulations, weak enforcement of regulations, and perceptions of limited regulatory impact were all significantly associated with decreased reliability of FSM services. Thus, reducing financial barriers, improving service provider availability, and strengthening regulatory awareness and enforcement were essential for enhancing FSM services efficiency in Hawassa Town.

4.7. Hypothesis Summary

Based on the parameter estimate and aligning with the hypothesis structure from H1 to H5, the hypothesis summary clearly states whether to accept or reject each null hypothesis (H_0) based on significant parameter estimate ($p < 0.05$) from the study on the effect of fecal sludge emptying and transport management on the efficiency of FSM services in Hawassa Town.

This study tested five hypotheses regarding the effects of financial constraints, service provider capacity, cost of emptying services, infrastructural challenges, and regulatory frameworks on the efficiency of fecal sludge management (FSM) services in Hawassa Town. Hypotheses were evaluated based on the statistical significance of the parameter estimates ($p < 0.05$) in the ordinal logistic regression analysis. The results were summarized below:

H1: Financial Constraints and FSM Efficiency

- Findings:

  The cost prevention on FSM services use ($p = 0.014$) and impacts of financial constraints

on access (p = 0.001) were both statistically significant predictors of FSM services reliability.

- Decision:
  Reject $H_0 1$ and Accept $H_1 1$:
  Financial constraints have a significant negative effect on the efficiency of FSM services in Hawassa Town.

H2: Capacity of Service Providers and FSM Efficiency

- Findings:
  The availability of FSM services providers was statistically significant (p = 0.004), demonstrating that reduced service provider availability negatively affected FSM services reliability.
- Decision:
  Reject $H_0 2$ and Accept $H_1 2$:
  The capacity of fecal sludge service providers has a significant positive effect on the efficiency of FSM services in Hawassa Town.

H3: Cost of Emptying Services and FSM Efficiency

- Findings:
  Delays due to costs were found to be statistically significant (p = 0.014), indicating that higher service costs negatively impacted FSM services reliability.
- Decision:
  Reject $H_0 3$ and Accept $H_1 3$:
  The cost of emptying services has a significant negative effect on the efficiency of FSM services in Hawassa Town.

H4: Infrastructural Challenges and FSM Efficiency

- Findings:
  None of the infrastructural challenge-related variables (e.g., accessibility to services, equipment adequacy, service disruptions) were statistically significant (p > 0.05).

- Decision:
  Fail to reject H_o4:
  There is no sufficient evidence to conclude that infrastructural challenges significantly affect the efficiency of FSM services in Hawassa Town.

H5: Regulatory Framework and FSM Efficiency

- Findings:
  Awareness of FSM regulations ($p = 0.038$), effectiveness of FSM regulations enforcement ($p = 0.010$), and perceived impact of FSM regulations ($p = 0.003$) were all statistically significant, indicating strong regulatory influences on FSM services reliability.
- Decision:
  Reject H_o5 and Accept $H_1 5$:
  Regulatory frameworks have a significant positive effect on the efficiency of FSM services in Hawassa Town.

Therefore, the hypothesis testing results demonstrated that financial factors, service provider capacity, cost of emptying services, and regulatory frameworks significantly influence the efficiency of FSM services. Infrastructural challenges, however, did not show a statistically significant effect based on this model.

Table 4.21. Hypothesis Testing Summary

Hypothesis	Findings	Decision
H_1: Financial Constraints significantly affect FSM efficiency	Cost prevention on FSM use ($p = 0.014$) and financial access impacts ($p = 0.001$) were significant.	Reject H_{o1} and Accept H_{11}
H_2: Capacity of Service Providers significantly affects FSM efficiency	Availability of service providers was significant ($p = 0.004$).	Reject H_{o2} and Accept H_{12}
H_3: Cost of Emptying Services significantly affects FSM efficiency	Delays due to cost were significant ($p = 0.014$).	Reject H_{o3} and Accept H_{13}

H_4: Infrastructural Challenges significantly affect FSM efficiency	No infrastructural challenge variables were significant ($p > 0.05$).	Fail to reject H_{04}
H_5: Regulatory Framework significantly affects FSM efficiency	Awareness ($p = 0.038$), enforcement ($p = 0.010$), and impact ($p = 0.003$) were significant.	Reject H_{05} and Accept H_{15}

Source: Survey primary data, 2025

Table 4.21 presented the summary of hypothesis testing results. Out of five hypotheses, four were supported by the data, demonstrating significant effects on FSM efficiency, while infrastructural challenges showed no significant effect.

4.8. Discussion of Findings

4.8.1. Restating the Purpose of the Study

Efficient fecal sludge management (FSM) services are vital for safeguarding urban sanitation and public health, especially in rapidly growing cities like Hawassa Town. This study assessed the effects of fecal sludge emptying and transport management on FSM service efficiency in Hawassa Town. It specifically examined the effects of financial constraints, service provider capacity, emptying costs, infrastructural challenges, and regulatory frameworks. Demographic and socio-economic characteristics of households were also considered to contextualize FSM service utilization patterns. Drawing on descriptive, correlation, and regression analyses, the study identified systemic inefficiencies and proposed targeted interventions.

4.8.2. Demographic and Socioeconomic Characteristics of Respondents

Household composition significantly affected sanitation demand and FSM service utilization. Most households (63.9%) stated having six or more members, increasing the use of sanitation facilities and, consequently, the demand for emptying services. Although 41.1% of households had no children under five, a sizable portion did, raising concerns over vulnerability to poor sanitation.

The majority of household heads (85.9%) were aged between 31 and 60, indicating adult decision-makers typically responsible for sanitation management. Male respondents dominated

(69.4%), which might suggest gender disparities in FSM-related decision-making. Educational attainment was relatively high, with over 70% of household heads having at least a secondary education, and 33.8% holding tertiary qualifications likely contributing to better awareness and potential adoption of FSM services. However, income disparities remain; while 67.8% earned over 5,000 ETB per month, 11.8% earned below 3,000 ETB, indicating financial barriers to service access.

Sanitation infrastructure has improved, with 83.6% of households using improved toilets such as VIP latrines and septic tanks. Yet, 15% still relied on unimproved pit latrines, 1.3% on public toilets, and 0.3% practice open defecation, underscoring persistent access challenges. Shared facilities were also common, raising hygiene and maintenance concerns that influence FSM needs.

These demographic and socio-economic dynamics shape FSM service uptake, particularly in terms of affordability and service efficiency.

4.8.3. Current State of FSM Services in Hawassa Town

Descriptive analysis revealed low FSM service uptake, with many households emptying sanitation facilities once every 8–13 years or never. Key barriers include limited awareness, financial constraints, and infrastructural inefficiencies. Although 38.7% of respondents described service quality as good, concerns over costs, service delays, and inconsistent provider availability were prevalent.

The findings further revealed that private service providers play a dominant role in fecal sludge emptying, serving 43.5% of households, compared to 21.5% served by the public utility (Hawassa Town Water and Sewerage Enterprise). A very small proportion relied on informal providers (1.8%) or practiced self-emptying (0.3%). This distribution highlights the significant role of the private sector, potentially due to perceived flexibility or availability, while the limited reliance on informal and self-service methods might suggest either regulatory deterrents or awareness of health risks. Notably, 33% of households had never emptied their sanitation facilities, and analysis of their responses revealed that lack of awareness (32.2%) and high perceived service costs (29.3%) were the most frequently cited barriers to FSM service

utilization, followed by general financial constraints (15.9%) and poor infrastructure (11.7%). These reasons were closely aligned with the broader constraints examined in this study namely, affordability, awareness, and infrastructure which suggested that even among non-users, the key efficiency barriers persist. Additionally, the descriptive analysis of the FSM efficiency score indicated that while 68% of users rated the services as moderately to highly efficient, a substantial 21.9% of respondents stated moderate-low to low efficiency, reflecting continued gaps in satisfaction and reliability. These perceptions further validated the regression and correlation results, confirming that issues such as cost, provider limitations, and access remain central to FSM service performance in Hawassa Town.

Correlation analysis highlighted significant negative associations between FSM efficiency and factors such as low awareness and affordability barriers. Regression findings confirmed affordability and service availability as significant predictors of service reliability. These findings validated the hypothesis that affordability and awareness significantly influence FSM efficiency, aligning with Conway (2023), who emphasized that service adoption in low-income areas was driven primarily by affordability and awareness.

Targeted awareness campaigns and financial support mechanisms are essential for improving service uptake.

4.8.4. Effect of Financial Constraints on FSM Efficiency

Financial constraints significantly hindered FSM efficiency. Over 70% of households viewed FSM services as expensive, limiting access and prompting reliance on informal or self-emptying methods. Correlation analysis confirmed a strong negative association between financial constraints and FSM efficiency ($r = -0.290$, $p < 0.01$). Regression results showed cost barriers as significant predictors of inefficiency (Estimate = 10.533, $p = 0.014$).

The hypothesis that financial constraints reduce FSM efficiency was strongly supported. High costs contribute to service avoidance, sanitation-related health risks, and environmental contamination. These findings aligned with Namuyonga and Sekitto (2025), Taweesen (2015), and Chibwe (2024), who similarly identified financial constraints as a major impediment to FSM efficiency in sub-Saharan African cities. Informal and unregulated FSM alternatives often result

in unsanitary waste disposal, posing public health risks and environmental contamination (Lerebours et al., 2021b; Weststrate et al., 2019; Rath et al., 2020; Maqbool et al., 2023).

Financial subsidies, tiered pricing structures and financial aid mechanisms for low-income households should be explored to improve affordability and promote FSM service adoption.

4.8.5. Effect of Capacity of Service Providers on FSM Efficiency

Service provider capacity significantly influenced FSM efficiency. Only 4% of respondents reported consistent provider availability, while 48.5% cited inadequate trucks or staff. Correlation analysis confirmed a strong positive association between provider availability and FSM reliability ($r = 0.396$, $p < 0.01$). Regression analysis reinforced these findings, showing provider availability as significantly associated with reliability (Estimate = -3.639, $p = 0.004$).

The hypothesis that provider capacity affects FSM efficiency was supported. Insufficient capacity causes delays, raises costs, decreases user confidence and FSM efficiency, leading to increased reliance on informal services. These findings reflected those of Peletz et al. (2020), Frenoux and Tsitsikalis (2014), and the Bill and Melinda Gates Foundation (2012). In countries like Bangladesh and Cambodia, unlicensed operators often resort to illegal dumping due to inadequate official services, causing environmental and public health problems (Strande et al., 2014; Rath et al., 2020).

Investments in workforce development, equipment modernization, and coverage expansion are necessary to improve FSM provider capacity and service efficiency.

4.8.6. Effect of Cost of Emptying Services on FSM Efficiency

High emptying costs were a major barrier. Most households (45.3%) paid between 3,500–5,500 ETB per service, discouraging usage and prompting informal alternatives. Actual cost of emptying were significantly correlated with reliability ($r = -0.324$, $p < 0.01$), affordability showed a moderate positive association ($r = 0.290$, $p < 0.01$). Regression analysis revealed a significant effect of cost-induced service delays (Estimate = -4.223, $p = 0.014$).

The hypothesis that emptying costs negatively affect FSM efficiency was supported. High costs lead to delays, decreased uptake, service avoidance and toward informal or self-managed FSM alternatives which reduced service efficiency and increasing health risks and environmental pollution. These results align with Conaway et al. (2023), Balasubramanya et al. (2017b), and Harper et al. (2021), who found that high-priced emptying costs led households resort to emptying themselves or stop using emptying and revert to open defecation and affect FSM efficiency.

Government subsidies, flexible pricing models, and financial aid are needed to remove these barriers.

4.8.7. Effect of Infrastructural Challenges on FSM Efficiency

Infrastructural constraints especially poor roads and outdated equipment were frequently cited, with 58.6% identifying them as challenges. Correlation results indicated a positive association between equipment adequacy and FSM efficiency ($r = 0.490$, $p < 0.01$). However, regression analysis found no statistically significant impact ($p > 0.05$), meaning the hypothesis was not supported.

While infrastructure remains a contributing factor, its effects may be mediated by financial or regulatory issues. This contrasts with studies by Chibwe (2024) and Conaway (2023), which identified infrastructure as a major factor in FSM performance. Future studies should investigate infrastructure-specific improvements in more detail, especially in relation to road access and logistics.

4.8.8. Effect of Regulatory Frameworks on FSM Efficiency

Regulatory enforcement played a critical role. About 66% of respondents were unaware of FSM regulations, and only 7.6% rated enforcement as effective. Correlation analysis showed a positive association between regulatory awareness and efficiency ($r = 0.321$, $p < 0.01$), while regression results confirmed enforcement as a significant predictor (Estimate = -7.778, $p = 0.010$).

The hypothesis that regulatory effectiveness affects FSM efficiency was supported. Weak enforcement leads to non-compliance, informal service reliance, and inefficient FSM operations. These findings align with Mohamed et al. (2023), Lerebours et al. (2021b), and Akumuntu et al. (2017), who emphasized that poor regulatory enforcement undermines FSM efficiency.

Strengthening institutional frameworks, enforcement mechanisms, and communication strategies is essential to create an enabling environment for FSM.

4.8.9. Implications for Policy and Practice

The findings of this study offered important implications for policymakers, service providers, and urban sanitation planners aiming to enhance the efficiency of fecal sludge management (FSM) services in Hawassa Town. First, the significant impact of financial constraints on service uptake highlights the urgent need for targeted financial support mechanisms such as household-level subsidies, flexible payment systems, or tiered pricing models that enhance affordability for economically disadvantaged groups. Second, the lack of service provider capacity, especially the limited availability of vacuum trucks and trained personnel, calls for investments in operational infrastructure and workforce development to expand service coverage and reliability. Third, the high cost of emptying services necessitates regulatory review and potential public-private partnerships that could reduce prices while ensuring quality standards were maintained. Additionally, the findings underscored the need for strengthened regulatory enforcement and public awareness campaigns; poor awareness and weak enforcement mechanisms contributed to informal service reliance and inefficient FSM operations. Improving regulatory frameworks through clear institutional mandates, better inter-sectoral coordination, and community engagement will be essential for driving compliance and sustainable service delivery. Although infrastructural challenges did not show a statistically significant effect in the regression analysis, the descriptive findings suggest that poor road access and outdated equipment still impede FSM accessibility in certain areas which highlighting a need for targeted investment in road infrastructure and localized service centers. Overall, this study emphasizes that improving FSM service efficiency in Hawassa requires a coordinated, multi-sectoral approach that addresses financial, institutional, and infrastructural barriers simultaneously.

In general, this study confirmed that financial constraints, provider capacity, emptying costs, and regulatory enforcement significantly influence FSM service efficiency in Hawassa Town. Addressing these issues through targeted financial, institutional, and policy reforms will be essential to achieving equitable and effective FSM services. This research adds to the limited body of knowledge on FSM performance in secondary cities and provides practical guidance for improving sanitation outcomes in similar urban contexts.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary of Major Findings

This section presents a concise summary of the study's key findings, organized by each of the six specific research objectives.

Objective 1: To evaluate the current state of fecal sludge emptying and transport services in Hawassa Town

Descriptive analysis revealed that 43.5% of households used private service providers for fecal sludge emptying, while 21.5% relied on the public utility (Hawassa Town Water and Sewerage Enterprise). Only 1.8% used informal providers and 0.3% practiced self-emptying. Notably, 33% of households had never emptied their sanitation facilities. The most cited reasons for not using FSM services were lack of awareness (32.2%) and high service costs (29.3%). Regarding perceived service efficiency, 68% of respondents rated FSM services as moderately to highly efficient, while 21.9% rated them as moderate-low or low in efficiency.

Objective 2: To analyze the effect of financial constraints on the efficiency of fecal sludge management services in Hawassa Town

Correlation analysis showed a moderate negative relationship between financial constraints and FSM service efficiency ($r = -0.290$, $p < 0.01$). Regression analysis further confirmed that financial constraints had a statistically significant negative effect on FSM efficiency (Estimate = 10.533, $p = 0.014$). The hypothesis that financial limitations reduce FSM efficiency was supported.

Objective 3: To assess the effect of capacity of service providers on the efficiency of fecal sludge management services in Hawassa Town

The availability of service providers showed a positive and significant correlation with FSM efficiency ($r = 0.396$, $p < 0.01$). Regression results indicated that low availability and provider delays were significantly associated with reduced service reliability (Estimate = -3.639, $p = 0.004$). This supports the hypothesis that service provider capacity significantly affects FSM service efficiency.

Objective 4: To analyze the effect of the cost of emptying services on the efficiency of fecal sludge management services in Hawassa Town

The correlation between actual emptying costs and service efficiency was statistically significant ($r = -0.324$, $p < 0.01$), affordability perception was positively associated ($r = 0.290$, $p < 0.01$). Regression analysis revealed that service delays due to cost were significantly linked to inefficiency (Estimate = -4.223, $p = 0.014$). Therefore, the hypothesis was supported , indicating that actual costs , affordability and cost-related delays may predict efficiency and do affect FSM efficiency.

Objective 5: To examine the effect of infrastructural challenges on the efficiency of fecal sludge management services in Hawassa Town

Descriptive findings highlighted that 58.6% of respondents cited infrastructural challenges such as poor road access and outdated equipment as key barriers. Correlation analysis showed a significant positive relationship between equipment adequacy and FSM efficiency ($r = 0.490$, $p < 0.01$). However, regression analysis did not find a statistically significant effect of infrastructure on FSM efficiency. Thus, the hypothesis was not supported, although infrastructure remains a descriptive concern.

Objective 6: To evaluate the effect of regulatory frameworks on the efficiency of fecal sludge management services in Hawassa Town

Correlation analysis demonstrated a positive relationship between regulatory awareness and FSM efficiency ($r = 0.321$, $p < 0.01$). Regression analysis confirmed that weak regulatory enforcement

was significantly associated with inefficiency in FSM services (Estimate = -7.778, p = 0.010). These results supported the hypothesis that stronger regulatory frameworks enhance FSM service efficiency.

5.2. Conclusion of the Study

This study was conducted to assess the effect of fecal sludge emptying and transport management on the efficiency of fecal sludge management (FSM) services in Hawassa Town. It aimed to examine key influencing factors namely financial constraints, capacity of service providers, cost of emptying services, infrastructural challenges, and regulatory frameworks through the lens of service efficiency as experienced by households. The study adopted a quantitative method approach and analyzed responses from 382 households to uncover patterns in FSM service uptake and delivery.

The findings revealed that FSM service uptake in Hawassa Town remains limited, with 33% of households having never emptied their sanitation facilities. Financial constraints emerged as a statistically significant barrier, with affordability and cost-related delays negatively affecting FSM service efficiency. Similarly, low availability of service providers and limited operational capacity were strongly associated with inefficiency. While actual service costs were not directly significant, the perception of affordability and delay due to cost played a substantial role. Regulatory awareness and enforcement also significantly influenced efficiency outcomes, whereas infrastructure was cited descriptively but not statistically confirmed as a significant determinant.

These findings offered critical insight into how systemic challenges particularly affordability, provider capacity, and regulatory enforcement undermined the effectiveness of FSM services in secondary cities. By demonstrating clear statistical relationships between these variables and service performance, the study contributes valuable empirical evidence to inform urban sanitation planning, especially in low-resource settings. It highlights how service inefficiency is often rooted in overlapping institutional, economic, and operational weaknesses.

This study expands the current understanding of FSM challenges in urban Ethiopia by quantifying the role of specific operational and governance-related factors in determining service

efficiency. Its localized focus on Hawassa Town provides a model that can inform broader regional sanitation strategies while offering practical benchmarks for other towns facing similar urbanization and service delivery pressures. Moreover, the integration of user and non-user perspectives adds depth to existing literature and reinforces the need for inclusive planning approaches.

In conclusion, the study confirms that improving FSM service efficiency requires integrated policy, operational, and financial responses. These findings provide a foundation for developing targeted recommendations to improve affordability, enhance provider capacity, address cost-related access barriers, and strengthen regulatory enforcement mechanisms.

5.3. Recommendations

- Establish and expand targeted subsidy programs to support low-income households in accessing FSM services. This can be achieved by integrating sanitation subsidies into municipal budgeting frameworks and collaborating with donor agencies or NGOs to design means-tested support systems based on household income levels and vulnerability criteria.
- Strengthen regulatory enforcement mechanisms by clarifying institutional responsibilities and enhancing monitoring. This involves revising local sanitation bylaws, delineating clear roles among regulatory bodies, investing in enforcement personnel, and implementing digital monitoring tools to track service compliance. Penalties for illegal dumping should be enforced through environmental health inspections.
- Incorporate FSM efficiency benchmarks into urban sanitation planning and reporting systems. Municipalities should adopt measurable indicators such as emptying frequency, user satisfaction, and response times in sanitation performance reviews, enabling data-driven decision-making and transparent performance audits.
- Build the operational capacity of service providers through investment in resources and training. This includes procurement of additional vacuum trucks, creating maintenance schedules, providing technical training for FSM workers, and establishing dedicated FSM support units within municipal structures or in coordination with private firms.

- Enhance public awareness and education about FSM services, especially among non-users. This can be done by launching community outreach campaigns using radio, social media, and local meetings, and by distributing multilingual informational materials that explain the health and environmental benefits of proper fecal sludge management.
- Introduce flexible payment models to reduce cost-related service delays. FSM providers and local authorities could pilot installment payment systems, mobile money billing options, or community-shared service plans that allow households to pay for services over time or in groups.
- Improve logistics and physical access infrastructure in underserved areas. FSM planning should be integrated with city road development projects, particularly in areas with poor access. Municipalities can prioritize road upgrades where desludging trucks face mobility challenges and coordinate routes for optimal coverage.
- Conduct longitudinal studies to track changes in FSM efficiency over time. Academic institutions and local research bodies should be engaged to carry out periodic impact assessments and operational studies that document how policy changes, infrastructure investments, or awareness campaigns affect service delivery.
- Explore the economic viability of public-private partnerships (PPPs) in FSM service delivery. Local governments can initiate feasibility studies to evaluate opportunities for PPPs, including cost-sharing arrangements, service-level agreements, and performance-based contracts with private desludging companies.
- Examine gender and intra-household decision-making dynamics in FSM service use. Future studies should disaggregate data by gender and assess how decisions about when and how to access FSM services are made within households, ensuring that women's and marginalized groups' voices are reflected in service design and outreach.

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ANNEX

Annex 1. Household Survey Questionnaire

Interviewer		PSU Number			HH Number		

A. Consent

Hello, My name is_____. I am conducting this research as a requirement for partial fulfillment of my graduate study in the field of Business Administration at Saint Mary's University, Addis Ababa, Ethiopia. The purpose of this questionnaire is to collect data for the study entitled "Effect of Fecal Sludge Emptying and Transport Management on The Efficiency of Fecal Sludge Management Services in Hawassa Town, Ethiopia" This questionnaire is designed to collect data purely for academic purposes. All information will be treated with strict confidence. Your participation is absolutely voluntary, can withdraw from the survey any time you want, and you may also choose not to answer any questions. Thank you!

A.1	Do you want to participate in our survey	Yes……01 No…….02

B. Identification

B.1 GPS Coordinates	
B.2.Respondent Name	Name:
B.3 Location	B3.1. Sub-city:
	B3.2. Kebele:
	B3.3. Village:

C. Survey Information

C.1 Interviewer	Name _____ ☐☐ Code
C.2 Date of Interview	Day ☐ Month ☐ Year ☐
C.3 Interview Start Time	In 24 Hour Format: ☐☐☐☐

D. **Household Demographics**

D1. Household Size and Composition

D1.1: How many people live in this household?

a. 1-2 01
b. 3-5 02
c. 6-8 03
d. 9 or more 04

D1.2: How many children under 5 years old live in the household?

a. None 01
b. 1 02
c. 2-3 03
d. 4 or more 04

.

D2. Gender and Age Distribution

D2.1.What is the gender of the head of the household?

a. Male 01
b. Female 02

D2.2. What is the age of the head of the household?

a. Under 30 01
b. 31-45 02
c. 46-60 03
d. 61-100 04

D3. Education and Occupation

D3.1. What is the highest level of education completed by the head of the household?

a. No formal education 01
b. Primary education 02

c. Secondary education 03
d. Tertiary education 04

D4. Household Income:

D4.1. What is the estimated monthly income of the household?

a. Less than 1000 Birr 01
b. 1001-3000 Birr 02
c. 3001-5000 Birr 03
d. 5001-10,000 Birr 04
e. More than 10,000 Birr 05

D5. Type of Dwelling:

D5.1. What type of dwelling does the household live in?

a. Semi-permanent house 01
b. Permanent house (brick, cement) 02
c. Others (specify) 44

E. Sanitation Facility Information

E1. Type of Sanitation Facility

E1.1.What type of sanitation facility does your household primarily use?

a. Pit latrine without a slab 01
b. Pit latrine with a slab 02
c. VIP latrine (ventilated improved pit latrine) 03
d. Flush toilet connected to a septic tank 04
e. public toilet 05
f. open defecation 06
g. Other (Specify) 44

E2. Ownership of Sanitation Facility

E2.1. Who owns the sanitation facility used by your household?

a. Privately owned by the household 01
b. Shared with other households (2-3 households) 02
c. Shared with multiple households (4 or more) 03
d. Public or communal facility 04

E3. Condition of Sanitation Facility

E3.1. How would you describe the current condition of your sanitation facility?

a. Excellent (clean, well-maintained) 01
b. Good (clean but requires maintenance) 02
c. Fair (some damage but functional) 03
d. Poor (severe damage, not fully functional) 04

E4. Frequency of Facility Emptying

E4.1. How often is your sanitation facility emptied?

a. Every 3 months or less 01
b. Every 6 months 02
c. Once a year 03
d. Every 2-7 years 04
e. Every 8-13 years 05
f. It has never been emptied 06

E5. Method of Emptying

E5.1. How is your sanitation facility emptied?

a. By a professional service provider 01
b. By informal service providers 02
c. By the household itself 03
d. It has never been emptied 04

E6. Cost of Emptying

E6.1. .How much do you typically pay for the emptying of your sanitation facility (if applicable)?

a. 1500 Birr 01
b. 2500 Birr 02
c. 3500 Birr 03
d. 4500 Birr 04
e. 5500 Birr 05
f. No cost (self-emptied) 06

E7. Satisfaction with Sanitation Facility

E7.1. How satisfied are you with the overall performance of your sanitation facility?

a. Very satisfied 01
b. Satisfied 02
c. Neutral 03
d. Dissatisfied 04
e. Very dissatisfied 05
f. I don't know 55

F. Current State of Fecal Sludge Emptying and Transport Services

F1. Service Provider

F1.1. Who usually empties your sanitation facility?

a. Hawassa Town Water and Sewerage Enterprise 01
b. Private service providers 02
c. Informal service providers (non-licensed) 03
d. Household members 04
e. Never emptied 05

F1.2. If your sanitation facility has never been emptied, why haven't you used fecal sludge emptying services before?

a. Services are too expensive 01
b. Lack of awareness about the services 02

c. Inaccessible due to poor infrastructure or distance 03
d. Alternative methods (e.g., self-emptying, informal providers) 04
e. Financial constraints 05
f. Other (please specify): _____ 44

F2. Frequency of Service Usage

F2.1. How often do you use fecal sludge emptying services?

a. Every 3 months or less 01
b. Every 6 months 02
c. Once a year 03
d. Every 2-7 years 04
e. Every 8-13 years 05
f. It has never received such services 06

F3. Service Quality

F3.1. How would you rate the quality of the fecal sludge emptying services you receive?

a. Excellent 01
b. Good 02
c. Fair 03
d. Poor 04
e. Very poor 05
f. I have never received such services 06

F4. Satisfaction with Cost

F4.1. How satisfied are you with the cost of fecal sludge emptying services?

a. Very satisfied 01
b. Satisfied 02
c. Neutral 03
d. Dissatisfied 04
e. Very dissatisfied 05
f. I don' know/not sure 55

F5. Service Availability

F5.1. Are fecal sludge emptying services readily available when you need them?

a. Always available 01
b. Usually available 02
c. Sometimes available 03
d. Rarely available 04
e. Never available 05
f. I don' know/not sure 55

F6. Willingness to Pay for Improved Services

F6.1. If the quality of fecal sludge management services were improved, would you be willing to pay more for the service?

a. Yes 01
b. No 02

c. Not sure 55

F7. Problems/challenges Encountered During Emptying and transport:

F7.1. Have you encountered any problem/challenges with fecal sludge emptying services?

a. Yes 01
b. No 02
c. I don' know 55

F7.2. If you are not using the services (or never emptied your toilet), please specify the problems with fecal sludge emptying services.(Please select all that apply)

a. High cost 01
b. Delays in service 02
c. Poor quality of service 03
d. Limited availability of service providers 04
e. Difficulty accessing service due to poor road infrastructure 05
f. Health or environmental concerns during emptying 06
g. Low income 07
h. I don' know 55
i. Others (please specify): _____ 44

G. Effect of Financial Constraints on the Efficiency of Fecal Sludge Management Services

G1. Affordability of FSM Services

G1.1. How affordable do you find the fecal sludge emptying services?

a. Very affordable 01
b. Affordable 02
c. Neutral 03
d. Expensive 04
e. Very expensive 05

G2. Effect of Cost on Service Frequency (Financial burden on service frequency)

G2.1. Has the cost of fecal sludge emptying services ever prevented you from using the service as frequently as needed?

a. Yes, often 01
b. Yes, sometimes 02
c. Rarely 03
d. No 04

G3. Payment Methods

D3.1. How do you usually pay for fecal sludge emptying services?

a. Cash 01
b. Credit (pay later) 02
c. Payment in installments 03
d. I have not paid for such services 04

G4. Willingness to Pay for Improved Services

G4.1. If fecal sludge management services were improved, would you be willing to pay more for the service?

a. Yes, I would pay more 01
b. No, I would not pay more 02
c. Not sure 55

G5. Service Payment Challenges:

G5.1. What is the biggest challenge you face in paying for fecal sludge emptying services?

a. Irregular income 01
b. High service costs 02
c. Lack of payment options 03
d. I don' know 55
e. Other (please specify) 44

G6. Effect of Financial Constraints on Health

G6.1. Have financial constraints on fecal sludge emptying services ever led to health problems in your household (e.g., due to delayed emptying or using unsafe alternatives)?

a. Yes 01
b. No 02
c. I don' know 55

G7. Subsidy or Financial Support Programs (Mechanisms):

G7.1. Are you aware of any subsidy or financial support programs for fecal sludge management services in your area?

a. Yes, I have used such a program 01
b. Yes, but I have not used any 02
c. No, I am not aware of any 03

G8. Cost effective alternatives

G8.1. What alternatives have you used if the formal fecal sludge emptying services are too costly for you?

a. Use informal service providers 01
b. Borrow money for the service 02
c. Delay emptying 03
d. Manage on your own 04
e. I don' know 55
f. Others (please specify) _____ 44

G9.Financial Constraints and Efficiency

G9.1. In your opinion, do financial constraints significantly impact your access to fecal sludge emptying services?

a. Yes 01
b. No 02
c. I don' know 55

G9. 2. Please explain how financial constraints have affected your access to and the efficiency of FSM services in your experience. You might consider the following aspects: (Select all that apply)

a. Inability to afford timely service or necessary emptying frequency 01
b. Reliance on informal or cheaper service providers and the implications of that choice 02
c. Delays in service due to budgeting or payment issues 03
d. Impact on service quality 04
e. Any health or sanitation concerns resulting from financial constraints 05
f. I don' know 55

G10. Recommendations

G10.1. What recommendations do you have to address financial constraints to improve access to FSM services in your area? (Select all that apply)

a. Implement subsidies or financial assistance programs for low-income households 01
b. Introduce flexible payment plans for FSM services 02
c. Increase awareness and education about available support options 03
d. Promote community-based solutions or collective emptying services 04
e. Advocate for policy changes to reduce service costs 05
f. I don' know 55
g. Other (please specify): _____ 44

H. Effect of Cost of Emptying Services on the Efficiency of Fecal Sludge Management Services

H1. Cost of Emptying Services

H1.1. How much did you pay for the last fecal sludge emptying service (in ETB)?

a. 1500 Birr 01
b. 2500 Birr 02
c. 3500 Birr 03
d. 4500 04
e. 5500 Birr 05
f. No cost (self-emptied) 06

H1.2. Was this cost affordable for you?

a. Yes 01
b. No 02
c. I don' know 55

H1.3. If no, why was this cost unaffordable? (Select all that apply)

a. Limited household income or budget constraints 01
b. Unexpected additional fees or costs 02
c. High frequency of service needs due to system issues 03
d. Lack of financial support or subsidy options 04
e. I don' know 55

f. Other (please specify): _____ 44

H1.4. What alternative solutions do you use when you cannot afford the service? (Select all that apply)

a. Delay or postpone emptying until affordable 01
b. Use informal or unlicensed service providers 02
c. Empty the pit or tank myself 03
d. Share service costs with neighbors or community members 04
e. Seek financial help from family or friends 05
f. I don' know 55
g. Other (please specify): _____ 44

H1.5. Do you think the current cost of fecal sludge emptying services is fair for the quality of service provided?

a. Yes 01
b. No 02
c. I don' know 55

H1.6. If no, why do you believe the cost is unfair? (Select all that apply)

a. The service quality is poor 01
b. The response time is too slow 02
c. The cost is high compared to similar services in other areas 03
d. Hidden or additional fees increase the total cost 04
e. Lack of reliability or consistency in service delivery 05
f. I don' know 55
g. Other (please specify): _____ 44

H2. Effect of Cost on FSM Service Efficiency

H2.1. How often do you delay requesting emptying services due to high costs?

a. Never 01
b. Occasionally 02
c. Frequently 03
d. Always 04
e. I don' know 55

H2.2. If you delay, what specific health or sanitation issues have you experienced as a result of these delays? (Select all that apply)

a. Overflow or leakage of waste, causing unsanitary conditions 01
b. Persistent unpleasant odors affecting indoor or outdoor spaces 02
c. Increased health risks, such as illnesses or infections 03
d. Attraction of pests (e.g., flies, rodents) 04
e. Structural damage to property (e.g., flooring, walls) 05
f. I don' know 55
g. Other (please specify): _____ 44

H3. Perception of Value for Cost

H3.1. What do you think is the primary reason for the high cost of fecal sludge emptying services in your area?

a. Lack of competition among service providers 01
b. High operational costs (fuel, labor, etc.) 02
c. Lack of government subsidy 03
d. Other (please specify): _____ 04

H4. Recommendations

H3.1. What recommendations do you have to address the cost of emptying services to improve access to FSM services in your area? (Select all that apply)

a. Implement subsidies or financial assistance programs for low-income households 01
b. Introduce flexible payment options (e.g., installment plans) 02
c. Lower taxes or fees associated with FSM services 03
d. Support community-based or cooperative FSM services to reduce costs 04
e. Increase competition among FSM service providers to lower prices 05

f. Raise public awareness on proper sanitation and available FSM options 06
g. I don' know 55
h. Other (please specify): _____ 44

I. Effect of Infrastructural Challenges on the Efficiency of FSM Services

I1. Accessibility of FSM Services

I1.1. How accessible are fecal sludge emptying services in your area?

a. Easily accessible 01
b. Moderately accessible 02
c. Poorly accessible 03
d. Not accessible at all 04

I1.2. If poorly or not accessible, what is the main reason for the lack of accessibility?

a. Lack of service providers 01
b. Poor road conditions 02
c. Distance from service providers 03
d. Other (please specify): _____ 44

I2. Condition of On-Site Sanitation Infrastructure

I2.1. How would you rate the condition of your household's sanitation infrastructure (e.g., septic tank, pit latrine)?

a. In excellent condition 01
b. In good condition 02
c. In fair condition, but needs maintenance 03
d. In poor condition and requires immediate attention 04

I2.2. Are service providers in your area equipped with the necessary tools and equipment to perform fecal sludge emptying effectively?

a. Yes, they are well-equipped 01
b. They have equipment, but it is outdated or inadequate 02
c. No, they often lack the necessary equipment 03
d. I don' know 55

I3. Effect of Infrastructural challenges on FSM Service Efficiency

I3.1. How frequently are FSM services disrupted or delayed in your area due to infrastructure problems (e.g., poor roads, traffic, lack of vehicles)?

a. Never 01
b. Occasionally 02
c. Frequently 03
d. Always 04
e. I don' know 55

I3.2. What types of interruptions occur?

a. Delayed service 01
b. Complete service cancellation 02
c. Increased wait times 03
d. I don' know 55
e. Other (please specify): _____ 44

I4. Recommendations for Improving Infrastructure

I4.1. What infrastructure improvements do you believe would most enhance the efficiency of FSM services in your area? (Select all that apply)

a. Improved road access 01
b. Better service vehicles 02
c. More frequent maintenance of public sanitation infrastructure 03
d. I don' know 55
e. Other (please specify): _____ 44

J. Effect of Capacity of Service Providers on the Efficiency of Fecal Sludge Management (FSM) Services

J1. Availability of Service Providers

J1.1. .How often are FSM service providers available in your area when you need them?

a. Always 01
b. Most of the time 02
c. Occasionally 03
d. Rarely 04
e. Never 05
f. I don' know 55

J2. Response Time of Service Providers

J2.1. .How long does it typically take for a service provider to respond after you request FSM services?

a. Same day 01
b. 1-2 days 02

c. 3-5 days 03
d. More than 5 days 04
e. No response at all 05
f. I have never considered requesting FSM services 06

J3. Skill and Expertise of Service Providers

J3.1. Do you think FSM service providers in your area have the necessary skills to carry out their tasks efficiently?

a. Yes 01
b. No 02
c. I don't know/Not sure 55

J4. Equipment and Resources

J4.1. Do FSM service providers in your area have the appropriate equipment to handle fecal sludge collection and transport efficiently?

a. Yes 01
b. No 02
c. Not sure 55

J5. Service Provider Capacity (Number of Trucks, Staff)

J5.1. Do you think there are enough service providers (trucks, staff) to meet the demand for FSM services in your area?

a. Yes 01
b. No 02
c. Sometimes 03
d. I am not aware of the availability of service providers 04

J5.2. If not, how does the shortage of FSM service providers affect the efficiency of the services? (Choose one)

a. Causes delays in service delivery 01
b. Increases costs for emergency services 02
c. Leads to environmental health risks 03
d. I don' know 55
e. Other (specify): _____ 44

J6. General Capacity of Service Providers

J6.1. How satisfied are you with the current capacity of fecal sludge management (FSM) service providers in terms of service quality?

a. Very satisfied 01
b. Satisfied 02
c. Neutral 03
d. Dissatisfied 04
e. Very dissatisfied 05
f. I don' know 55

J7. Availability of Resources and Staff

J7.1. How often have you experienced delays in service due to lack of equipment or personnel from FSM service providers?

a. Always 01
b. Often 02
c. Sometimes 03
d. Rarely 04
e. Never 05
f. I don't know / I have no experience with FSM services 55

J8. Recommendation

J81.What improvements do you suggest for FSM service providers to enhance their capacity (in terms of resources, staff, and equipment)?

a. More vehicles 01
b. More staff 02
c. Better training 03
d. Improved equipment 04
e. I don' know 55
f. Other (please specify): _____ 44

K. Effect of Regulatory Framework on the Efficiency of FSM Services

K1. Awareness of Regulations

K1.1. Are you aware of any government regulations or policies regarding fecal sludge management (FSM) services in your area?

a. Yes, well-informed 01
b. Somewhat aware 02
c. Aware, but unsure of details 03
d. Not aware at all 04

K2. Importance of Compliance

K2.1. How important do you think it is for FSM service providers to comply with regulations to maintain public health and safety?

a. Very important 01
b. Important 02
c. Slightly important 03
d. Not important 04
e. I don' know 55

K3. Enforcement and Impact of Regulations

K3.1. In your experience, how effectively are FSM regulations enforced by local authorities?

a. Very effective 01
b. Moderately effective 02
c. Slightly effective 03
d. Not effective at all 04
e. I don' know 55

K4. Regulatory Impact on Service Quality

K4.1. How much do you feel regulatory policies impact the quality of FSM services you receive?

a. Greatly improve quality 01
b. Somewhat improve quality 02
c. Have little impact on quality 03
d. Reduce service quality 04
e. I don' know 55

K5. Recommendations

K5.1. What improvements would you suggest in FSM service regulations to better meet community needs?

a. Increase enforcement and monitoring 01
b. Provide financial support for low-income households 02
c. Increase transparency in provider performance 03
d. Enhance accountability of service providers 04
e. I don't know 55
f. Other (please specify) 44

L. Efficiency of Fecal Sludge Management (FSM) Services

L1. Accessibility of FSM Services

L1.1. How accessible are fecal sludge management services in your area?

a. Easily accessible (service available at any time) 01
b. Moderately accessible (service available with some delays) 02
c. Difficult to access (long delays in getting service) 03
d. Not accessible at all 04
e. I don' know 55

L2. Affordability of FSM Services

L2.1. How affordable are the fecal sludge management services in your area?

a. Very affordable 01
b. Moderately affordable 02
c. Expensive, but manageable 03
d. Very expensive, unaffordable 04
e. I don' know 55

L3. Reliability of FSM Services

L3.1. How reliable are the fecal sludge management services in your area?

a. Very reliable (always provided on time) 01
b. Mostly reliable, with occasional delays 02
c. Often unreliable, with frequent delays or issues 03
d. Completely unreliable 04
e. I don' know 55

L4. Timeliness of FSM Service Delivery

L4.1. How timely is the fecal sludge emptying service when you request it?

a. Always delivered within 24 hours 01
b. Delivered within 2-3 days 02
c. Delivered within a week 03
d. Delivered after more than a week 04
e. I don' know 55

L5. Service Provider Responsiveness

L5.1. How responsive are the fecal sludge management service providers when you need assistance or face issues with the service?

a. Very responsive, issues are resolved immediately 01
b. Somewhat responsive, but slow to address issues 02
c. Rarely responsive, issues often remain unresolved 03
d. Not responsive at all 04
e. I don' know 55

L6. Satisfaction with FSM Service Quality

L6.1. How satisfied are you with the overall quality of the fecal sludge management services in your area?

a. Very satisfied 01
b. Satisfied 02
c. Dissatisfied 03
d. Very dissatisfied 04
e. I don' know 55

L7. Perception of Service Improvement

L7.1. Have the fecal sludge management services in your area improved over the past year?

a. Yes, significantly improved 01
b. Improved somewhat 02
c. Stayed the same 03
d. Worsened 04
e. I don' know 55

L8. Factors Hindering Service Efficiency

L8.1. What do you think is the biggest challenge hindering the efficiency of fecal sludge management services in your area? (Select all that apply)

a. Financial constraints 01
b. Lack of service providers 02
c. High cost of emptying services 03
d. Poor infrastructure 04
e. Lack of community awareness 05
f. Weak regulatory framework 06
g. I don' know 55
h. Other (please specify)_____ 44

L9. Impact of Inefficient FSM Services on the Community

L9.1. How does inefficient fecal sludge management impact your household or community?

a.	Health risks due to poor sanitation	01
b.	Increased expenses	02
c.	Environmental pollution	03
d.	Social or community conflict over services	04
e.	I don’ know	55
f.	Other (please specify)	44

Annex 2. Parameter Estimate

Parameter Estimates						
		Estimate	Std. Error	Wald	df	Sig.
Threshold	[L.3.1Howreliablearethefecalsludgemanagementservicesinyourarea = 1]	-34.666	9.607	13.020	1	.000
	[L.3.1Howreliablearethefecalsludgemanagementservicesinyourarea = 2]	-13.775	4.893	7.927	1	.005
	[L.3.1Howreliablearethefecalsludgemanagementservicesinyourarea = 3]	-2.194	4.085	.288	1	.591
Location	[H1.1.Cost of emptying]	.000	.000	.310	1	.578
	[G.2.1Hasthecostoffecalsludgeemptyingserviceseverpreventedyoufrom=0]	10.533	4.277	6.064	1	.014
	[G.2.1Hasthecostoffecalsludgeemptyingserviceseverpreventedyoufrom=1]	2.030	2.629	.596	1	.440
	[G.2.1Hasthecostoffecalsludgeemptyingserviceseverpreventedyoufrom=2]	1.544	2.532	.372	1	.542
	[G.2.1Hasthecostoffecalsludgeemptyingserviceseverpreventedyoufrom=3]	0[a]			0	
	[G.6.1Havefinancialconstraintsonfecalsludgeemptyingserviceseverle=0]	-.657	1.077	.372	1	.542
	[G.6.1Havefinancialconstraintsonfecalsludgeemptyingserviceseverle=1]	0[a]			0	
	[G.9.1Inyouropiniondofinancialconstraintssignificantlyimpactyoura=0]	-9.847	3.039	10.500	1	.001
	[G.9.1Inyouropiniondofinancialconstraintssignificantlyimpactyoura=1]	0[a]			0	
	[H.2.1Howoftendoyoudelayrequestingemptyingservicesduetohighcosts=1]	1.511	9.666	.024	1	.876
	[H.2.1Howoftendoyoudelayrequestingemptyingservicesduetohighcosts=2]	-4.223	1.718	6.042	1	.014

	[H.2.1Howoftendoyoudelayrequestingemptyingservicesduetohighcosts=3]	-1.732	1.214	2.036	1	.154
	[H.2.1Howoftendoyoudelayrequestingemptyingservicesduetohighcosts=4]	0[a]			0	
	[I.1.1Howaccessiblearefecalsludgeemptyingservicesinyourarea=1]	-5.813	30.324	.037	1	.848
	[I.1.1Howaccessiblearefecalsludgeemptyingservicesinyourarea=2]	-2.992	2.647	1.278	1	.258
	[I.1.1Howaccessiblearefecalsludgeemptyingservicesinyourarea=3]	.253	1.001	.064	1	.800
	[I.1.1Howaccessiblearefecalsludgeemptyingservicesinyourarea=4]	0[a]			0	
	[I.2.2Areserviceprovidersinyourareaequippedwiththenecessarytoolsa=1]	.746	1.766	.178	1	.673
	[I.2.2Areserviceprovidersinyourareaequippedwiththenecessarytoolsa=2]	.838	1.503	.310	1	.577
	[I.2.2Areserviceprovidersinyourareaequippedwiththenecessarytoolsa=3]	0[a]			0	
	[I.3.1HowfrequentlyareFSMservicesdisruptedordelayedinyourareaduet=2]	2.819	1.574	3.208	1	.073
	[I.3.1HowfrequentlyareFSMservicesdisruptedordelayedinyourareaduet=3]	1.939	1.090	3.165	1	.075
	[I.3.1HowfrequentlyareFSMservicesdisruptedordelayedinyourareaduet=4]	0[a]			0	
	[J.1.1HowoftenareFSMserviceprovidersavailableinyourareawhenyounee=2]	-6.319	3.642	3.010	1	.083
	[J.1.1HowoftenareFSMserviceprovidersavailableinyourareawhenyounee=3]	-3.910	1.343	8.470	1	.004
	[J.1.1HowoftenareFSMserviceprovidersavailableinyourareawhenyounee=4]	-3.639	1.252	8.450	1	.004
	[J.1.1HowoftenareFSMserviceprovidersavailableinyourareawhenyounee=5]	0[a]			0	
	[J.3.1DoyouthinkFSMserviceprovidersinyourareahavethenecessaryskil=0]	-1.937	1.368	2.004	1	.157

	[J.3.1DoyouthinkFSMserviceprovidersinyourareahavethenecessaryskil=1]	0[a]			0	
	[J.4.1DoFSMserviceprovidersinyourareahavetheappropriateequipmentt=0]	-.744	1.371	.294	1	.588
	[J.4.1DoFSMserviceprovidersinyourareahavetheappropriateequipmentt=1]	0[a]			0	
	[K.3.1Inyourexperiencehoweffectivelyare FSMregulationsenforcedbylo=1]	-7.778	3.005	6.697	1	.010
	[K.3.1Inyourexperiencehoweffectivelyare FSMregulationsenforcedbylo=2]	-1.084	1.030	1.108	1	.292
	[K.3.1Inyourexperiencehoweffectivelyare FSMregulationsenforcedbylo=3]	-1.738	1.057	2.703	1	.100
	[K.3.1Inyourexperiencehoweffectivelyare FSMregulationsenforcedbylo=4]	0[a]			0	
	[K1.1.Awareness of regulation=1]	-2.247	1.083	4.299	1	.038
	[K1.1.Awareness of regulation=2]	-1.075	1.044	1.061	1	.303
	[K1.1. Awareness of regulation=3]	-.898	1.251	.516	1	.473
	[K1.1. Awareness of regulation=4]	0[a]			0	
	[K4.1.Impact of regulation=1]	-25.695	18.253	1.982	1	.159
	[K4.1. Impact of regulation=2]	-7.482	2.532	8.729	1	.003
	[K4.1. Impact of regulation=3]	.611	1.051	.338	1	.561
	[K4.1. Impact of regulation =4]	0[a]			0	
Link function: Logit.						
a. This parameter is set to zero because it is redundant.						