

**AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND
ENTREPRENEURIAL DEVELOPMENT**

**ASSESSING THE IMPACT OF ESICApps ON EFFICIENT AND EFFECTIVE
MONITORING AND COLLECTION OF ENVIRONMENTAL HEALTH
DATA IN GHANA**

MICHAEL ETSE NYAVI

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EFFECTIVE MONITORING AND COLLECTION OF ENVIRONMENTAL
HEALTH DATA IN GHANA**

BY

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fulfillment of the requirements for the award of a Master of Philosophy degree in
Environmental and Occupational Health Education**

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis, with the exception of quotations and references contained in published works which have been duly acknowledged; is the result of my own original work and that no part of it has been presented for another degree at this university or elsewhere.

Micheal Etse Nyavi

Signature: Date:

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

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DEDICATION

To God be the glory for all the great things He has done. This work is dedicated to my lovely mother Selina Kokroko Nyavi (Tsormenor), A phenomenal woman who has given me strength, fortitude, and love, So that, "...I shall be telling this with a sigh somewhere ages and ages hence: Two roads diverged in a wood, and I, I took the one less traveled by, and that has made all the difference". - Robert Frost

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ABBREVIATIONS

AAMUSTED	Akenten Appiah-Menka University of Skills Training And Entrepreneurial Development
CBOs	Community Based Organizations
CHRPE	Committee on Human Research, Publications, and Ethics
CLTS	Community-Led-Total-Sanitation
CONIWAS	Coalition of NGOs in water and Sanitation
CSG	Civil Society Groups
EHOs	Environmental Health Officers
EHP	Environmental Health Project
EHSM	Environmental health and Sanitation Management
EPA	Environmental Protection Agency
ESICApps	Expanded Sanitation Inspection and Compliance mobile Apps
ESICOME	Expanded Sanitation Inspection Compliance and Enforcement
GHS	Ghana Health Service
GSS	Ghana Statistical Service
ICDDR	International Centre for Diarrhea Disease Research
JMP	Joint Monitoring Programme
LFA	Logical Framework Approach
LGS	Local Government Service
MDGs	Millennium Development Goals
MINT	Materials in Transition
MLGRD	Ministry of Local Government and Rural Development

MMDAs	Metropolitan, Municipal, and District Assemblies
MoH	Ministry of Health
NESSAP	National Environmental Sanitation Strategy and Action Plan
NGOs	Non – Governmental Organisations
PHAST	Participatory Hygiene and Sanitation Transformation Tool
RCC	Regional Co-ordination Council
REHO	Regional Environmental Health Office
RHMT	Rural Health Multidisciplinary Training
SANALL	Sanitation for All
SDGs	Sustainable Development Goals
UN	United Nation
UNDP	United Nation Development Programme
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WASH	Water, Sanitation, And Hygiene
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organisation
WSP	Water and Sanitation Program
WSSCC	Water Supply and Sanitation Collaborative Council

ABSTRACT

ESICApps is a digital platform designed to improve environmental health data monitoring and collection. It enhances the efficiency, accuracy, and reliability of Environmental Health Officers (EHOs) in enforcing sanitation regulations. However, challenges like technical issues, user-friendliness, and accessibility may affect its effectiveness. This study assessed the impact of ESICApps on efficient and effective monitoring and collection of environmental health data in Ghana. A descriptive cross-sectional study was conducted among Environmental Health Officers (EHOs) in 24 Metropolitan, Municipal, and District Assemblies (MMDAs) within the Greater Accra Region. A total of 254 EHOs were selected using a multi-stage sampling approach, incorporating census, snowball, and convenience sampling techniques. Data were collected using a structured questionnaire. Descriptive statistics and chi-square tests were performed using SPSS version 25 to assess user experiences, efficiency, and the factors influencing satisfaction levels. The majority (56.3%) of participants were aged between 31 and 40 years, with 63.0% being male. Majority (53.9%) agreed that they could return to their previous task after an interruption, and 76.0% found ESICApps easy to operate. Additionally, 78.7% indicated that the platform enabled accurate fieldwork and data collection. A significant association was observed between education level and perception of ESICApps' accuracy in field data collection ($\chi^2=7.1$, $p=0.034$), with Cramer's V indicating a moderate association ($V=0.20$, $p=0.034$). Participants with certificate qualifications were 90% less likely to perceive ESICApps as facilitating accurate fieldwork compared to those with higher education [AOR=0.1 (0.02–0.72), $p=0.019$]. Nearly half (49.2%) of the participants agreed that ESICApps functioned reliably, while 93.7% expressed comfort using the platform. Assistant officers were five times more likely to report satisfaction compared to officers

[AOR=5.2 (1.01–26.34), p=0.049]. Furthermore, 92.9% found ESICApps easier to use than ESICOMES, and 42.1% strongly agreed that it enhanced fieldwork efficiency. However, 51.2% reported that the application sometimes crashed or slowed down their phones. ESICApps demonstrated significant potential for improving data collection accuracy, efficiency, and overall environmental health monitoring. However, occasional system crashes and slow response times affected workflow. Higher education levels were associated with greater confidence in the system’s capabilities, and assistants reported higher satisfaction levels than senior officers. Despite these challenges, ESICApps was perceived as a more reliable and effective alternative to traditional paper-based methods. The Environmental Protection Agency (EPA) should leverage ESICApps data for environmental risk assessments, while NGOs and civil society groups should support MMDAs with resources such as mobile devices and training workshops to enhance adoption and usability.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The field of Environmental health and Sanitation Management (EHSM) is rapidly evolving. The integration of digital technology in environmental health and sanitation management has significantly improved data collection, monitoring, and compliance enforcement (Mensah, 2017). Advanced technologies such as big data analytics, artificial intelligence, and mobile-based applications have revolutionized the way environmental data is gathered, processed, and utilized (Panga, 2024). These innovations enable real-time data collection, facilitating better decision-making and enhancing public health interventions (Babarinde et al., 2023). The need for an efficient, integrated environmental data collection system has become crucial, particularly for Metropolitan, Municipal, and District Assemblies (MMDAs), where traditional methods often result in data inconsistencies, delays, and inefficiencies (Ofosuhene, 2021).

In Ghana, the Ministry of Sanitation and Water Resources introduced the Expanded Sanitation Inspection and Compliance mobile Apps (ESICApps), a digital tool designed to enhance environmental health data collection and monitoring (Mahajan, 2022). ESICApps provides real-time information on sanitation access, potable water supply, and waste management practices in residential and commercial areas, particularly in Accra. The transition from manual, paper-based documentation to a centralized digital platform has significantly improved data accuracy, security, and accessibility (Ofosuhene, 2021). This digital transformation has also streamlined the

monitoring of Environmental Health Officers (EHOs), improved productivity, and increased the recognition of MMDAs in sanitation management.

Before the implementation of ESICApps, the Ministry of Sanitation and Water Resources (MSWR) faced considerable delays in receiving reports from field officers, often resulting in incomplete or lost data (Mahajan, 2022). The manual data collection system lacked efficiency, transparency, and graphical representation, limiting its usability for decision-making (Rossi et al., 2020). With ESICApps, environmental health data is transmitted promptly to the MSWR, securely stored, and automatically structured into well-organized charts and reports. Additionally, the application allows the Ministry of Sanitation and Water Resources (MSWR) to monitor the field activities of EHOs more effectively, ensuring accountability and improved service delivery.

The primary objective of ESICApps is to enhance data accessibility within the environmental health sector while improving sanitation and water supply services across MMDAs. To replace traditional paper-based processes and reducing human errors associated with the traditional Environmental Sanitation Inspection Compliance Monitoring and Enforcement (ESICOME) system, ESICApps ensures more accurate and efficient data collection. The application also facilitates periodic assessments of progress within the environmental health sector, enables the capturing of field images for documentation purposes, and provides tiered levels of data access to stakeholders for effective monitoring and decision-making (Ofosuhene, 2021). This study assessed the impact of ESICApps on the efficiency and effectiveness of environmental health data collection and monitoring in Ghana.

1.2 Problem Statement

In Ghana, Environmental Health data collection has traditionally relied on paper-based systems, which are often inefficient due to delays in data processing, difficulties in retrieval, and errors from manual entry. In many Municipal, Metropolitan, and District Assemblies (MMDAs), the effectiveness of solid waste data reporting is significantly hampered by manual collection systems. For instance, according to one Ministry of Sanitation and Water Resources, up to 20% of manually collected reports go missing or are submitted with considerable delays (Mahajan, 2022). In some cases, it can take as long as five months for paper-based reports to reach the national office for processing. This undermines timely intervention and decision-making, particularly in areas where rapid response is critical for public health and environmental management. In order to resolve these problems, the Ministry of Sanitation and Water Resources introduced the Environmental Sanitation Inspection and Compliance Application (ESICApp), a digital tool designed to enhance data collection and management by Environmental Health Officers (EHOs). ESICApp aims to improve the efficiency of environmental health monitoring by facilitating real-time data entry, storage, and analysis, thereby strengthening proactive sanitation management across Metropolitan, Municipal, and District Assemblies (MMDAs). However, despite its introduction, there is limited empirical evidence assessing its effectiveness, particularly in comparison to the traditional Expanded Sanitation Inspection and Compliance Monitoring Exercise (ESICOME), which relies on paper-based data collection. Key concerns such as ESICApp's usability, functionality, and user satisfaction remain unexplored, raising questions about its overall impact on environmental health data collection and sanitation management. Additionally, understanding the advantages and limitations of ESICApp relative to ESICOME is

essential for informing policy decisions and optimizing its implementation. Furthermore, this study seeks to assess the impact of ESICApp on the efficient and effective monitoring and collection of environmental health data, providing insights into its role in enhancing environmental health services within MMDAs in Ghana.

1.3 Aim and Objectives

The main aim of this study is to assess the impact of ESICApps on efficient and effective monitoring and collection of Environmental Health data.

1.3.1 Objectives of the Study

Specifically, the study seeks to achieve the following objectives:

1. Assess the effectiveness (functionality and usability) of ESICApps as a tool for collecting environmental field-level data
2. Examine the satisfaction of EHOs in using the ESICApps for environmental health field-level data collection.
3. Examine the advantages and disadvantages of using ESICApps compared to ESICOME, the paper-based data collection system.
4. Assess the impact of ESICApps on improved proactive environmental and sanitation management within user MMDAs.

1.4 Research Questions

The research will be guided by the following questions;

1. What is the effectiveness (functionality and usability) of ESICApps as a tool for collecting field level data?

2. What is the satisfaction of EHO's in using the ESICApps for environmental field-level data?
3. What are the advantages and disadvantages of using ESICApps as compared to ESICOME (paper based data collection system)?
4. What is the impact of ESICApps on improved proactive environmental and sanitation management within user MMDAs?

1.5 Justification

Environmental sanitation remains a persistent challenge in Ghana, contributing to substantial health risks and economic losses, including an estimated 5.2% reduction in the country's Gross Domestic Product (GDP) due to poor sanitation in Ghana underscores the urgent need to prioritize water and sanitation infrastructure, aligning with national development goals and Sustainable Development Goal 6, which aims to ensure availability and sustainable management of water and sanitation for all (Basiru et al., 2022). Accurate and timely data is critical to address these challenges effectively. The traditional paper-based system, ESICOME, has proven inefficient characterized by delays in data processing, missing reports, and limited real-time responsiveness thereby hindering proactive environmental health interventions by MMDAs.

In response, the Ministry of Sanitation and Water Resources introduced ESICApps to digitize data collection and streamline environmental health monitoring. However, despite the potential of ESICApps to improve efficiency and decision-making, there is limited empirical evidence evaluating its actual performance, usability, and stakeholder satisfaction in the field. This study is therefore justified as it seeks to fill

this knowledge gap by assessing the effectiveness, advantages, and challenges of ESICApps compared to the traditional system, thereby supporting evidence-based policymaking and digital transformation in environmental health surveillance.

1.6 Significance of the Study

This study is important because it goes beyond merely testing a mobile app and examines how digital tools like ESICApps can actually improve the way we manage sanitation and public health in Ghana. Evaluating how well the app works in the real world especially in busy MMDAs, the research helps us understand whether the shift from paper-based systems to digital platforms is truly making a difference.

The findings will directly benefit government agencies like the Ministry of Sanitation and Water Resources, helping them make better decisions on scaling up or improving ESICApps. Environmental Health Officers (EHOs), who are on the frontlines of sanitation monitoring, will also benefit from insights into what works well and what needs to be improved for them to do their jobs more efficiently.

Beyond that, the study offers value to NGOs, civil society organizations, and development partners interested in supporting better sanitation outcomes. Ultimately, when tools like ESICApps work well, communities benefit through cleaner environments, quicker responses to sanitation problems, and healthier living conditions contributing to national goals like Sustainable Development Goal 6 on clean water and sanitation.

1.7 Scope of the Study

This study concentrated on sanitation and environmental health management in Ghanaian Metropolitan, Municipal, and District Assemblies (MMDAs). However, the research was carried out in the Greater Accra Region because of the country's enormous geographic expanse. This region was selected not only for its accessibility and ease of data collection but also because it encompasses a diverse range of MMDAs, providing a representative sample for the study. Additionally, Greater Accra was the only region at the time to have implemented ESICApp in practice, making it the most suitable location for assessing its impact on environmental health data collection and sanitation management.

1.8 Thesis Organization

The study is divided into six main chapters. The first chapter addresses the background of the study, the problem statement, objectives, research questions for the study, justification, significance of the study, scope and organization of the study. In the second chapter, relevant literature related to this research topic was thoroughly examined. Chapter three focuses on presenting the study area and the methodology employed to conduct the research. Moving on to chapter four, the study data is presented. Chapter five discussed the findings of the study. Lastly, in chapter six, the summary of the results is presented, along with drawing conclusions based on the main findings and offering recommendations based on the study's outcomes.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents a comprehensive review of existing literature on the impact of ESICApps on the efficient and effective monitoring and collection of environmental health data in Ghana. It explores relevant studies, research findings, and theoretical frameworks related to digital health systems, environmental health data management, and the role of technology in public health surveillance.

The review critically examines the benefits and challenges associated with digital platforms in environmental health data collection, with a specific focus on ESICApps. Key concepts such as real-time data collection, data accuracy, system usability, and stakeholder engagement in digital health innovations are discussed. Additionally, the chapter analyzes studies on sanitation-related issues and their implications for public health, highlighting their relevance to the study. The literature review is structured around subject areas that align with the thematic focus of the research, ensuring a thorough analysis of pertinent contributions.

2.1 The Concept of Sanitation

The practice of taking steps to eliminate unhealthy elements, especially in relation to dirt and diseases, is known as sanitation (Kasiva, 2023). An increasing amount of research indicates that local communities' decisions, attitudes, behavior, and way of life can all be directly or indirectly tied to today's environmental issues (Awan, 2013). This is particularly true of the nineteenth-century Sanitation Revolution, which fueled

the pressures and causes of numerous problems (Ezeudu, 2020). The sustainability of environmental services in the community and the subsidiarity of decision-making processes both depend on a thorough approach to problem-solving participation that acknowledges the involvement of all stakeholders in the various environmental sanitation processes (Feris, 2015).

Currently, out of the 7.96 billion people in the globe, 2.6 billion live in Asia and sub-Saharan Africa and are still without access to proper sanitation (Speidel et al., 2009). Therefore, it is necessary to move away from simply delivering centralized planned infrastructure and toward strategies that can foster and support people's motivation to improve their own sanitation (WHO/UNICEF, 2013). This is due to the fact that in developing nations, inadequate sanitary facilities are now the primary contributor to a wide range of major health issues (Bryant, 2019). However, unless they are combined with better cleanliness practices, improvements to these services don't appear to have much of an impact on health (Ziraba et al., 2016; Zwane & Kremer, 2007). The two conditions seem to be related in that exposure to one may make the affected individual more susceptible to the other. Approximately half of the impacts of maternal and childhood underweight are still caused by inadequate water delivery systems, poor sanitation, and poor hygiene (Khanna & Das, 2016). Therefore, it is necessary to create novel strategies and incorporate them into societal institutions like schools, marketplaces, and healthcare facilities (Nutor, 2018).

Also, epidemiological studies have shown that even without latrines, which have traditionally been the focus of sanitation strategies, diarrhea morbidity can be significantly decreased with the adoption of improved hygiene behaviors

(Waddington et al., 2009). However, it has been observed that a large number of national data and progress reports on the Millennium Development Goals (MDGs) target on sanitation have mostly concentrated on access at the household level without mentioning access at public locations such as bus stations, schools, and urban markets, despite the fact that these locations are unusual settings and temporary residences where people commute or work for a living (Weststrate et al., 2019). Because of the possibility of open defecation, less cohesive community systems, and higher population concentrations, urban sanitation is much more complex (McGranahan, 2013). The collection, transportation, and appropriate handling or disposal of excreta are all included in the systems-based approach known as urban sanitation. It is more than just giving every home a toilet (Owusu, 2010). Furthermore, access to sanitation has not advanced much because the emphasis has been on water and hygiene, even though WASH (water, sanitation, and hygiene) is a single sector (Welch, 2021).

2.2 Urban Sanitation

According to Ezeudu et al., (2019), urban authorities have numerous issues that they appear unable to handle or manage. Most of these issues are frequently brought on by urbanization, and waste management is one of the issues they encounter. Paper, plastic, glass, cloth, metal, and organic materials make up the waste that is produced by residential, commercial, institutional, and industrial sources (Ezeudu et al., 2019). Waste Electrical and Electronic Equipment (WEEE), the greatest component of solid waste, Biodegradable Organic Fraction (BOF), wastewater, and feces sludge are just a few of the sanitation issues that urban centers face (MLGRD, 2010). In emerging countries, the pace of waste generation and accumulation is quickly evolving into a

significant issue with regard to sanitation and environmental health (Khan et al., 2022). Sanitation is a complicated subject that affects not just health but also social and economic growth (Brewer, 2022). This makes it a necessary service (Environmental Sanitation Policy, 2010). Despite the fact that there are several strategies, rural sanitation is the focus of most of them.

Therefore, much work needs to be done to address the numerous issues with urban sanitation (Adorsu-Djentuh, 2018). Many countries believe that the government or municipal assembly should be solely in charge of collecting and disposing of waste, but they are unable to do so for a variety of reasons, such as a lack of funding, a lack of organizational abilities, a lack of personnel, and a lack of data, among others (Adorsu-Djentuh, 2018). This is made worse by the fact that the majority of people do not believe they share responsibility for waste collection and disposal (Brewer, 2022). However, poor sanitation or a failure to implement sanitary measures poses a harm to the ecosystem as a whole as well as to human health. In order to increase both people's quality of life and their productivity in their activities, sanitation has become a basic requirement in metropolitan places. Urban sanitation is a difficult issue, thus it requires facilities and services that are both affordable and long-lasting. Prior to selection, local (financial, technical, and institutional) capacities must be accurately assessed, and site-specific factors in system design, construction, and operation must be taken into account (Brewer, 2022). Even though numerous governments and other stakeholders are working hard to address issues linked to garbage, there are still many significant gaps that need to be filled, which makes it difficult for developing nations to manage their waste effectively.

The majority of current efforts are focused on decreasing final volumes and raising enough money for trash management. Even while water and hygiene have long been viewed as a single concept, sanitation has received less attention, particularly in terms of data and finances, than water and hygiene, which has led to this dilemma (Khan et al., 2022). The UNDP Human Development Report (2006) states that while sanitation is getting better everywhere, it is not true in sub-Saharan Africa. As a result, it is crucial to find strategies to guarantee that the communities are aware of the issue in order to promote their engagement as a whole. This may cause a shift in the community's members from being victims to being change agents (Kookana et al., 2020). According to Konteh (2008), low income countries are unable to handle their problems with urban sanitation because of flaws in policy and a lack of data that must guide the delivery of services (Konteh, 2008).

2.3 Sanitation Promotion Strategies

In order to achieve the Millennium Development Goals, several groups and nations have therefore devised a number of ways to promote sanitation. These tactics have changed over time and gotten better as the years have gone by (Government of Nepal Sanitation and Hygiene Master Plan, 2011). Most of this wide range of innovative methods have been applied in low-income countries. However, the truth is that many people would like to have sanitation facilities but frequently cannot afford the prices associated with what is being supplied to them, even when such approaches show a waning interest in sanitation-related concerns. Therefore, the way sanitation is provided must change; the solution must be appropriate, cost-effective, and data-based (Kookana et al., 2020).

A variety of creative solutions that have been used in low-income nations are included in the documented strategies, including community-led efforts like Community Health Clubs, Community-Led-Total-Sanitation (CLTS), and the Participatory Hygiene and Sanitation Transformation Tool (PHAST) (CHCs). In low-income areas, hygiene and sanitation programs that are based in schools and kid-friendly are also very popular (Jenkins and Scott, 2007). Similar to this, social marketing strategies are becoming more and more common. Examples include promoting the use of soap when washing your hands and employing marketing techniques to promote sanitation (World Bank EHP, 2005). Instead of just focusing on standards or health issues, CLTSs try to promote self-respect (Kookana et al., 2020). This is to provide sanitation with a different strategy than what industry experts have focused on over the years as defined (Marshall & Farahbakhsh, 2013). The World Bank Water and Sanitation Programme (2005) evaluated works on different approaches from around the world and discovered that many of the solutions lacked comprehensive evaluations and intervention trials. They also examined three strategies: Happy Healthy and Hygienic/Program Saniya, which aimed to highlight risk factors for promoting hygiene; PHAST, which uses a participatory methodology to encourage active participation of those who must benefit from the development process; and Center for Health Care Strategies (CHCs), which seeks to help people improve their own hygiene practices by combining community mobilization and health education (Adorsu-Djentuh, 2018).

2.4 Environmental Sanitation Situation within Ghana

According to epidemiological studies, the adoption of better hygiene behaviors can significantly lower diarrhea morbidity even in the absence of latrines, which have

traditionally been the focus of sanitation programs (Ngakane, 2021). (Ministry of Local Government and Rural Development, 2010) states that there is a dearth of nationwide information on sanitation. Water, Sanitation, and Hygiene (WASH) is a single sector, but because water and hygiene have received greater attention, little progress has been made in gaining access to sanitation statistics (Loevinsohn *et al.*, 2004). Atuahene (2010) contends that although the country's Metropolitan, Municipal, and District Assemblies (MMDAs) are directly responsible for sanitation, they face numerous challenges, including inadequate data, inadequate planning for waste management programs, inadequate operations funding and equipment to support waste management activities, inadequate sites and facilities for waste management operations, inadequate waste management skills and capacity, and more. The poor status and recognition of sanitation workers, inappropriate procedures, a lack of political will, and ignoring customer preferences are also cited as obstacles (Marshall & Farahbakhsh, 2013). Overall, it may be claimed that Ghana's sanitation status is in a crisis. Ghana has made varying degrees of progress toward achieving the ESP, MDGs, and SDGs in terms of environmental sanitation. Ghana's water sector made a notable progress toward achieving the Millennium Development Goals (MDGs) water target (UNICEF, 2015). While the percentage of persons with access to better sanitation saw a slight increase (Ngakane, 2021), most sanitation goals, including the MDGs in sanitation, have been missed by significant amounts (Marshall & Farahbakhsh, 2013). Only 15% of Ghana's population, as reported by the WHO in 2015, has access to better sanitation, with the country's rates of open defecation among urban and rural populations being 19% and 34%, respectively. Five million Ghanaians, or one in five, are thought to defecate in public. According to the Joint Monitoring Programme (JMP, 2015), called the difficulty of getting access to better

sanitation in Ghana "starker." According to the survey, Ghana was also placed seventh-worst globally on the sanitation index, just ahead of Sierra Leone (13%), Chad, Madagascar, and Togo (12%), Niger (11%), and South Sudan (7% coverage) (UNICEF, 2015).

One of the biggest environmental sanitation issues facing Ghanaian city administrations is waste disposal. Each day, thousands of tons of solid waste are produced; the majority of these are discarded at disposal facilities, but some find up in sewers where they exacerbate other environmental dangers like flooding (Khan et al., 2022). In the majority of localities, people dispose of their garbage in primary drains and waterways. The growing urban population and urban sprawl of new suburbs are the main causes of the growing solid waste generation and management issues. The issue is made worse by the MMDAs' and the private sector's inability to collect all of the daily waste produced.

Additionally, due to frequent outbreaks of sanitation-related diseases like cholera, diarrhea, and malaria, poor hygiene leads in over 7,500 children dying each year (UNICEF, 2015). This scenario is especially concerning because good sanitation is necessary for both healthy economic development and human health and well-being (Ngakane, 2021). State and municipal administrations in Ghana have failed to solve the problem of environmental health and sanitation management. Rapid population growth, which produces significant volumes of garbage and puts strain on the current sanitation equipment, adds to the already existing difficulties (Medina, 2010). Regardless of the obstacles, the consequences of poor sanitation are sufficient to warrant attention.

A great deal of focus has been placed on developing regulatory frameworks and policies that support sanitation. Twelve policy documents, environmental and waste management guidelines, and legislative instruments addressing sanitation issues were produced between 1991 and 2010. These include of the Local Government Act of 1993 (Act 462), the National Environmental Policy of 1991, and Environmental Protection Agency Act, 1994 (Act 490); Water Resources Commission Act, 1996 (Act 522); National Building Regulations, 1996 (LI 1630) and National Environmental Quality Guidelines (1998). The rest are Environmental Sanitation Policy, 1999; Environmental Assessment Regulations, 1999 (LI 1652); Landfill Guidelines (2002); Guidelines for the Management of Health Care and Veterinary Waste in Ghana (2002); Revised Environmental Sanitation Policy, 2007 and Environmental Sanitation Policy, Revised, 2010. All stakeholders, including the state, municipal assemblies, communities, NGOs, people, the Ministry of Health, educational institutions, the commercial sector, and research institutes, have been given specific tasks and activities that must be taken under these policies. Despite the abundance of environmental sanitation policies, Ghana's urban sanitation infrastructure consistently fails (Adorsu-Djentuh, 2018). The implementation of successful programs has been negatively impacted by these and other challenges (WHO Sanitation Promotion Handbook, 1998). A typical country in sub-Saharan Africa, Ghana faces severe sanitation problems (Amoah et al., 2007). In 2010, the Environmental Health and Sanitation Directorate of the Ministry of Local Government and Rural Development developed the National Environmental Sanitation Strategy and Action Plan. The NESSAP.

The trash produced was called "Materials in Transition" (MINT). Raising public awareness of the need to change people's perceptions about rubbish as a way of life is MINT's objective. MINT investigates the potential for waste management to create jobs and reduce waste management expenses (NESSAP, 2010). Environmental sanitation is therefore covered in full in the National Environmental Sanitation Strategy and Action Plan (NESSAP). All parties involved in the various sectors, including NGOs, development partners, traditional authorities, Ministries, Departments, and Agencies (MMDAs), Metropolitan, Municipal, and District Assemblies (MMDAs), and even the media, are supposed to use it as a guide.

2.5 Stakeholders in Sanitation Promotion

Promotion of sanitation needs stakeholders. For environmental health and sanitation activities to be relevant and suitable, it is suggested that stakeholders must play a key role in establishing the projects' aims and goals (Adorsu-Djentuh, 2018). An excellent illustration of the cooperation of several stakeholders is the expansion of NESSAP in Ghana. They include the Ministry of Women and Children, the Ministry of Education, the Ministry of Health, the Environmental Protection Agency, and Regional Coordinating Councils. The MoH, the MLGRD, and the MoE are major stakeholders in Ghana's environmental health and sanitation education (NESSAP, 2010). The Red Cross, community committees, regional, district, and village development committees, municipal level WASH coordinating committees, local government agencies, school kid clubs, and non-governmental organizations are all involved in the promotion of cleanliness. This is essential to ensure complete involvement and develop a comprehensive plan that can help the entire nation (Lienert *et al.*, 2013).

Additionally, there are worldwide or global organizations engaged in the sanitation industry, including the World Bank, USAID, UNICEF, and the Water Supply and Sanitation Collaborative Council (WSSCC). The U.S. Agency for International Development (USAID) serves as a stand-alone department of the American government and offers economic, humanitarian, and development assistance to several nations worldwide. The Environmental Health Project (EHP) has been receiving assistance from USAID since 1994, and the organization has worked substantially in the field of environmental health. The Environment and Sanitation (WES) Program of the United Nations Children's Fund (UNICEF) encourages child survival. With the goal of accelerating access to basic water and sanitation services and enhancing hygiene practices, UNICEF is active in more than 90 countries.

A 1990 UN Resolution established the Water Supply and Sanitation Collaborative Council (WSSCC) with the mandate to quicken the process toward providing everyone with access to safe water, adequate sanitation, and good hygiene. Working in 33 countries at the moment, WSSCC keeps WASH issues at the top of the global agenda by managing three primary programs of activity: advocacy and communications, theme working groups, and national/regional plans of action. The goal of the Water and Sanitation Program (WSP), an international collaboration, is to reduce poverty by assisting the underprivileged in obtaining enduring access to better water and sanitation services. It is overseen by the World Bank and establishes alliances to carry out the structural and regulatory changes necessary for a wide-ranging sectoral change as well as to come up with innovative ways to design and carry out sustainable investment initiatives (Adorsu-Djentuh, 2018).

2.5.1 Government

The World Bank (2005) states that one aspect of the government's role in promoting sanitation and hygiene is creating sanitation policies, which are necessary to create an atmosphere that will further support and encourage better access to sanitary facilities. The World Bank (2005) examined the impact of national sanitation policies and the effectiveness of programs to improve hygiene and sanitation coverage and developed a list of policy ingredients that are thought to be essential conditions for adequate policies to allow for appropriate enabling environments. Therefore, it is believed that national and local government agencies are the most important stakeholders (Guerrero *et al.*, 2012).

The key component is political will, which may be shown in a variety of ways, including political pronouncements, institutional responsibilities, resource allocation, and projects, to name a few. Stakeholder acceptance of policy is the next component. The possibility of enhanced promotion and sustainability is thought to exist if stakeholders generally agree on the significance of government initiatives. The law must expressly establish the obligations and responsibilities of stakeholders (Whittington *et al.*, 1993). Other crucial elements include health considerations, the environment, financial decisions, adequate and appropriate service levels, efficient demographic targeting, and various institutional roles and responsibilities (The World Bank, 2005).

2.5.2 The Health Sector

A significant public health concern has been the positive correlation between poor sanitation, hygiene, and water supply and illness (Bartram and Cairncross, 2010).

Sanitation promotion is therefore one of the most important contributions the health sector can make to environmental health planning. This is so that diarrheal diseases can be prevented through the health systems' efforts to modify behavior. The industry, which offers numerous opportunities for experts and the public to interact, can convey recurrent messages that highlight the importance of shared responsibility for the mitigation of environmental health concerns (Ministry of Local Government and Rural Development, 2011).

To raise awareness of health issues, the Ghana Health Service's Health Education Unit regularly collaborates with the Ministry of Health in Ghana. Among other things, they use campaigns, ads, and visual and audio-visual materials (MLGRD, 2010). Additionally, doctors can play an important role in advocacy and leadership because the public and politicians listen to them. According to Duncan et al. (2010), this requires the medical community to voice their opinions on all important health-related problems, including cleanliness.

2.5.3 Non-Governmental Organizations, Community Based Organizations (CBOs) and Civil Society Groups (CSG)

In addition to providing support in the form of money and resources for the promotion of hygiene and sanitation, NGOs and CBOs also play catalytic roles in the promotion of sanitation activities at the policy development, implementation, and monitoring levels. They could engage in community organizing, volunteer work, and sanitization problems awareness raising (Sanitation and Hygiene Master Plan, 2014). The capacity to build technical support for training to close the knowledge gap, assist in creating monitoring frameworks, and gather information on environmental and sanitary health

hazards are additional skills that stakeholders possess (Mehta and Knapp, 2004). In addition to gathering resources for advocacy, stakeholders can help develop monitoring frameworks, provide technical support for training to bridge the knowledge gap, and collect data on environmental and sanitation health issues (Mehta and Knapp, 2004). In Ghana, nongovernmental organizations have joined cleaning campaigns, especially at the district level, where they offer technical assistance (Welle, 2011). At the district, regional, and national levels, the Coalition of NGOs in Water and Sanitation (CONIWAS) has consistently addressed a number of issues directly (Ainuson, 2009).

2.5.4 The Private Sector

Companies that produce or have the capacity to develop goods that can aid in promoting environmental hygiene and sanitation are considered to be part of the private sector. Through collaborations between the public and private sectors, they can be encouraged to localize facilities to satisfy local demand (Rheinlander et al; 2011). Sanitation marketing is one possible approach, in which marketing concepts are applied to promote sanitation. The private sector has the power to uncover unmet needs for sanitation, boost demand for it, and increase revenue (Bramley and Breslin, 2010). They went on to say that entrepreneurs might establish relationships with institutions and households to benefit from sanitation opportunities. Additionally, the economic crisis has brought state capabilities to the verge of collapse, necessitating the involvement of the private sector in efforts to promote sanitation. By 1999, the Ghanaian government had intended for all environmental services, such as waste management, cleaning, and sanitation, to be provided by private companies on a full

cost-recovery basis or by service providers under public contracts (Crook and Aryee, 2006).

2.6 Dealing with Sanitation in Public Places

Dreibelbis et al. (2013) contend that because the success of any intervention heavily relies on a confluence of structural, behavioral, individual, and community components, sanitation promotion has aided in the development of theoretical frameworks, explanatory frameworks, and decision-making models (Parker et al, 2012). Among these approaches is the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH). It facilitates the development of interventions that extend beyond the individual and household levels; structurally based interventions are very cost-effective and have the ability to reach the biggest segments of the population (Sweat et al., 2006). IBM-WASH was developed after an assessment of existing frameworks and concepts for changing behavior and keeping such changes (Parker et al., 2012).

Recent studies in Ghana similarly indicate that many health and sanitation interventions still focus primarily on individual behavior and neglect the broader institutional, structural, or environmental determinants (Mensah et al., 2023; Basiru, Arkorful, & Gyekye, 2022). Furthermore, monitoring and evaluation frameworks are often inadequate or unevenly implemented at different administrative levels, leading to inconsistencies in measuring outcomes and accountability (Akanbang, 2021; Tchouchu, 2023). The International Centre for Diarrhea Disease Research (ICDDR) created the IBM-WASH after conducting a pilot research in Bangladesh. It has three interconnected components, including contextual, psychological, and technological

aspects (Dreibelbis *et al.*, 2006). According to Wood et al. (2012), the psychosocial dimension integrates behavioral, social, and psychological elements to influence new technologies and desired behavioral outcomes; the contextual dimension takes into account the individual and his surroundings or environment that affects behavior changes that may ultimately result in the adoption of new technologies; and the technological dimension considers the suitability of new technologies that have influenced their adoption.

Recent studies both globally and in Ghana continue to operationalize the Social-Ecological Model with five nested levels of influence intrapersonal, interpersonal, organizational/institutional, community, and public policy. For example, a study on food insecurity among older persons in Ghana used these five spheres to identify how education, social support networks, institutional policies, community infrastructure, and national legislation each play a role. Another investigation into substance abuse in Ghana also highlighted structural/regulatory challenges at the organizational and policy levels, and resource availability and social norms at the community/institutional levels. The third level, known as the interpersonal/household level, encourages norms, access sharing, and roles and responsibilities. The fourth level, the person level, is associated with issues such as perceived dangers, age, gender, status, and education, as well as the price of items (Jenkins and Scott, 2010). At stage five, it is ingrained. It considers how easily and efficiently the generated products can be used, as well as whether the surroundings are favorable for the formation of habits (Wood et al., 2012).

The "Rights Approach" in Sanitation for All (SANALL) by United Nations Children's Fund (UNICEF, 2000) is another strategy worth mentioning because it views sanitation as promoting human rights and dignity and refers to inadequate sanitation as "a public health calamity" (UNICEF (SANALL), 2000). Children, girls, and women who occasionally had to wait until dusk to relieve themselves in areas without such facilities, the sick and aged, as well as the entire society, require this. These individuals' discomforts may potentially be accompanied by life-threatening conditions (Mara, 2008). According to SANALL, two of the many benefits of good sanitation include enhanced personal dignity and national pride (Songco, 2002). Additionally, SANALL identifies what works political will and a strong role for the government, encouraging behavior change, involving schoolchildren, providing families with a choice, community planning and management, and cost sharing and what doesn't the low priority of sanitation, the narrow focus on technology, the disregard for the family as a whole, the adoption of a one-size-fits-all approach, top-down operations, and limited access to funds and credit (UNICEF, 2000, Mara, 2008).

SANALL offers eight suggestions for policymakers. Step one proposes prioritizing sanitation by creating regulations that integrate the efforts of multiple organizations and provide local authorities the freedom to create strategies that would work best for them (Songco, 2002). To boost local demand for sanitation services, step two promotes partnering with the media, the commercial sector, and civil society organizations (Tayler et al., 2003). In order to prevent the transmission of disease, step four entails promoting and supporting the implementation of basic sanitary practices, while step three entails developing plans and strategies to achieve community involvement (UNICEF, 2000). In order to promote healthy lifelong habit

changes and hygienic living conditions, step five is to concentrate on the needs of women, girls, and children. Step six is to prioritize sanitation programs in schools (Mara, 2008). While step eight promotes information gathering and sharing on the challenges and successes that can be fostered through effective monitoring and research, step seven is to provide quick alternative access to sanitation during emergencies and disasters (Tayler et al., 2003). There must consequently be protective measures in place when addressing public sanitation requirements to stop diarrheal illnesses (Chin, 2000). The approach to technical infrastructure, policy infrastructure, and cost recovery for urban sanitation solutions has to be more adaptable (McFarlane, 2008). The need to create strategies that are most effective for particular needs is growing as the world struggles to keep up with sanitation initiatives (McConville, 2008). It is obvious that in order to support sustainability, sanitation issues must be addressed holistically and collaboratively.

While SANALL offers a comprehensive rights-based approach to sanitation, not all its steps may be directly transferable to the Ghanaian MMDA context. For instance, Step Two, which emphasizes broad partnerships with civil society and the media, assumes a high level of civic engagement and institutional trust, which may not be uniformly present across districts. Step Six, which prioritizes sanitation in schools, is highly relevant but often constrained by limited budget allocations at the district level. Moreover, Step Eight, which recommends extensive information gathering and dissemination, may be hampered by low data management capacity at the local government level. These limitations suggest that while SANALL provides useful direction, its full implementation would require resource mobilization, local capacity strengthening, and tailored adaptation to MMDA realities.

Several strategies that could be taken into account when designing initiatives for environmental health and sanitation have also resulted from this. In the process of promoting cleanliness, a number of agencies have adopted these ideas as frameworks. Among these are the Logical Framework Approach (LFA) (Ortegren, 2004), Open Planning of Sanitation Systems (Ridderstolpe, 2000), the Strategic Choice Approach (Friend, 1992), and Sanitation 21. (International Water Association, 2006). These frameworks, which are mostly planning-oriented, outline the basic procedures that must be taken in strategic planning for sanitation development initiatives. To assess the present or prevailing situations, the first of the suggested phases is problem identification, which uses some strategic techniques like PEST and SWOT analysis (Ortegren, 2004). The following phase entails identifying the goals and desired results. (International Water Association, 2006). Next, a variety of possibilities and the available technology that might be sustained must be taken into account in order to decide how to attain the goals. The following stage of the process selection process, which ultimately results in the project's action plan, is determined by the options that are accessible (Ortegren, 2004). Monitoring and evaluation, which serve as a roadmap for success and a tool for improving action plan shortcomings, come next.

The Hygiene Improvement Framework is one of the most complete strategies for preventing diarrheal infections brought on by poor sanitation (The WB EHP and partners, 2004). Three main elements or dimensions make up the framework. The first is expanding access to equipment for water and sanitization. A water delivery system, better sanitation, and household technologies are some of its indicators. Water supply considers the availability of water in terms of its quality and quantity to assist lower the risk of food contamination (Howard and Bartram, 2003).

The second indicator is improved sanitation. It entails providing facilities for disposing of human waste in a way that protects the environment and the general public's health. Septic tanks, different types of latrines, and water-borne toilets are a few disposal methods. The third indicator, household technologies, examines how well homes and other facilities can supply the resources needed to encourage healthy behaviors, such as potties for young children, chlorine, filters, soap or locally available alternatives for hand washing, and hygienic and efficient water storage containers (The WBEHP and partners, 2004). Promotion of good hygiene is the second element. The first sign of it is communication intended to increase awareness of hygiene-related facilities and behaviors. Information exchange within the targeted group is also helpful in promoting behavioural change. The traditional media, music, song and dance, community drama, literacy resources, brochures, posters, pamphlets, movies, and house visits are a few examples of communication channels (Nunoo et al, 2009). Common locations include neighborhood events, health facilities, schools, daycare and nutrition facilities, and homes (Pinfold, 1999). Because of this, it's critical to provide training in hygiene promotion to healthcare professionals, educators, and community leaders. Social mobilization is the second indication. It is a procedure for gaining and sustaining the participation of various community groups and sectors in the control of disease (Nandha and Krishnamoorthy, 2007). Supporting a local organization in developing and implementing a campaign to promote the proper use and maintenance of sanitary facilities or to boost the usage of soap for handwashing could result in this. Advocacy, which seeks to persuade individuals such as donors, program managers, and community representatives to advocate for the cause; social marketing, which applies marketing principles like partnerships with producers of hygiene promotion items to contribute to hygiene promotion; and

community participation, which involves the community (ethnic, religious groups, women, children, etc.) in the design, implementation, and monitoring of strategies aimed at behavior change (World Bank Environmental Health Project [EHP] & Partners, 2004).

Strengthening the supportive environment is the third element. This could occur at the local, municipal, state, or federal levels and could take the shape of strengthened institutions, better policies, community organizations, and finance alliances (Dreibelbis *et al.*, 2013). Examining the sufficiency of national policies, spotting loopholes, and making recommendations and gaining support for more effective policy development are all part of policy reform. The goal of institutional strengthening is to assist organizations in clearly defining their roles and duties as well as enhancing their capacity for leadership, processes and procedures, technical proficiency, and staff training (Cairncross, 2010).

The next step is to encourage community involvement. This requires gaining the community's commitment to maintaining the current systems. It is believed that locals are more committed to preserving and safeguarding their investments when they have put in the effort and invested their own time, effort, and money to create improved water and sanitation systems. The cost problem is addressed through financing and cost recovery. This aims to encourage financial stability so that projects can obtain financing (Bartram, Lewis, Lenton, & Wright, 2005). In order to work together using their core skills, various public and private organizations are brought together in cross-sector and public-private partnerships. Some of these organizations include task forces, steering committees, and interagency committees (The WBEHP and partners,

2004). This framework was originally created to support methods of creating better programs for reducing pediatric diarrhea, one of the top three killer diseases in underdeveloped nations, and thereby a reduction in child mortality (Evans, 2005).

An approach is required to successfully address all three conditions thoroughly, as there are approximately 4 billion episodes of diarrhea related diseases each year, which are primarily attributed to three major environmental causes, including poor hygiene, poor sanitation, and tainted food and water (Bartram *et al.*, 2005). The framework identifies contamination channels and proposes targeted measures to block them, emphasising prevention along the entire sanitation chain rather than only providing direct services. It further recommends strengthening national and local capacities — including education, programme design, and policy development — so that countries can manage risks, implement sustainable interventions, and scale up effective practices. This prevention-and-capacity approach aligns with the principles of the *Sanitation Safety Planning Framework* developed by the World Health Organization (WHO, 2022). More recent frameworks, such as the Stockholm International Water Institute (SIWI, 2024), emphasise the importance of building institutional and sectoral capacity for policy implementation and governance to ensure long-term environmental health sustainability..

The framework is therefore a comprehensive approach to diarrhea prevention in terms of facilitating access to the necessary instruments or technology, promoting healthy behaviors, and bolstering long-term sustainability.

2.7 Esicome Concept

The Expanded Sanitary Inspection and Compliance Enforcement (ESICOME) is an intervention designed and implemented to increasingly improve premises inspection to respond to the emerging sanitation challenges and to accelerate socio economic development. The primary goal of ESICOME is to encourage property owners and tenants, whether they are residential, commercial, or otherwise, to create and maintain hygienic conditions on their properties and in the surrounding areas. Additionally, it would actively educate, motivate, and support property owners and residents to value and want environmental changes and willingly use sufficient resources to make them a reality.

The objective, implementation strategy as well as expected benefits and outcomes of the ESICOME are detailed in this section of the guidelines document.

2.8 Redefining of Responsibilities for Sanitation

For the purposes of the ESICOME, the responsibilities of the major players in environmental sanitation has been redefined and categorized as follows:-

- (i) The Premises Owners/Occupants Responsibilities
- (ii) The District Assembly Responsibilities

i. The Premises Owners/Occupants Responsibility

Owners and Occupants are legally responsible for maintaining a state of good sanitation in their premises from their own resources.

Owners/ Occupants are required to comply with the existing sanitary bye-laws and legislation.

(ii) The District Assemblies Responsibilities

The District Assemblies from their own resources operate municipal services beneficial to the public and/or complementary to provisions by the individual premises Owners/Occupants (eg: public cleaning and refuse collection service). The Assemblies additionally have obligation to ensure that the responsibilities of Owners/Occupants are fully discharged. The detailed activities of the four components are listed in Section 3.3. in addition to the four major components, a fifth component call Complementary Component is proposed to be undertaken by the Assemblies to maximize the impact the Programme would achieve on the control of mosquitoes. The Premises Inspection component has several sub-components. Each sub-component has its detailed activities described. The other three components of the ESICOME Programme Are applied during premises inspection to support and enhance the effectiveness of the Inspection. The sub-components are presented below.

2.9 Hygiene Education and Sensitization

Use appropriate methodology including the participatory method to teach principles of environmental hygiene primarily as pertains to problems of given premises and their environs. Identify positive sanitary practices, such as provision of approved dustbin and encourage adoption of new and better practices. Identify negative sanitary practices e.g. insanitary disposal of waste water in backyards and encourage adoption of approved practices. Teach proper utilization of facilities. Offer information on sanitary products (e.g. types of dustbins, pesticides, toilet facilities). Offer information on available sanitation service (e.g. Cesspit Emptier Services, Refuse Collection, Pest Control, and Water Tanks Services). Order abatement of nuisances. Prosecute for non-compliance and notices issued for abatement. Explain relevant laws. The

complementary programme is required for mosquito control in open public places (e.g. drains, swamps, lagoons, streams) by the District Assemblies.

There are several significant benefits and outcomes that would be derived from the implementation of the ESICOME Programme. It is worth noting that these benefits and outcomes are the major expectations of both Government and the public. An outline of the benefits and outcomes are presented below:

Higher level of responsible behaviour with respect to the maintenance of environmental hygiene at home and in public. Public acquisition and application of knowledge of legislation (ACT, bye- laws etc.) regulating environmental hygiene practices and associated sanctions. Minimization of indiscriminate creating of domestic and public nuisances with disregard to regulations. Establishment of culture of self-policing by members of the community with respect to commitment of sanitary offences by neighbours.

Table 2.1: Roles and Responsibilities of Mlgrd/mmdas for Planning, Implementation, Monitoring and Evaluation

S/N	DESCRIPTION OF ROLES AND RESPONSIBILITIES	RESPONSIBILITIES	
		LEAD	COLLABORATORS
1	National Planning: Development of Guidelines which includes but not limited to; <ol style="list-style-type: none"> 1. Monitoring and Evaluation 2. Hygiene Education 3. Application of Regulation of bye laws. 	MLGRD (EHSD)	GHS MWWR, LGS
2	Technical Support and Assistance: <ol style="list-style-type: none"> 1. Capacity strengthening 2. Technical advice 3. Provision of special equipment and supplies e.g. Spraying machines and insecticides, rodenticides and snake poison 	MLGRD (EHSD)	GHS MWWR DPs
3	Monitoring and Evaluation: <ol style="list-style-type: none"> 1. Coordinating and reporting of activities of the Districts 2. Coordinating and reporting of activities of the Regions 3. Institutionalization of Annual ESICOME Review Seminar 	RCC (REHO) MLGRD (EHSD) MLGRD (EHSD)	RHMT GHS MWRS DPs
4	Implementation Guidelines <ol style="list-style-type: none"> 1. Start-up Plan <ol style="list-style-type: none"> i. ESICOME Document 2. District Plan 3. Orientation and Training 4. Monitoring and Evaluation 	MMDAs	
5	Input: Field staff Stationery and Other logistics	MMDAs	
6	Sustainability approaches: <ol style="list-style-type: none"> 1. Full commitment to; <ol style="list-style-type: none"> i. Provision of resources. ii. Capacity strengthening iii. Periodic review 	MLGRD MMDAs	

FIG. 1: ESICOME ORGANOGRAM

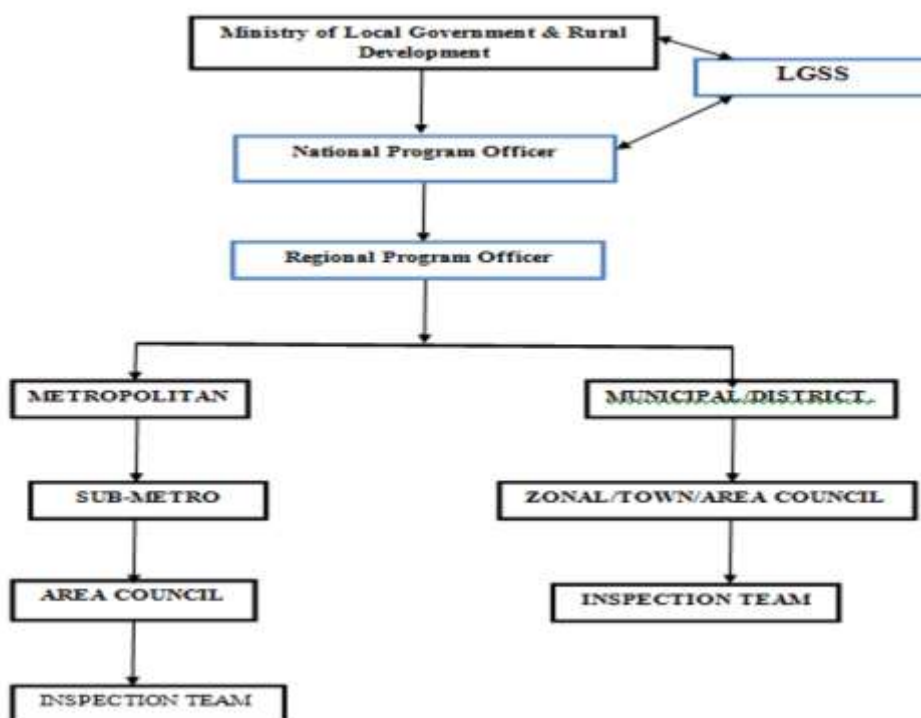


Figure 2.1: Esicome Organogram (MLGRD, 2020)

2.10 Comparative Evaluation of Digital Sanitation Monitoring Tools

Similar digital transitions have proven effective in other countries. In Kenya, for instance, the use of a community health surveillance app reduced response times and improved real-time monitoring in rural areas (Jenkins et al., 2023; van Herpen et al., 2023). In Bangladesh, a digital surveillance tool used in the Malaria Elimination Demonstration Project enabled quick case detection and workforce management (Rajvanshi et al., 2021). A scoping review by Silenou et al. (2021) further confirms the availability and impact of digital health tools across Africa, emphasizing their role in pandemic control and public health data management (Silenou et al., 2021).

2.11 Comparative Adoption of ESICApps

A study reported a relatively high adoption rate of ESICApps among EHOs in urban MMDAs where officers had regular internet access, adequate training, and support from senior management (Musenga, 2024). In contrast, (Ofori-Mensah, 2023) observed low usage in semi-urban and rural districts, where adoption was hindered by lack of mobile devices, inconsistent power supply, and poor technical support. These contrasting findings highlight the importance of contextual enablers such as infrastructure, digital literacy, and institutional commitment (Ofori-Mensah, 2023). Therefore, adoption of digital sanitation tools is not solely dependent on the tool's features but also on the systemic readiness of the implementing MMDAs.

2.12 Conceptual Framework

The conceptual framework of this study is based on the Technology Acceptance Model (TAM) and the concept of Efficiency and Effectiveness in Information Systems.

It illustrates how the use of ESICApps influences the efficiency and effectiveness of environmental health data collection and monitoring through three core elements:

1. Inputs:
 - Availability of ICT tools (smartphones, tablets, internet)
 - Training and technical support for Environmental Health Officers
 - Institutional policies promoting digital reporting
2. Process (Mediating Factors):
 - Functionality and usability of ESICApps
 - User satisfaction and ease of use
 - Data entry, transmission, and real-time analysis

3. Outputs (Outcomes):

- Improved data accuracy and timeliness
- Enhanced decision-making and reporting efficiency
- Strengthened environmental health management and service delivery

2.13 Research Philosophy

This study is grounded in the Pragmatist research philosophy.

- Pragmatism focuses on practical solutions to real-world problems rather than rigid theoretical positions.
- Since the study seeks to assess the real-world performance and usefulness of ESICApps in data monitoring, Pragmatism allows the combination of quantitative and qualitative reasoning to draw meaningful conclusions.
- It aligns with the study's applied nature, emphasizing "what works" in improving environmental health data systems.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter outlines the methodological approach used in assessing the impact of ESICApps on the efficient and effective monitoring and collection of environmental health data in Ghana. It covers the study design, area and site of study, population and sampling strategies, data collection tools and procedures, as well as data analysis techniques and ethical considerations. The subsections include: Study Design, Study Area and Site, Study Population, Inclusion and Exclusion Criteria, Sample Size Estimation, Sampling Techniques, Data Collection Tools and Procedures, Validity and Reliability, Data Management and Analysis, and Ethical Review.

3.1 Study Design

The influence of ESICApps in evaluating technology on environmental health data monitoring and gathering within a subset of Ghanaian Metropolitan, Municipal, and District Assemblies (MMDAs) was assessed using a descriptive cross-sectional approach. This approach is suitable because it makes it possible to gather data all at once, allowing for the analysis of Environmental Health Officers' (EHOs') present experiences, attitudes, and views of ESICApps.

The simultaneous evaluation of factors including system functionality, usability, user happiness, and perceived advancements in data-driven environmental and sanitation management is made easier by the cross-sectional approach. Comparative analysis between ESICApps and the conventional paper-based ESICOME system is also

supported. The design fits the study's goal of assessing the present state and results of ESICApps deployment because it is economical and effective.

By providing a validated framework for assessing how well ESICApps enable data collecting and decision-making, the researcher hope to advance knowledge of the use of digital health tools (computer apps) in environmental health and sanitation management.

3.2 Study Area

The Greater Accra Region of Ghana, which consists of 24 MMDAs with ESICApps deployed, was the study's site. With a population of about 5.4 million, Greater Accra is the most urbanized and densely inhabited region (GSS, 2021). Initiatives related to environmental health and administration are centered there. The region's varied environmental conditions, which range from semi-rural to urban, offered an appropriate setting for assessing the usefulness and effects of ESICApps.

With a land size of roughly 3,245 square kilometers, the Greater Accra Region is the smallest of Ghana's sixteen administrative regions (GSS, 2021). Despite its small size, it is home to Ghana's capital city, Accra, and is the most densely inhabited area in the nation (GSS, 2021). The area is geographically located along the Gulf of Guinea and borders the Eastern area to the north and the Central Region to the west. The 29 Metropolitan, Municipal, and District Assemblies (MMDAs) that make up the Greater Accra Region's administrative division are the main local government entities in charge of development planning, governance, and public service provision (MLGDRD, 2020).

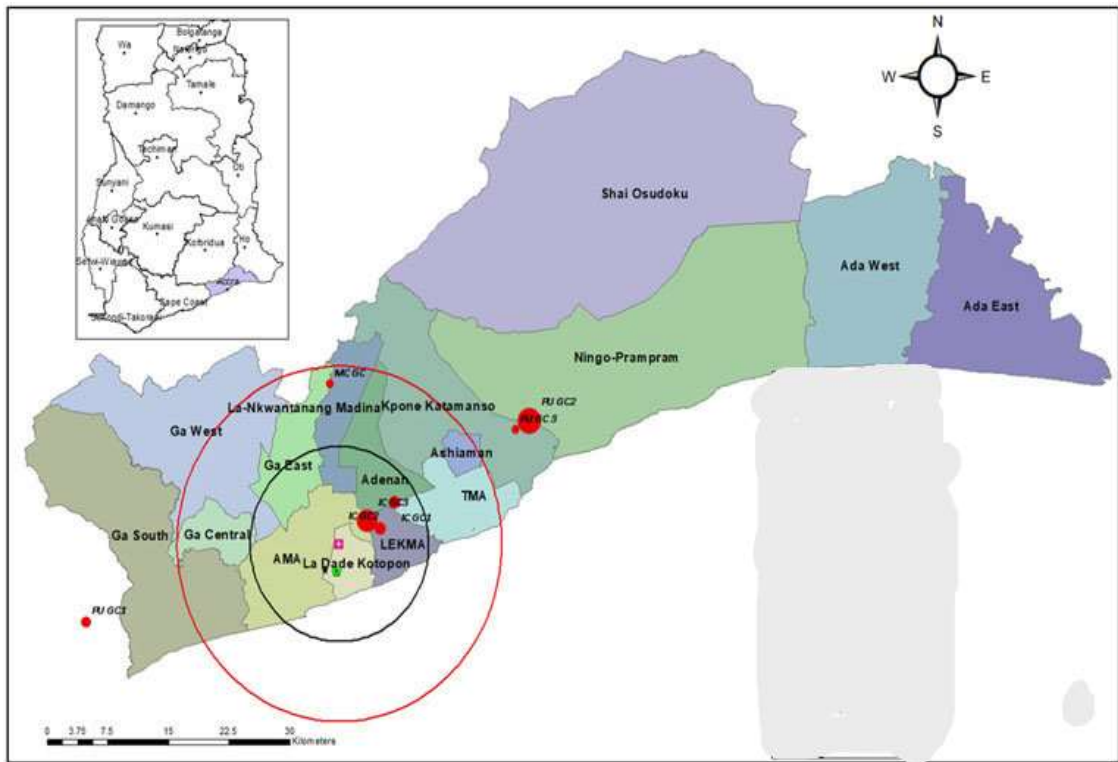


Figure 3.1: MMDAs Map of the Greater Accra Region (GSS, 2021)

3.3 Study Site

Data collection for the study was conducted across twenty-four (24) Metropolitan, Municipal, and District Assemblies (MMDAs) within the Greater Accra Region. These assemblies, were purposively selected based on their active utilization of the ESICApps platform. This selection ensured a comprehensive assessment of the system’s performance across diverse socio-environmental and geographical contexts. The participating MMDAs comprised Ablekuma Central Municipal Assembly, Ablekuma North Municipal Assembly, Ablekuma West Municipal Assembly, Accra Metropolitan Assembly, Adenta Municipal Assembly, Ashaiman Municipal Assembly, Ayawaso Central Municipal Assembly, Ayawaso East Municipal Assembly, Ayawaso North Municipal Assembly, Ayawaso West Municipal Assembly, Ga Central Municipal Assembly, Ga East Municipal Assembly, Ga North

Municipal Assembly, Ga South Municipal Assembly, Ga West Municipal Assembly, Korle Klottay Municipal Assembly, Krowor Municipal Assembly, La Dadekotopon Municipal Assembly, La Nkwantanang-Madina Municipal Assembly, Ledzokuku Municipal Assembly, Okaikwei Municipal Assembly, Tema Municipal Assembly, Tema West Municipal Assembly, and Weija-Gbawe Municipal Assembly.

3.4 Study Population

Fraenkel and Warren (2002) define a population as the entire group of people (subjects or events) that share the traits that the researcher is interested in. For the purpose of this study, the target population comprised of all Environmental Health Officers (EHOs) operating within the 24 selected MMDAs in the Greater Accra Region. Records from the Regional Environmental Health Office (REHO) for 2022 show that there were 563 officers in all.

The EHOs, as frontline personnel responsible for Environmental health monitoring, provided critical insights into the use and effectiveness of ESICApps in real-world settings. They were the perfect group to evaluate the tool's usefulness and impact because of their direct participation in field-level data gathering and compliance enforcement.

According to GSS (2021), the Greater Accra Region has an estimated population of approximately 5.4 million people. With more than 90% of the people residing in cities, it is Ghana's most urbanized region. According to the population's age distribution, roughly 30% of people are children between the ages of 0 and 14, 35% are young people between the ages of 15 and 35, 60% are working-age individuals

between the ages of 15 and 64, and 5% are 65 and above. The sex ratio in the area is roughly 95 males for every 100 females, meaning that there are slightly more females than males.

3.5 Sample Size Estimation

The sample size for this study was estimated using Cochran's formula $[N = (Z^2pq)/e^2]$ as previously described in (Sarmah et al., 2013):

where N is the required sample size

Z is the standard normal variate at a 95% confidence level (1.96)

p is the estimated proportion of an attribute present in the population (563 workers across all the 24 MMDAs)

$$q = 1 - p = 0.5$$

and e is the desired level of precision or sampling error (5% or 0.05).

Given the required sample size (N) = 384.16

Given that the total population of environmental health officers using ESICApps in the selected Metropolitan, Municipal, and District Assemblies (MMDAs) was 563, a finite population correction (FPC) was applied to adjust the sample size:

$$\text{Adjust Sample Size} = \frac{N}{1 + \frac{N - 1}{\text{Population}}}$$

Given the adjusted sample size of 228.67

To minimize sampling bias and improve the robustness of the study, the adjusted sample size was increased by 30%, bringing the final target sample size to approximately 300 respondents. However, a total sample size of 254 were used in the data analysis.

3.6 Sampling Techniques

According to Creswell (2018), sampling techniques refer to the methods used to select a subset (sample) of individuals, items, or data points from a larger population to make inferences or generalizations about that population. The goal of sampling is to collect data that accurately represents the entire population without the need to study every individual within it. Quota sampling was the sample strategy employed in this research. Quota sampling is a non-probability sampling technique where units are chosen for a sample based on pre-specified attributes so that the overall sample has the same distribution of attributes thought to be present in the population (Babbie, 2020).

Quota sampling was selected to ensure equal representation from all 24 MMDAs where ESICApps is operational. This method allowed for proportional inclusion (10 EHOs per MMDA), ensuring geographic diversity and administrative balance in the study. Although quota sampling is a non-probability technique, it was preferred over simple random sampling due to logistical constraints such as uneven distribution of EHOs across districts and variability in ESICApps usage. Moreover, the emphasis of the study was on descriptive and associative analysis rather than population generalizability, making quota sampling an appropriate and pragmatic choice.

3.7 Data Collection Tools

A structured questionnaire was used to collect data from participants. The structured questionnaire was designed to obtain information on participants' socio-demographic characteristics, knowledge and awareness of ESICApps, and perceptions of its efficiency and effectiveness in monitoring and collecting environmental health data. It

was used to evaluate the usefulness and functionality of ESICApps in procedures involving real-time data collecting and monitoring. This tool was essential to guaranteeing thorough data gathering for the research. The questionnaire included a Likert scale to gauge respondents' degrees of agreement with several important propositions. Both primary and secondary sources of information were used.

3.8 Validity and Reliability

Validity is the degree to which an instrument measures what it purports to measure. It ensures the accuracy and truthfulness of the results (Creswell, 2018). Reliability, on the other hand, describes how well a measurement represents the entire population being studied and how consistent or stable it is (Kothari, 2004). The data collection tools were pre-tested in an MMDA with comparable ESICApps usage that was not part of the main study. The content and face validity of ESICApps are reviewed by focal individuals. The questionnaire was pre-tested with the focus persons using ESICApps in order to guarantee the validity and reliability of the study tools. Environmental health officers evaluated the face and content validity of the instrument to make sure it included all pertinent study elements.

A pilot study involving 24 participants was conducted to assess the reliability of the instrument (questionnaire), and Cronbach's alpha coefficient was employed to determine its internal consistency. A dependability coefficient was deemed satisfactory if it was 0.7 or more. Cronbach's Alpha gives an estimate of internal consistency dependability by measuring how closely scale items are related to one another, Saunders (2019).

Before the main study was conducted, a pilot test was carried out to evaluate the data collection tools. Feedback from the pilot participants was carefully reviewed to identify areas for improvement. As a result, the structure, language, and clarity of the instruments were refined to enhance their reliability and comprehensibility.

Table 3.1: Below presents the Cronbach’s alpha values obtained during the pilot testing of the questionnaire scales:

Scale	Number of Items	Cronbach’s Alpha (α)
Usability and Functionality of ESICApps	8	0.82
User Satisfaction with ESICApps	7	0.78
Perceived Advantages and Disadvantages	6	0.74
General Perception of ESICApps	5	0.80

All scales demonstrated acceptable internal consistency, with $\alpha \geq 0.7$.

3.9 Data Collection Procedure

The methodical process by which researchers obtain information from relevant sources to address research questions is referred to as the data collection technique. According to Creswell (2018), the data collection process must be carefully designed to ensure consistency, standardization, and ethical rigor in line with the chosen research design. In this study, a structured questionnaire (see **Appendix A**) was developed using Google Forms and distributed electronically through WhatsApp and email. Prior to completing the questionnaire, participants were informed about the purpose of the study and provided their digital consent to participate

3.10 Data Management and Statistical Analysis

3.10.1 Data Management

Data management, according to DAMA (2017), is the act of gathering, storing, organizing, safeguarding, processing, and preserving data during the course of its lifespan in order to guarantee its security, dependability, quality, and accessibility. After being checked for accuracy and consistency, the collected data was imported into Microsoft Excel (2016) and then exported to IBM SPSS version 22.0 for analysis.

3.10.2 Statistical Analysis

The process of gathering, organizing, interpreting, presenting, and analyzing numerical data using statistical tools and procedures is known as statistical analysis. It is a critical step in quantitative research, as it helps to identify patterns, relationships, trends, and differences within the data and supports evidence-based decision (Creswell (2018)).

The data was analyzed using both descriptive and inferential statistical approaches. Descriptive statistics, such as frequencies and percentages, were utilized to compile the EHOs demographic details and their opinions on the effectiveness of ESICApps. To find the relationship between categorical variables including demographic characteristics and opinions about the effectiveness of ESICApps, chi-square tests were used. After adjusting for relevant confounders such as EHOs' experience, education, and ESICApp training, regression analysis was used to evaluate the impact of ESICApps on environmental health data collecting and monitoring.

3.11 Ethical Review and Clearance

Ethical review and clearance is the formal process by which an independent ethics committee or Institutional Review Board (IRB) evaluates a proposed research project to ensure that it meets ethical standards and guidelines, particularly those pertaining to research participants' rights, safety, dignity, and well-being. The ethical clearance assures that the research is carried out in a way that respects participants' rights and maintains scientific integrity (WHO, 2011).

The Committee on Human Research, Publications, and Ethics (CHRPE) at KNUST provided ethical permission (reference: CHRPE/AP/717/25). Additional approval was granted by Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). The permissions were also received from the 24 participating MMDAs. The EHOs were advised of their rights, which included voluntary participation and the ability to resign at any moment. Confidentiality and anonymity were preserved throughout the study by not recording any personal identifiers.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents the results of the study. The presentation of the results is based on the specific objectives and covers the following sub-headings: Demographic Characteristics of Participants, Effectiveness (functionality and usability) of ESICApps, Satisfaction of EHOs in using the ESICApps, Advantages and Disadvantages of using ESICApps and Impact of ESICApps on Environmental Health and Sanitation Management.

4.1 Demographic Characteristics of Participants

In **Table 4.1**, the majority (56.3%) of participants were aged between 31 and 40 years. Males constituted 63.0% of the sample, while females accounted for 37.0%. Regarding educational qualifications, 32.3% held a diploma, and most participants (36.6%) had between 5 and 9 years of work experience. In terms of job positions, 41.7% were Assistant Environmental Health Officers, 37.8% were Officers, and 20.5% were Analysts or Engineers.

Table 4.1: Demographic Characteristics of Participants

Demographic Characteristics	Frequency (N= 254)	Percentage %
Age		
20-30	59	23.2
31-40	143	56.3
> 41	52	20.5
Gender		
Male	160	63.0
Female	94	37.0
Education		
Certificate	80	31.5
Diploma	82	32.3
First Degree	80	31.5
Postgraduate degree	12	4.7
Working Experience		
< 5 years	48	18.9
5-9 years	93	36.6
10-14 years	81	31.9
> 14 years	32	12.6
Position		
Analyst/Engineer	52	20.5
Assistant	106	41.7
Officer	96	37.8

(Data Source: Field Survey, 2024)

4.2 Effectiveness (functionality and usability) of ESICApps

In **Table 4.2A** and **figure 4.1**, majority (53.9%) of the participants agreed that they could return to their previous task after accidentally leaving the ESICApps platform, while 27.6% strongly agreed. Similarly, 47.6% agreed that they could recover previously inputted or uploaded data after an interruption, whereas 29.5% strongly agreed. Regarding the understanding of essential features, 39.8% agreed, and 35.8% strongly agreed. A majority (76.0%) found the platform easy to operate and control in the field. Additionally, 43.7% agreed that it did not take them long to understand how to use the platform, while 33.9% strongly agreed. The response time of ESICApps functions was considered reasonably good by 46.5% of participants, with 25.2% strongly agreeing. Furthermore, 40.6% agreed that the platform processed information

efficiently, while 31.5% strongly agreed. Lastly, most participants (78.7%) indicated that ESICApps enabled them to accurately perform fieldwork and collect complete data.

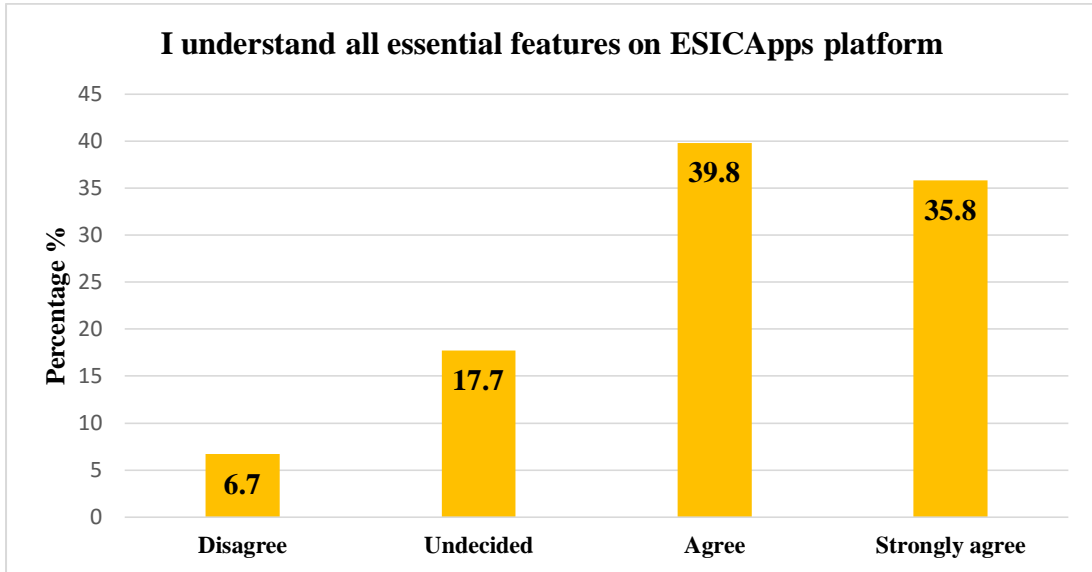


Figure 4.1: I understand all Features on ESICApps platform

Table 4.2A: Effectiveness (functionality and usability) of ESICApps

Variable	Frequency (N= 254)	Percentage %
Able to return when I accidentally leave the ESICApps		
Strongly Disagree	3	1.2
Disagree	15	5.9
Undecided	29	11.4
Agree	137	53.9
Strongly agree	70	27.6
Able to recover data when interruption on ESICApps platform		
Strongly Disagree	5	2.0
Disagree	15	5.9
Undecided	38	15.0
Agree	121	47.6
Strongly agree	75	29.5
ESICApps platform is easy to operate and control on the field		
No	61	24.0
Yes	193	76.0
didn't take much effort to understand how to use ESICApps		
Disagree	11	4.3
Undecided	46	18.1
Agree	111	43.7
Strongly agree	86	33.9
time taken for functions when clicked on is reasonably good		
Strongly Disagree	4	1.6
Disagree	16	6.3
Undecided	52	20.5
Agree	118	46.5
Strongly agree	64	25.2
time taken to process information is reasonably good		
Strongly Disagree	4	1.6
Disagree	22	8.7
Undecided	45	17.7
Agree	103	40.6
Strongly agree	80	31.5
ESICApps enables me to accurately perform field work		
No	54	21.3
Yes	200	78.7

(Data Source: Field Survey, 2024)

4.2.1 Association of Demographic Factors and Participants Perception on Effectiveness of ESICApps

Table 4.2B presents the association between demographic factors and participants' perception of the ease of operating the ESICApps platform. The chi-square test did not reveal any statistically significant association between age, gender, education, work experience and position of participants (**P-value > 0.05**).

Table 4.2C presents the relationship between demographic factors and participants' perceptions of ESICApps' effectiveness in ensuring accurate fieldwork performance. A significant association was observed between education level and the perception of accuracy of ESICApps' in field data collection ($\chi^2=7.1$, $p=0.034$). Cramer's V indicated a moderate association ($V=0.20$, $p=0.034$). Notably, participants with a certificate qualification were 90% less likely to perceive ESICApps as facilitating accurate fieldwork compared to those with a higher level of education [AOR=0.1 (0.02 – 0.72), $p=0.019$].

Table 4.2B: Factor that influence the ESICApps platform operation and control on the field

Factors	ESICApps platform is easy to operate		χ^2 (P-value)	Cramer's V/Phi (P-v)	AOR (95%CI) p-v
	No (%)	Yes (%)			
Age					
20-30	18 (30.5)	41 (69.5)	4.7 (0.094)	0.14 (0.094)	Ref
31-40	27 (18.9)	116 (81.1)			1.5 (0.47, 4.86) 0.492
> 41	16 (30.8)	36 (69.2)			0.7 (0.26, 1.79) 0.434
Gender					
Male	42 (26.3)	118 (73.8)	2.2 (0.139)	0.10 (0.139)	Ref
female	16 (18.0)	73 (82.0)			1.8 (0.90, 3.54) 0.095
Education					
Certificate	18 (22.5)	62 (77.5)	0.22 (0.974)	0.03 (0.974)	Ref
Diploma	21 (25.6)	61 (74.4)			0.5 (0.07, 2.86) 0.404
First Degree	19 (23.8)	61 (76.3)			0.6 (0.10, 3.15) 0.508
Postgraduate degree	3 (25.0)	9 (75.0)			0.9 (0.20, 4.64) 0.958
Work Experience					
< 5 years	11 (22.9)	37 (77.1)	2.6 (0.459)	0.10 (0.459)	Ref
5-9 years	19 (20.4)	74 (79.6)			0.6 (0.21, 1.53) 0.263
10-14 years	20 (24.4)	61 (75.3)			0.5 (0.20, 1.19) 0.115
> 14 years	11 (34.4)	21 (65.6)			0.6 (0.26, 1.52) 0.301
Position					
Analyst/engineer	9 (17.3)	43 (82.7)	2.2 (0.336)	0.09 (0.336)	Ref
Assistant	25 (23.6)	81 (76.4)			0.5 (0.23, 1.25) 0.147
Officer	27 (28.1)	69 (71.9)			0.8 (0.42, 1.48) 0.462

(Data Source: Field Survey, 2024)

Note: P-v = P-Value; Ref = reference; CI = confidence interval.

Cramer's V < 0.10 → Weak association, **V between 0.10–0.30** → Moderate association and **V > 0.30** → Strong association.

Table 4.2C: Factors influencing accurate performance of ESICApps

Factors	ESICApps help to accurately perform field work		χ^2 (P-value)	Cramer's V/Phi (P-v)	AOR (95%CI) p-v
	No (%)	Yes (%)			
Age					
20-30	11 (18.6)	48 (81.4)	2.3 (0.321)	0.09 (0.321)	Ref
31-40	28 (19.6)	115 (80.4)			1.2 (0.34, 3.85) 0.818
> 41	15 (28.8)	37 (71.2)			1.0 (0.40, 2.60) 0.980
Gender					
male	37 (23.1)	123 (76.9)	0.9 (0.342)	0.06 (0.342)	Ref
female	16 (18.0)	73 (82.0)			1.4 (0.71, 2.75) 0.341
Education					
Certificate	13 (16.3)	67 (83.8)	7.1 (0.034)	0.20 (0.034)	0.1 (0.02, 0.72) 0.019
Diploma	18 (22.0)	64 (78.0)			0.2 (0.04, 1.01) 0.051
First Degree	17 (21.3)	63 (78.8)			0.3 (0.07, 1.03) 0.055
Postgraduate degree	6 (50.0)	6 (50.0)			Ref
Working Experience					
< 5 years	9 (18.8)	39 (81.3)	4.1 (0.249)	0.13 (0.249)	Ref
5-9 years	15 (16.6)	78 (83.9)			0.4 (0.10, 1.72) 0.222
10-14 years	20 (24.7)	61 (75.3)			0.3 (0.09, 1.25) 0.105
> 14 years	10 (31.3)	22 (68.8)			0.8 (0.26, 2.23) 0.614
Position					
Analyst/engineer	12 (23.1)	40 (76.9)	0.6 (0.733)	0.05 (0.733)	Ref
Assistant	20 (18.9)	86 (81.1)			0.4 (0.12, 1.44) 0.169
Officer	22 (22.9)	74 (77.1)			1.0 (0.38, 2.74) 0.960

(Data Source: Field Survey, 2024)

Note: P-v = P-Value; Ref = reference; CI = confidence interval.

Cramer's V < 0.10 → Weak association, **V between 0.10–0.30** → Moderate association and **V > 0.30** → Strong association.

4.3 Satisfaction of EHOs in using the ESICApps

In **Table 4.3A** and **figure 4.2**, nearly half (49.2%) of the participants agreed that the ESICApps platform functions as it was designed and is likely to continue performing reliably, while 27.6% strongly agreed. Similarly, 51.2% agreed that the user interface is attractive and satisfying to use, with 27.6% strongly agreeing. The majority (93.7%) of participants reported feeling comfortable using ESICApps for fieldwork, and the

same percentage expressed satisfaction with its use. Additionally, 37.8% agreed that ESICApps should be implemented in all MMDAs across the country, while 41.3% strongly agreed. When comparing ESICApps to ESICOME, 44.5% agreed that ESICApps was more effective, and 31.1% strongly agreed. In terms of efficiency, 46.1% agreed that ESICApps improved their daily work, while 29.9% strongly agreed. Lastly, after using ESICApps, 46.9% of participants felt satisfied, while 30.3% strongly agreed with their satisfaction.

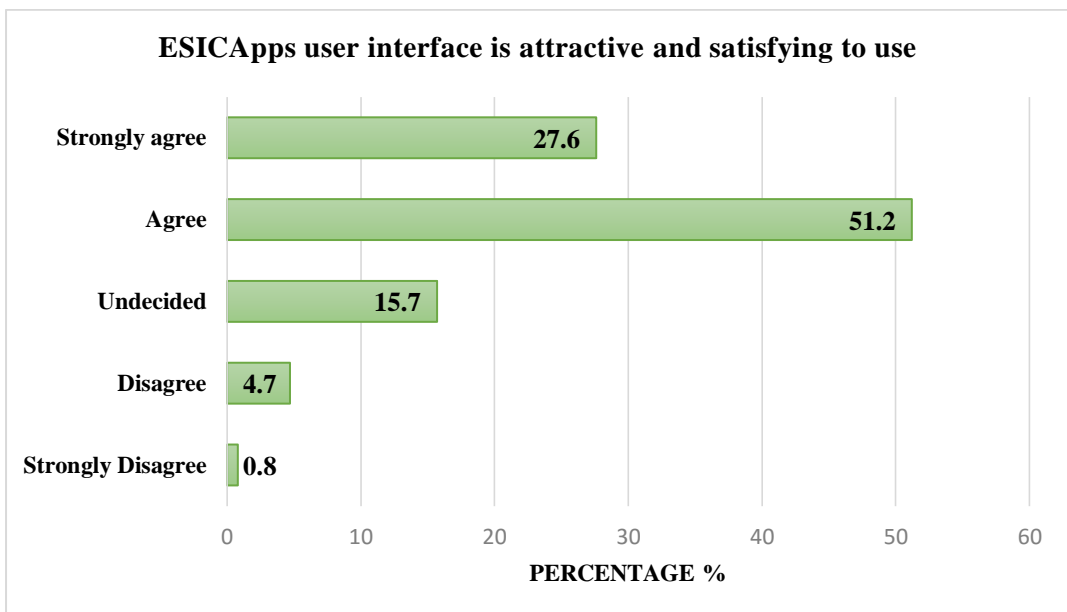


Figure 4.2: ESICApps User Interface is Satisfying to Use

Table 4.3A: Satisfaction of EHO's in using the ESICApps

Variable	Frequency (N= 254)	Percentage %
ESICApps platform behaves as intended		
Strongly Disagree	3	1.2
Disagree	9	3.5
Undecided	47	18.5
Agree	125	49.2
Strongly agree	70	27.6
comfortable with the use of ESICApps for field work		
No	16	6.3
Yes	238	93.7
satisfied with the use of ESICApps for field work		
No	16	6.3
Yes	238	93.7
ESICApps should be implemented in all MMDAs in the country		
Strongly Disagree	1	.4
Disagree	9	3.5
Undecided	43	16.9
Agree	96	37.8
Strongly agree	105	41.3
How effective is ESICApps compared to ESICOME		
Strongly Disagree	1	.4
Disagree	8	3.1
Undecided	53	20.9
Agree	113	44.5
Strongly agree	79	31.1
How would you rate efficiency of ESICApps in your daily work		
Strongly Disagree	1	.4
Disagree	10	3.9
Undecided	50	19.7
Agree	117	46.1
Strongly agree	76	29.9
How satisfy are you after using ESICApps		
Strongly Disagree	1	.4
Disagree	7	2.8
Undecided	50	19.7
Agree	119	46.9
Strongly agree	77	30.3

(Data Source: Field Survey, 2024)

4.3.1 Factors influencing the Satisfaction of EHO's in using the ESICApps

Table 4.3B presents the association between demographic factors and participants' comfort in using the ESICApps platform for fieldwork. The chi-square test did not reveal any statistically significant association between age, gender, education, work experience, and position of participants with comfort in using ESICApps (**P-value > 0.05**).

Table 4.3C examines the relationship between demographic factors and participants' satisfaction with ESICApps for fieldwork. A significant association was found between education level and satisfaction with ESICApps ($\chi^2=8.2$, $p=0.042$). Cramer's V indicated a moderate association ($V=0.20$, $p=0.042$). Participants with a certificate qualification were 97% less likely to be satisfied with ESICApps compared to those with a postgraduate degree [AOR=0.03 (0.001 – 0.6), $p=0.023$]. Additionally, participants in the assistant role were 5 times more likely to report satisfaction with ESICApps compared to officers [AOR=5.2 (1.01 – 26.34), $p=0.049$].

Table 4.3B: Factors influencing comfortability in using ESICApps for field

Factors	comfortable using ESICApps		χ^2 (P-value)	Cramer's V/Phi (P-v)	AOR (95%CI) p-v
	No (%)	Yes (%)			
Age					
20-30	1 (1.7)	58 (98.3)	3.2 (0.201)	0.11 (0.201)	Ref
31-40	10 (7.0)	133 (93.0)			0.4 (0.03, 5.36) 0.498
> 41	5 (9.6)	47 (90.4)			1.5 (0.33, 6.91) 0.592
Gender					
male	11 (6.9)	149 (93.1)	0.2 (0.698)	0.03 (0.698)	Ref
female	5 (5.6)	84 (94.4)			1.2 (0.37, 4.12) 0.730
Education					
Certificate	5 (6.3)	75 (93.8)	5.1 (0.167)	0.14 (0.167)	Ref
Diploma	2 (2.4)	80 (97.6)			0.3 (0.06, 1.95) 0.223
First Degree	7 (8.8)	73 (91.3)			0.1 (0.02, 1.0) 0.050
Postgraduate degree	2 (16.7)	10 (83.3)			0.5 (0.09, 2.64) 0.398
Working Experience					
< 5 years	3 (6.3)	45 (93.8)	3.7 (0.291)	0.12 (0.291)	Ref
5-9 years	3 (3.2)	90 (96.8)			0.2 (0.02, 2.23) 0.196
10-14 years	6 (7.4)	75 (92.6)			0.2 (0.02, 1.49) 0.112
> 14 years	4 (12.5)	28 (87.5)			0.5 (0.09, 2.67) 0.418
Position					
Analyst/engineer	3 (5.8)	49 (94.2)	3.4 (0.180)	0.12 (0.180)	Ref
Assistant	10 (9.4)	96 (90.6)			0.3 (0.03, 2.32) 0.233
Officer	3 (3.1)	93 (96.9)			4.0 (0.71, 22.7) 0.116

(Data Source: Field Survey, 2024)

Note: P-v = P-Value; Ref = reference; CI = confidence interval.

Cramer's V < 0.10 → Weak association, V between **0.10–0.30** → Moderate association and **V > 0.30** → Strong association.

Table 4.3C: Factor influencing satisfaction with the use of ESICApps for field work

Factors	satisfied with the use of ESICApps Yes (%)		χ^2 (P-value)	Cramer's V/Phi (P-v)	AOR (95%CI) p-v
Age					
20-30	1 (1.7)	58 (98.3)	4.5 (0.103)	0.13 (0.103)	1.2 (0.07, 21.6) 0.890
31-40	13 (9.1)	130 (90.9)			5.3 (0.79, 36.4) 0.087
> 41	2 (3.8)	50 (96.2)			Ref
Gender					
male	10 (6.3)	150 (93.8)	0.02 (0.880)	0.01 (0.880)	0.9 (0.27, 2.92) 0.854
female	6 (6.7)	83 (93.3)			Ref
Education					
Certificate	2 (2.5)	78 (97.5)		0.20 (0.042)	0.03 (0.001, 0.6) 0.023
Diploma	3 (3.7)	79 (96.3)			0.15 (0.01, 2.39) 0.180
First Degree	10 (12.5)	70 (87.5)			0.51 (0.04, 5.93) 0.593
Postgraduate degree	1 (8.3)	11 (91.7)			Ref
Working Experience					
< 5 years	4 (8.3)	44 (91.7)	1.1 (0.769)	0.07 (0.769)	0.2 (0.02, 3.24) 0.283
5-9 years	4 (4.3)	89 (95.7)			0.3 (0.03, 2.85) 0.279
10-14 years	6 (7.4)	75 (92.6)			0.6 (0.09, 4.62) 0.648
> 14 years	2 (6.3)	75 (92.6)			Ref
Position					
Analyst/engineer	3 (5.8)	49 (94.2)	1.6 (0.443)	0.1 (0.443)	0.4 (0.05, 2.93) 0.367
Assistant	9 (8.5)	97 (91.5)			5.2 (1.01, 26.34) 0.049
Officer	4 (4.2)	92 (95.8)			Ref

(Data Source: Field Survey, 2024)

Note: P-v = P-Value; Ref = reference; CI = confidence interval.

Cramer's V < 0.10 → Weak association, V between 0.10–0.30 → Moderate association and V > 0.30 → Strong association.

4.4 Advantages and Disadvantages of Using ESICApps

In Table 4.4A and figure 4.3, the majority (92.9%) of participants indicated that the ESICApps platform is easier to use for fieldwork compared to the paper-based ESICOMES. Additionally, 40.6% agreed and 42.1% strongly agreed that ESICApps enables them to conduct fieldwork more efficiently. In terms of flexibility, 40.9%

agreed, and 41.3% strongly agreed that ESICApps is more adaptable than ESICOMES. Regarding spatial and GPS data collection, 41.3% agreed, and 40.9% strongly agreed that ESICApps provides an advantage over ESICOMES.

When asked about the effectiveness of ESICApps in daily work, 40.9% agreed, and 34.3% strongly agreed. Similarly, 42.9% agreed, and 34.3% strongly agreed that ESICApps is more reliable for fieldwork with minimal data loss. In terms of cost, 42.9% agreed that ESICApps is more affordable to operate than ESICOMES, while 23.6% strongly agreed. Regarding organizational appreciation, 51.2% agreed, and 24.8% strongly agreed that ESICApps supports report writing. Lastly, 50.4% agreed, and 29.9% strongly agreed that ESICApps improves data collection compared to ESICOME.

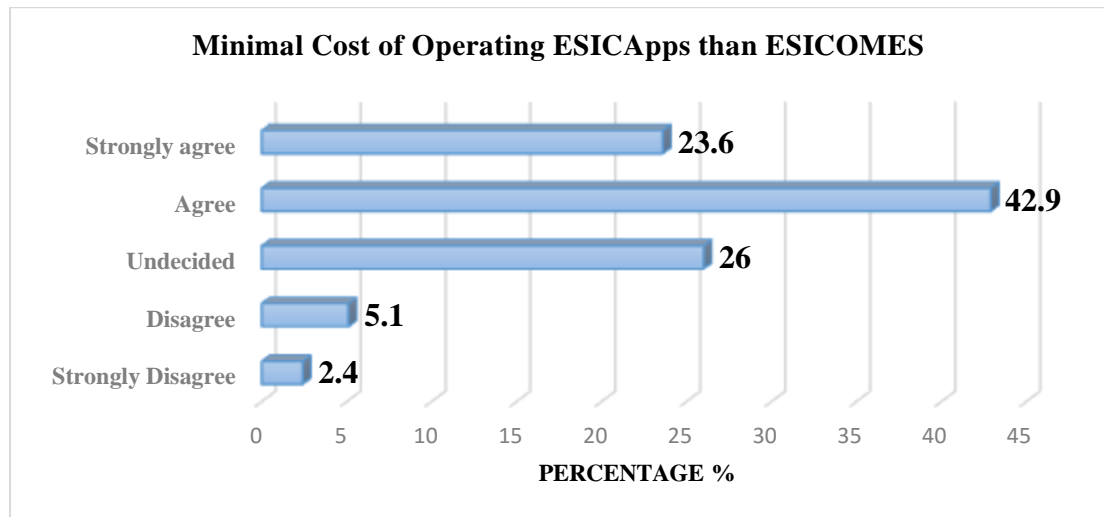


Figure 4.3: Cost of Operating ESICApps

Table 4.4A: Advantages and Disadvantages of using ESICApps

Variable	Frequency (N= 254)	Percentage %
ESICApps is easy to use than paper-based ESICOMES		
No	18	7.1
Yes	236	92.9
ESICApps help work with speed/efficiency than ESICOMES		
Strongly Disagree	3	1.2
Disagree	12	4.7
Undecided	29	11.4
Agree	103	40.6
Strongly agree	107	42.1
ESICApps is more flexible to use than ESICOMES		
Disagree	8	3.1
Undecided	37	14.6
Agree	104	40.9
Strongly agree	105	41.3
ESICApps enables EHOs to collect spatial/GPS data		
Strongly Disagree	1	.4
Disagree	4	1.6
Undecided	40	15.7
Agree	105	41.3
Strongly agree	104	40.9
Is the use of ESICApps effective in your daily work		
Strongly Disagree	1	.4
Disagree	14	5.5
Undecided	48	18.9
Agree	104	40.9
Strongly agree	87	34.3
ESICApps is more reliable with minimum potential data loss		
Disagree	9	3.5
Undecided	49	19.3
Agree	109	42.9
Strongly agree	87	34.3
Our organisation appreciate ESICApps use in report writing		
Strongly Disagree	2	.8
Disagree	14	5.5
Undecided	45	17.7
Agree	130	51.2
Strongly agree	63	24.8
ESICApps usage improve data collection than ESICOME		
Disagree	6	2.4
Undecided	44	17.3
Agree	128	50.4
Strongly agree	76	29.9

(Data Source: Field Survey, 2024)

4.5 Perceived Effects of ESICApps on Environmental Health and Sanitation Management

In Table 4.5, a significant proportion (40.6%) of participants strongly disagreed and 32.3% disagreed that they face challenges in generating outputs and reports using ESICApps. However, 33.1% agreed and 22.0% strongly agreed that the platform does not function properly on some mobile devices. Regarding user-friendliness, 36.2% disagreed, and 33.1% strongly disagreed that the ESICApps interface is not user-friendly.

A majority (62.6%) of participants indicated that the ESICApps platform allows them to communicate or share information with other EHOs, while 37.4% stated otherwise. Regarding access to data bundles, 26.4% disagreed, while 18.5% strongly agreed that they struggle with acquiring adequate data bundles. More than half (51.2%) of respondents indicated that ESICApps sometimes crashes or slows down their phones. Furthermore, 25.2% disagreed, and 18.1% strongly disagreed that poor network connectivity affects the use of the platform, while 20.5% strongly agreed.

Table 4.5: Perceived Effects of ESICApps on Environmental and Sanitation Management

Variable	Frequency (N= 254)	Percentage %
Challenges generating outputs and reports using ESICApps		
Strongly Disagree	103	40.6
Disagree	82	32.3
Undecided	26	10.2
Agree	21	8.3
Strongly agree	22	8.7
ESICApps does not function properly on some mobile devices		
Strongly Disagree	52	20.5
Disagree	26	10.2
Undecided	36	14.2
Agree	84	33.1
Strongly agree	56	22.0
interface of the ESICApps platform is not user friendly		
Strongly Disagree	84	33.1
Disagree	92	36.2
Undecided	42	16.5
Agree	24	9.4
Strongly agree	12	4.7
ESICApps platform lacks the ability to enable you share information with other EHOs		
No	159	62.6
Yes	95	37.4
Find it difficult to get adequate access to data bundles to use the platform		
Strongly Disagree	48	18.9
Disagree	67	26.4
Undecided	46	18.1
Agree	46	18.1
Strongly agree	47	18.5
ESICApps sometimes crashes or slows down my phone		
No	124	48.8
Yes	130	51.2
Poor network connectivity makes it difficult to use the platform sometimes		
Strongly Disagree	46	18.1
Disagree	64	25.2
Undecided	42	16.5
Agree	50	19.7
Strongly agree	52	20.5

(Data Source: Field Survey, 2024)

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter presents a comprehensive discussion of the key findings of the study, which assessed the impact of ESICApps on efficient and effective monitoring and collection of environmental health data in Ghana. The discussion is structured around the study's specific objectives, focusing on the efficiency of ESICApps in environmental health data collection, its effectiveness in improving monitoring and reporting processes, and the challenges associated with its implementation.

The monitoring and collection of environmental health data are critical for informed decision-making, policy formulation, and effective public health interventions. Traditional methods of data collection and monitoring often present challenges such as delays, inaccuracies, and inefficiencies, which hinder timely responses to environmental health issues. Digital tools like ESICApps have the potential to enhance data accuracy, streamline reporting processes, and improve overall efficiency in environmental health surveillance.

This chapter critically examines the findings in relation to existing literature, technological advancements, and public health frameworks on environmental health data management. By comparing the study results with previous research, the discussion provides insights into the strengths, limitations, and potential improvements needed to optimize ESICApps for enhanced environmental health monitoring in Ghana.

5.1 Effectiveness (Functionality and Usability) of ESICApps

The findings of this study reveal that ESICApps is perceived as an effective tool for the monitoring and collection of environmental health data in Ghana. A significant proportion of participants (53.9%) agreed that they could return to their previous task after accidentally leaving the ESICApps platform, while 27.6% strongly agreed. This indicates that the platform provides a seamless user experience, reducing the risk of data loss due to unintended exits. Moreover, 47.6% of respondents agreed, and 29.5% strongly agreed that they could recover previously inputted or uploaded data after an interruption. These findings align with previous studies that emphasize the importance of data recovery mechanisms in digital health applications to ensure continuous workflow and prevent the loss of critical environmental health data (Kimaro & Nhampossa, 2005). The ability to resume tasks and retrieve lost data enhances the efficiency of field officers, minimizing delays in data collection and reporting.

Another key aspect of ESICApps' effectiveness is its ease of use. A majority of the participants (76.0%) found the platform easy to operate and control in the field, suggesting that its interface and functionalities are user-friendly. Similarly, 43.7% of respondents agreed, and 33.9% strongly agreed that it did not take them long to understand how to use the platform. This supports research that highlights the significance of user-friendly interfaces in digital health tools to enhance usability and adoption (Dzenowagis, 2009). The ease of understanding and navigating the platform suggests that ESICApps requires minimal training, which can facilitate its widespread implementation among environmental health officers. Additionally, the study found that 39.8% of participants agreed, and 35.8% strongly agreed that they understood the essential features of the platform. These findings indicate that ESICApps has an

intuitive design that allows users to effectively utilize its functionalities with minimal learning curves.

The study also assessed the response time and processing efficiency of ESICApps, which are critical factors in determining its effectiveness. Findings revealed that 46.5% of participants agreed that the response time of ESICApps functions was reasonably good, while 25.2% strongly agreed. Additionally, 40.6% of respondents agreed, and 31.5% strongly agreed that the platform processed information efficiently. These results suggest that ESICApps performs well in real-time data processing, enabling swift reporting and analysis of environmental health conditions. Prior research has shown that digital tools with efficient processing capabilities contribute to improved decision-making in public health interventions (Blaya et al., 2010). Therefore, the positive response regarding ESICApps' speed and efficiency underscores its potential to enhance environmental health data management in Ghana. Furthermore, the accuracy of data collection using ESICApps was highly rated by participants. The majority (78.7%) indicated that the platform enabled them to accurately perform fieldwork and collect complete data. This finding highlights ESICApps' potential to enhance data reliability and reduce human errors associated with manual data collection. Similar studies have demonstrated that digital applications improve data accuracy, consistency, and completeness, which are crucial for effective environmental health monitoring (WHO, 2016). The ability to ensure accurate data collection can enhance policy formulation and interventions aimed at improving public health and environmental conditions.

Overall, the findings suggest that ESICApps is a functional and user-friendly tool that facilitates efficient environmental health data collection and monitoring. The study underlines the importance of digital solutions in strengthening environmental health surveillance, ensuring timely reporting, and enhancing decision-making. However, for sustained success, continuous user training, system updates, and technical support must be provided to optimize the platform's usability and efficiency. Future research could explore the scalability of ESICApps across different regions in Ghana to assess its long-term impact on environmental health data management.

5.1.1 Factors Influencing the Effectiveness of ESICApps in Environmental Health Data Collection

This study examined the factors influencing the effectiveness of ESICApps in monitoring and collecting environmental health data in Ghana. Findings revealed that education level significantly influenced participants' perception of ESICApps' accuracy and effectiveness in data collection. Specifically, participants with only a certificate qualification were 90% less likely to perceive ESICApps as facilitating accurate fieldwork compared to those with a higher level of education (AOR = 0.1, $p = 0.019$). This finding suggests that educational background plays a critical role in determining how environmental health officers (EHOs) engage with digital health tools, aligning with previous studies that emphasize the importance of digital literacy in technology adoption (Aung et al., 2020; Feroz et al., 2021). Higher levels of education may provide EHOs with the necessary skills to navigate and effectively utilize digital tools, thereby enhancing data accuracy and fieldwork efficiency.

Additionally, this study found no statistically significant association between demographic factors such as age, gender, work experience, and position with the ease of operating the ESICApps platform ($p > 0.05$). This suggests that the usability of ESICApps is not inherently biased toward a particular demographic group. However, previous research has indicated that individual experience with technology and prior exposure to digital tools could still impact user adaptability (Wang et al., 2019). The findings highlight the need for targeted digital training programs to improve user engagement with ESICApps, particularly among EHOs with lower educational qualifications. Such training initiatives could bridge knowledge gaps and enhance the tool's effectiveness in environmental health data collection.

The study also revealed a significant association between education level and satisfaction with ESICApps ($\chi^2 = 8.2$, $p = 0.042$), with participants possessing a certificate qualification being significantly less likely to report satisfaction compared to those with a postgraduate degree. This finding underscores the role of educational attainment in influencing users' perceptions of digital health tools, reinforcing the need for structured capacity-building interventions (Keceli Kaysili et al., 2022). Furthermore, the study found that EHOs in assistant roles were five times more likely to express satisfaction with ESICApps compared to officers (AOR = 5.2, $p = 0.049$). This may be attributed to variations in job responsibilities, as assistants may find ESICApps more beneficial for streamlining their tasks, whereas officers might experience higher expectations and challenges in system integration.

Given these findings, policy interventions should focus on providing comprehensive digital literacy training for all EHOs, particularly those with lower academic

qualifications, to enhance their confidence and proficiency in using ESICApps. Additionally, continuous system evaluation and user feedback mechanisms should be integrated into the ESICApps framework to address potential concerns and optimize user experience. Future research should explore the long-term impact of digital health tools on environmental health data collection efficiency and overall public health outcomes.

5.2 Satisfaction of EHOs in Using the ESICApps

The findings of this study indicate that the majority of Environmental Health Officers (EHOs) in Ghana express a high level of satisfaction with the ESICApps platform. Nearly half (49.2%) of the participants agreed that the platform behaves as intended and performs reliably, while 27.6% strongly agreed. This aligns with prior research suggesting that the usability and reliability of digital applications significantly influence user satisfaction and continued adoption. In Ghana, for example, a study applying TAM found that perceived ease of use and perceived usefulness significantly predicted citizens' intention to adopt mHealth services (Mensah et al., 2022). Another study using TAM in the context of caller tunes showed consistency with these predictors in motivating intention to use such health-supportive mobile technologies (Mensah et al., 2022). Moreover, 51.2% of participants found the user interface of ESICApps attractive and satisfying, with 27.6% strongly agreeing. A well-designed user interface enhances usability and facilitates efficient workflow, ultimately improving performance in environmental health monitoring (Nielsen, 1993).

The study further reveals that the overwhelming majority (93.7%) of EHOs reported feeling comfortable using ESICApps for fieldwork, with the same percentage

expressing overall satisfaction with its use. This finding is consistent with research highlighting the importance of digital tools in improving field data collection, where ease of use and accessibility directly impact the efficiency of environmental health officers (Venkatesh et al., 2003). Additionally, 37.8% of participants agreed that ESICApps should be implemented in all Metropolitan, Municipal, and District Assemblies (MMDAs) across Ghana, while 41.3% strongly agreed. This suggests that the platform holds the potential for nationwide adoption, given its effectiveness in streamlining data collection and monitoring processes (Agarwal & Prasad, 1999).

A comparative analysis between ESICApps and ESICOME revealed that 44.5% of participants agreed that ESICApps was more effective, while 31.1% strongly agreed. The efficiency of digital tools plays a critical role in enhancing service delivery in environmental health, as confirmed by previous studies on digital monitoring systems in public health (Sharma et al., 2017). Furthermore, 46.1% of participants agreed that ESICApps improved their daily work, while 29.9% strongly agreed. The integration of technology into environmental health monitoring ensures timely data collection, better decision-making, and improved environmental interventions (Zhang & Weng, 2015).

Finally, the study found that 46.9% of participants felt satisfied after using ESICApps, with 30.3% strongly agreeing. This high satisfaction rate suggests that the platform effectively addresses the challenges faced by EHOs in the field, providing a reliable and user-friendly tool for environmental health data collection. These findings underscore the need for continued investment in digital innovations to enhance environmental health monitoring and policy implementation in Ghana (Rogers, 2003).

Future research should explore long-term user experiences and potential areas for system improvements to maximize the impact of ESICApps.

5.2.1 Factors Influencing the Satisfaction of EHOs in Using the ESICApps

This study examined the factors influencing Environmental Health Officers' (EHOs) satisfaction in using the ESICApps platform for fieldwork. The findings indicate that demographic factors such as age, gender, education level, work experience, and job position did not show a statistically significant association with EHOs' comfort in using ESICApps ($p > 0.05$). However, education level significantly influenced satisfaction with the platform ($\chi^2 = 8.2, p = 0.042$), suggesting that higher educational attainment positively correlates with better user experiences. Participants with only a certificate qualification were 97% less likely to be satisfied with ESICApps compared to those with a postgraduate degree [AOR = 0.03 (0.001 – 0.6), $p = 0.023$]. This finding aligns with previous studies that highlight the role of digital literacy and technical expertise in shaping user experiences with health informatics tools (Gagnon et al., 2016; van Gemert-Pijnen et al., 2018).

The study further found that the level of responsibility within the organization affected satisfaction with ESICApps. Assistant-level EHOs were five times more likely to report satisfaction with ESICApps compared to officers [AOR = 5.2 (1.01 – 26.34), $p = 0.049$]. This suggests that assistants, who often have more direct field interactions, may find the application more relevant to their workflow, while officers who engage in higher-level administrative tasks may encounter challenges in integrating the platform into their roles. Similar findings have been reported in health

information system research, where differences in user roles influence perceptions of system usability (Luna et al., 2014; Kruse et al., 2016).

While education level and job role influenced satisfaction, other structural and operational challenges were observed. Many participants (33.1%) agreed that the ESICApps platform was not user-friendly, and 51.2% reported that the application occasionally crashed or slowed down their devices. Such issues can hinder the effective adoption of digital health tools, as technical difficulties reduce efficiency and increase frustration among users (Davis et al., 2018). Furthermore, the study found that a lack of adequate mobile data bundles was a barrier for some EHOs, with 26.4% of respondents disagreeing with the statement that they could easily access internet resources to operate the application. Previous studies have emphasized the need for stable network infrastructure and affordable internet access to optimize the use of health technology in resource-limited settings (WHO, 2021; Olu et al., 2019).

To enhance satisfaction and usability, it is crucial to implement targeted training programs to improve digital literacy among EHOs, particularly those with lower educational qualifications. Additionally, addressing technical glitches, improving system responsiveness, and ensuring stable internet connectivity will significantly enhance the efficiency of ESICApps in environmental health monitoring. The findings of this study contribute to the growing body of knowledge on digital health interventions in Ghana and highlight the need for ongoing system optimization to maximize the platform's potential in environmental health management.

5.3 Advantages and Disadvantages of Using ESICApps for Environmental Health Data Collection

The findings of this study indicate that ESICApps significantly enhances the efficiency and effectiveness of environmental health data collection compared to the traditional paper-based ESICOMES system. The majority (92.9%) of participants reported that ESICApps is easier to use for fieldwork, suggesting a user-friendly interface that facilitates seamless data entry and retrieval. This aligns with studies on digital data collection platforms that highlight the advantages of mobile-based applications in streamlining environmental health surveillance (Tomlinson et al., 2013). Additionally, 40.6% of participants agreed, and 42.1% strongly agreed that ESICApps improves fieldwork efficiency, reinforcing the idea that digital tools can enhance real-time data monitoring and reporting (MHealth Alliance, 2014). These findings suggest that the adoption of ESICApps in environmental health monitoring can contribute to timely and accurate data collection, ultimately improving decision-making processes.

Another key advantage of ESICApps is its flexibility and adaptability. Findings from the study reveal that 40.9% of participants agreed, and 41.3% strongly agreed that ESICApps is more adaptable than ESICOMES. This suggests that environmental health officers (EHOs) can easily modify data collection processes to suit different field conditions. The ability of ESICApps to integrate spatial and GPS data collection was also recognized, with 41.3% of participants agreeing, and 40.9% strongly agreeing that it provides an advantage over the paper-based system. The incorporation of geospatial technology in environmental health data collection has been widely acknowledged as a key innovation that enhances precision in monitoring

environmental hazards (Githeko et al., 2014). The improved accuracy and reliability of ESICApps in capturing field data ensure that environmental health officers have access to high-quality information for planning and intervention.

Despite these advantages, some challenges associated with the implementation of ESICApps were identified. While 42.9% of participants agreed that ESICApps is more cost-effective than ESICOMES, only 23.6% strongly agreed. This suggests that although the digital platform reduces expenses related to printing and physical storage, there may be initial costs related to acquiring devices and training staff. Additionally, some respondents may require further capacity building to maximize the benefits of the application. Research on digital health interventions emphasizes the need for continuous training and technical support to ensure optimal utilization of new technologies (Agarwal et al., 2016). Therefore, the successful scaling-up of ESICApps requires adequate investments in infrastructure, capacity building, and technical support to enhance sustainability.

Overall, the findings suggest that ESICApps offers significant improvements in efficiency, reliability, and cost-effectiveness for environmental health data collection. With 50.4% of participants agreeing, and 29.9% strongly agreeing that ESICApps improves data collection compared to ESICOMES, it is evident that digitalization is a viable strategy for enhancing environmental health monitoring. However, for successful nationwide implementation, challenges such as cost implications, training needs, and technical support must be addressed. Future research should explore long-term impacts and user experiences with ESICApps to refine its functionality and ensure its sustainability in Ghana's environmental health sector.

5.4 Impact of ESICApps on Environmental and Sanitation Management

The findings of this study indicate that ESICApps has significantly improved the efficiency of environmental health officers (EHOs) in monitoring and collecting environmental health data. A majority (92.9%) of respondents found the platform easier to use compared to the traditional paper-based ESICOMES. This finding aligns with studies highlighting the benefits of digital data collection platforms in streamlining field operations and reducing paperwork (Karahalios et al., 2020). Additionally, 42.1% of respondents strongly agreed that ESICApps enhances efficiency in fieldwork, suggesting that digital tools can enhance productivity in environmental health monitoring.

One notable advantage of ESICApps is its flexibility and adaptability. The study revealed that 41.3% of participants strongly agreed that ESICApps is more adaptable than ESICOMES, while a similar proportion (40.9%) acknowledged its advantage in spatial and GPS data collection. These findings corroborate earlier research by Smith et al. (2019), which found that GIS-integrated environmental monitoring tools improve the accuracy of data collection and decision-making processes. However, despite these advantages, some participants (33.1%) agreed and (22.0%) strongly agreed that the platform does not function properly on some mobile devices. This suggests that technical limitations, such as device compatibility issues, may hinder the full adoption and functionality of ESICApps (Brown & Green, 2021).

The study also highlights ESICApps' role in improving communication and collaboration among EHOs. A majority (62.6%) of respondents indicated that the platform allows for seamless information sharing among officers. This is in line with

research by Anderson et al. (2022), which underscores the importance of digital platforms in enhancing teamwork and coordination in environmental health management. However, challenges such as high data costs and unreliable network connectivity were noted, with 26.4% of participants disagreeing and 18.5% strongly agreeing that acquiring adequate data bundles is a challenge. These findings suggest that while digital tools like ESICApps enhance efficiency, infrastructural challenges such as internet accessibility and affordability must be addressed to optimize their usage (Dube et al., 2020).

Furthermore, system stability remains a concern for some users, as more than half (51.2%) of respondents indicated that ESICApps sometimes crashes or slows down their devices. This issue may be attributed to software glitches or device incompatibility, which has been reported in similar studies on mobile health and environmental monitoring applications (Jones et al., 2021). Addressing these technical concerns through regular software updates and technical support could enhance the reliability and effectiveness of the platform.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of the key findings of the study, which assessed the impact of ESICApps on the efficient and effective monitoring and collection of environmental health data. It highlights major findings related to the functionality, usability, and effectiveness of ESICApps in data collection and management. Additionally, the chapter discusses the study's limitations, draws conclusions based on the findings, and provides recommendations for enhancing the use of ESICApps to improve environmental health monitoring and decision-making.

6.2 Summary of the Key Findings

The majority (56.3%) of participants were aged between 31 and 40 years, with 63.0% being male. Most participants (32.3%) held a diploma, and 36.6% had 5-9 years of work experience. A majority (53.9%) of participants agreed that they could return to their previous task after accidentally leaving the ESICApps platform. Similarly, 47.6% agreed that they could recover previously inputted or uploaded data after an interruption, whereas 29.5% strongly agreed. Most participants (76.0%) found the platform easy to operate and control in the field. Additionally, 43.7% agreed that it did not take them long to understand how to use the platform, while 33.9% strongly agreed. The response time of ESICApps functions was considered reasonably good by 46.5% of participants, with 25.2% strongly agreeing. Furthermore, 40.6% agreed that the platform processed information efficiently, while 31.5% strongly agreed. Most

participants (78.7%) indicated that ESICApps enabled them to accurately perform fieldwork and collect complete data.

A significant association was observed between education level and the perception of ESICApps' accuracy in field data collection ($\chi^2=7.1$, $p=0.034$). Cramer's V indicated a moderate association ($V=0.20$, $p=0.034$). Participants with a certificate qualification were 90% less likely to perceive ESICApps as facilitating accurate fieldwork compared to those with a higher level of education [AOR=0.1 (0.02–0.72), $p=0.019$]. Nearly half (49.2%) of the participants agreed that ESICApps behaves as intended and performs reliably, while 27.6% strongly agreed. A majority (93.7%) felt comfortable using ESICApps for fieldwork, and the same percentage expressed overall satisfaction. Additionally, 37.8% agreed that ESICApps should be implemented in all MMDAs, while 41.3% strongly agreed. Participants with a certificate qualification were 97% less likely to be satisfied with ESICApps compared to those with a postgraduate degree [AOR=0.03 (0.001–0.6), $p=0.023$]. Additionally, assistants were five times more likely to report satisfaction with ESICApps compared to officers [AOR=5.2 (1.01–26.34), $p=0.049$].

Most participants (92.9%) indicated that ESICApps is easier to use for fieldwork than ESICOMES. Regarding efficiency, 40.6% agreed and 42.1% strongly agreed that ESICApps enables them to conduct fieldwork more efficiently. In terms of reliability, 42.9% agreed and 34.3% strongly agreed that ESICApps ensures minimal data loss. Over half (51.2%) agreed that ESICApps sometimes crashes or slows down their phones. Additionally, 51.2% agreed, and 24.8% strongly agreed that ESICApps supports report writing, improving data collection compared to ESICOMES.

6.3 Study Limitation

This study relied on self-reported information from Environmental Health Officers (EHOs), which introduces the possibility of response bias, as participants may overestimate or underestimate the effectiveness and usability of ESICApps. Additionally, some EHOs might have provided socially desirable responses rather than accurate reflections of their experiences. To mitigate this, respondents were assured of confidentiality to encourage honest feedback.

Additionally, while the study provides insights into the efficiency of ESICApps in the Greater Accra Region, the findings may not be fully generalizable to other regions with different infrastructural and technological conditions. The reliance on non-random sampling techniques also limits the external validity of the results. Despite these limitations, the study provides valuable insights into the effectiveness of ESICApps in environmental health data collection. The findings are crucial for policymakers, software developers, and EHOs in enhancing digital tools for improved environmental health monitoring and management.

6.4 Conclusion

The study achieved its objectives by comprehensively assessing the impact of ESICApps on environmental health data monitoring and collection within MMDAs in Ghana.

Objective 1: *To evaluate the performance and reliability of ESICApps in environmental data collection.*

The findings revealed that the majority of Environmental Health Officers (EHOs) found the platform functional, user-friendly, and reliable. Most respondents could efficiently navigate the system, retrieve data, and complete tasks with minimal errors. However, some experienced challenges such as occasional system crashes and slow response times, which affected their workflow. Despite these limitations, ESICApps demonstrated significant potential for improving data accuracy and operational efficiency compared to traditional paper-based methods.

Objective 2: *To assess user satisfaction and usability of the ESICApps platform.*

The level of satisfaction among EHOs was generally high. Most participants expressed comfort with the platform, citing its ease of use, accessibility, and ability to streamline fieldwork processes. Satisfaction levels varied by educational background—officers with higher academic qualifications reported greater confidence in the system, while assistant officers showed higher satisfaction overall, suggesting a need for additional user training among senior staff.

Objective 3: *To examine the advantages and disadvantages of ESICApps compared to ESICOME (paper-based data collection).*

The study highlighted that ESICApps enhanced efficiency, accuracy, and timeliness in report generation, while ESICOME was prone to errors and data loss. However, some users experienced technical issues such as system crashes and device compatibility challenges. Despite these, the overall perception was that ESICApps offers a more reliable and effective data management solution.

Overall Contribution:

The research found that ESICApps significantly contributes to proactive environmental and sanitation management within MMDAs. Its real-time data collection and reporting capabilities enable EHOs to respond promptly to environmental health issues, thereby improving decision-making, monitoring, and policy implementation. The system's adoption across all MMDAs is expected to further strengthen environmental health governance and service delivery in Ghana.

6.5 Recommendations

6.5.1 Ministry of Local Government, Decentralization, and Rural Development

- ❖ Mandate the adoption of ESICApps across all Metropolitan, Municipal, and District Assemblies (MMDAs) to enhance environmental health data collection and decision-making.
- ❖ Allocate funding for regular maintenance, system upgrades, and procurement of necessary devices such as smartphones and tablets for EHOs.
- ❖ Establish a centralized database to integrate data collected via ESICApps, enabling real-time monitoring and policy formulation.

6.5.2 Ghana Health Service (GHS) and Ministry of Health (MoH)

- Integrate ESICApps into the national health surveillance system to strengthen environmental health monitoring and disease prevention efforts.
- Provide continuous capacity-building programs for EHOs on digital data management, ensuring optimal use of ESICApps.
- Collaborate with software developers to enhance the usability and reliability of ESICApps by addressing challenges such as system crashes and data loss.

6.5.3 Environmental Protection Agency (EPA)

- ❖ Utilize data from ESICApps for environmental risk assessment and enforcement of environmental sanitation policies.
- ❖ Develop partnerships with MMDAs to ensure that data collected through ESICApps informs strategic environmental health interventions.
- ❖ Support research initiatives to evaluate the effectiveness of ESICApps in reducing environmental health risks and improving field operations.

6.5.4 Non-Governmental Organizations (NGOs) and Civil Society Groups

- ✓ Support MMDAs with resources such as mobile devices, internet access, and training workshops to improve the adoption and usage of ESICApps.
- ✓ Advocate for policy reforms that prioritize digital tools in environmental health management and sanitation monitoring.
- ✓ Conduct independent assessments on the impact of ESICApps in improving public health outcomes, ensuring accountability and efficiency.

6.5.5 Future Research

- Examine the cost-effectiveness of ESICApps compared to other digital and traditional data collection methods in environmental health monitoring.
- Assess the long-term impact of ESICApps on environmental health interventions, policy implementation, and service delivery at the district and national levels.
- Investigate potential technological improvements, such as AI integration, to enhance ESICApps' predictive capabilities for environmental health management.

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APPENDIX
QUESTIONNAIRE

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND
ENTREPRENEURIAL DEVELOPMENT, ASANTE-MAMPONG

QUESTIONNAIRE

This is a questionnaire for a research intended to evaluate the impact of ESICApps on efficient and effective monitoring and collection of environmental health data in Ghana: a case study of MMDA’s in greater Accra. The study is solely for academic purposes, and will therefore, not be used for any other purpose. Be assured that the confidentiality of the information you provide will be respected.

Serial Number:

SECTION A: SOCIO-DEMOGRAPHIC DATA

SECTION A: BACKGROUND INFORMATION			
Please kindly indicate the best description of you with respect to the following questions.			
SN.	Variable	Category	Tick (√) here
A1	What is your age bracket?	20-30	[1]
		31-40	[2]
		41-50	[3]
		>50	[4]
A2	What is your gender?	Male	[1]
		Female	[2]

A3	What is your highest level of education?	Certificate	[1]
		Diploma	[2]
		First Degree	[3]
		Postgraduate degree	[4]
A4	How many years have you been doing this work?	< 5	[1]
		5-9	[2]
		10-14	[3]
		> 14	[4]
A5	What is your position/rank?	Analyst	[1]
		Officer	[2]
		Assistance	[3]
A6	In what MMDA do you work?	

**SECTION B: EFFECTIVENESS (FUNCTIONALITY AND USABILITY) OF
ESICAPPS (OBJECTIVE 1)**

The table below contains a list of statements that will help me understand the effectiveness of the ESICApps platform in the conduct of the work of EHOs. Kindly indicate in your own view the extent to which you agree to each of the listed statements.

Use the following scale: 1- Strongly Disagree; 2- Disagree; 3- Undecided; 4- Agree; 5- Strongly Agree.

SN	Statement	Scale				
B1	In the event of an interruption or when I accidentally leave the ESICApps platform, I am able to return to the previous task to complete the data input. 2	[1]	[2]	[3]	[4]	[5]
B2	In the event of an interruption or when I accidentally leave the ESICApps platform, I am able to recover data that I had previously inputted or uploaded 2, 3	[1]	[2]	[3]	[4]	[5]
B3	I understand all the essential features and functions on the ESICApps platform. 4	[1]	[2]	[3]	[4]	[5]
B4	It didn't take me a long time or much effort to understand how to use the ESICApps platform on the field 2	[1]	[2]	[3]	[4]	[5]
B5	The ESICApps platform is easy to operate and control on the field. 1	[1]	[2]	[3]	[4]	[5]
B6	The time taken for functions on the ESICApps to respond when clicked on is reasonably good. 2	[1]	[2]	[3]	[4]	[5]
B7	The time taken for the ESICApps platform to process information is reasonably good. 1, 2	[1]	[2]	[3]	[4]	[5]
B8	The ESICApps enables me to accurately perform field work and collect complete data. 2, 3, 4	[1]	[2]	[3]	[4]	[5]

SECTION C: SATISFACTION WITH ESICApps (OBJECTIVE 2)

The table below contains a list of statements that will help me understand your satisfaction with the ESICApps platform in the conduct of your work as EHOs. Kindly indicate in your own view the extent to which you agree to each of the listed statements.

Use the following scale: 1- Strongly Disagree; 2- Disagree; 3- Undecided; 4- Agree; 5- Strongly Agree.

SN	Statement	Scale				
C1	The ESICApps platform behaves as intended and I am confident it will continue performing as intended.	[1]	[2]	[3]	[4]	[5]
C2	The ESICApps user interface is attractive and satisfying to use. 2	[1]	[2]	[3]	[4]	[5]
C3	I am comfortable with the use of ESICApps for field work. 2	[1]	[2]	[3]	[4]	[5]
C4	I am satisfied with the use of ESICApps for field work. 2	[1]	[2]	[3]	[4]	[5]
C5	The ESICApps platform is easy to operate and control on the field. 1, 2	[1]	[2]	[3]	[4]	[5]
C6	I would recommend that the ESICApps is implemented in all MMDAs in the country 4	[1]	[2]	[3]	[4]	[5]
C7	How effective is ESICApps compared to ESICOME 1	[1]	[2]	[3]	[4]	[5]
C8	How would you rate the efficiency of ESICApps in your daily work 1	[1]	[2]	[3]	[4]	[5]

C9	How satisfy are you after using ESICApps? 1, 4	[1]	[2]	[3]	[4]	[5]
C10	What are the advantages of using ESICApps among the EHOs? (select as many). 2, 3	[1]	ESICApps helps to have accurate data for the sector than ESICOME			
		[2]	Data collected with ESICApps is rapidity than ESICOME			
		[3]	ESICApps puts less pressure on the respondents			
		[4]	Repetitive Informations are quickly			

SECTION D: ADVANTAGES OF ESICApps OVER THE PAPER-BASED SYSTEM (OBJECTIVE 3)

The table below contains a list of statements that will help me understand the advantages of the ESICApps platform compared to ESICOMES. Kindly indicate in your own view the extent to which you agree to each of the listed statements.

Use the following scale: 1- Strongly Disagree; 2- Disagree; 3- Undecided; 4- Agree; 5- Strongly Agree.

SN	Statement	Scale				
D1	The ESICApps platform is easy to use for field work compared to the paper-based ESICOMES. 2, 3	[1]	[2]	[3]	[4]	[5]
D2	The ESICApps enables me to do field work with speed/efficiency compared to the paper-based ESICOMES. 1, 2, 4	[1]	[2]	[3]	[4]	[5]
D3	The ESICApps is more flexible to use compared to the paper-based ESICOMES. 2	[1]	[2]	[3]	[4]	[5]
D4	The ESICApps enables EHOs to collect spatial/GPS data as compared to the paper-based ESICOMES 1, 2, 4	[1]	[2]	[3]	[4]	[5]
D5	Is the use of ESICApps effective in your daily work? 1, 4	[1]	[2]	[3]	[4]	[5]
D6	The ESICApps platform for field work is more reliable with minimum potential of data loss compared to the ESICOMES 4	[1]	[2]	[3]	[4]	[5]

D7	The cost of operating the ESICApps platform is minimal compared to the ESICOMES 4	[1]	[2]	[3]	[4]	[5]
D8	Our organisation appreciate the use of ESICApps in report writing. 4	[1]	[2]	[3]	[4]	[5]
D9	How does ESICApps usage improve your data collection than ESICOME? 2, 4	[1]	[2]	[3]	[4]	[5]

SECTION E: CHALLENGES ASSOCIATED WITH THE USE OF ESICApps

The table below contains a list of statements that will help me understand the challenges associated with the use of the ESICApps platform. Kindly indicate in your own view the extent to which you agree to each of the listed statements.

Use the following scale: 1- Strongly Disagree; 2- Disagree; 3- Undecided; 4- Agree; 5- Strongly Agree.

SN	Statement	Scale				
E1	Challenges generating outputs and reports using ESICApps	[1]	[2]	[3]	[4]	[5]
E2	The ESICApps platform does not function properly on some mobile devices. 3	[1]	[2]	[3]	[4]	[5]
E3	The interface of the ESICApps platform is not user friendly 3	[1]	[2]	[3]	[4]	[5]
E4	The ESICApps platform lacks the ability to enable you communicate or share information with other EHOs. 3	[1]	[2]	[3]	[4]	[5]

E5	I sometimes cannot use the ESICApps on the field due to low battery. 1, 4	[1]	[2]	[3]	[4]	[5]
E6	Lack of smart phones to use the ESICApps. 1, 3	[1]	[2]	[3]	[4]	[5]
E7	Find it difficult to get adequate access to data bundles to use the platform. 3	[1]	[2]	[3]	[4]	[5]
E8	The ESICApps sometimes crashes or slows down my phone. 1, 3	[1]	[2]	[3]	[4]	[5]
E9	Poor network connectivity makes it difficult to use the platform sometimes. 1, 3	[1]	[2]	[3]	[4]	[5]
E10	What are some of the challenges faced when using ESICOME? 3	[1]	Lost of accurate data for the sector			
		[2]	Rain destroying the data books			
		[3]	voluminous and error prone paper work			
		[4]	Reviewing the progress of the Environmental sector becomes difficult			

The 24 MMDA's combined have an estimated employee population of five hundred and sixty-three EHOs (563) as at 2024

1. Ablekuma Central Mun. Assembly	21
2. Ablekuma North Mun. Assembly	18
3. Ablekuma West Mun. Assembly	22
4. Accra Metropolitan Assembly	34
5. Adenta Mun. Assembly	26
6. Ashiamu Municipal Assembly	32
7. Ayawaso Central Mun. Assembly	21
8. Ayawaso East Mun. Assembly	20
9. Ayawaso North Mun. Assembly	12
10. Ayawaso West Mun. Assembly	18
11. Ga Central Mun. Assembly	25
12. Ga East Mun. Assembly	28
13. Ga North Mun. Assembly	23
14. Ga South Municipal Assembly	21
15. Ga West Mun. Assembly	25
16. Korle Klottey Mun. Assembly	21
17. Krowor Municipal Assembly	20
18. La Dadekotopong Mun. Assembly	23
19. La Nkwantanang Madina Mun. Assembly..	37
20. Ledzokuku Municipal Assembly	22
21. Okaikwei Mun. Assembly	18
22. Tema Municipal Assembly	28
23. Tema West Municipal Assembly	23
24. Weija Gbawe Municipal Assembly	25
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TOTAL	563
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