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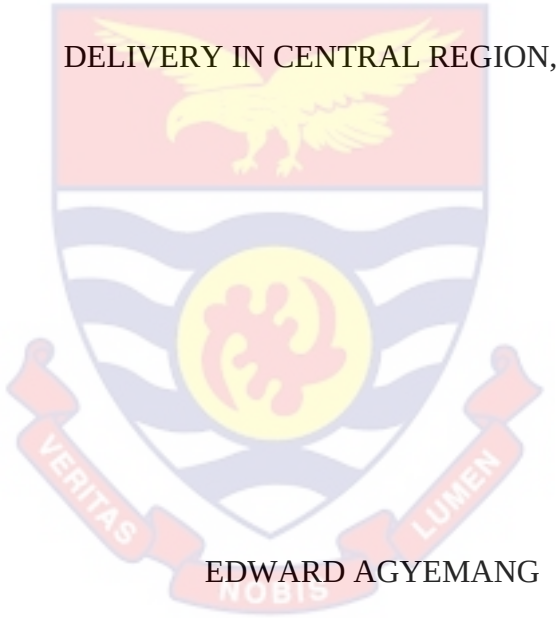
ELECTRONIC HEALTH RECORD SYSTEM FOR HEALTH SERVICE DELIVERY IN CENTRAL REGION, GHANA



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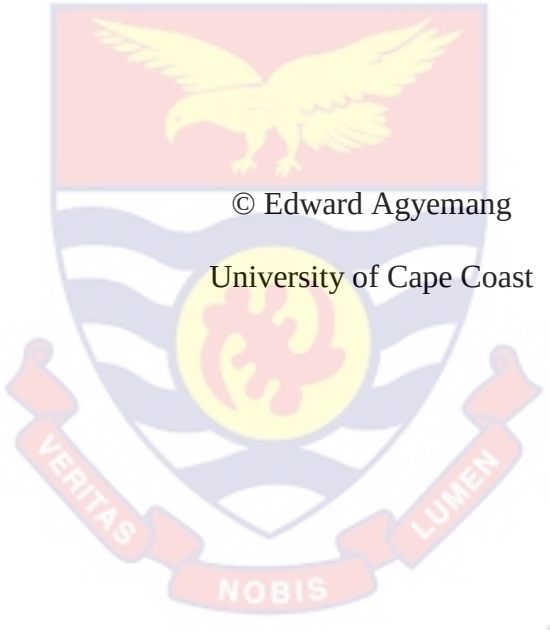

UNIVERSITY OF CAPE COAST

ELECTRONIC HEALTH RECORD SYSTEM FOR HEALTH SERVICE DELIVERY IN CENTRAL REGION, GHANA

BY

EDWARD AGYEMANG

Thesis submitted to the Department of Population and Health of the Faculty of Social Sciences, College of Humanities and Legal Studies, University of Cape Coast, in partial fulfilment of the requirement for the award of a Doctor of Philosophy Degree in Population and Health

MAY 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature……..... Date……..…

Name: Edward Agyemang

Supervisors' Declaration

We hereby declare that the presentation and preparation of the thesis were supervised following the guidelines on supervision of the thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature…… Date…….

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Co-Supervisor's Signature…….. Date…….

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ABSTRACT

This study assesses the Lightwave Hospital Information Management System for health service delivery in the Central Region of Ghana. The Theory of Planned Behaviour, Technology Acceptance Model, and the ISO Usability Framework underpinned the study. The study design adopted was cross-sectional and phenomenology. The survey recruited 1126 health professionals and 30 Unit Heads for the qualitative interviews from 10 healthcare facilities that utilised the LHIMS. Data was analysed using SPSS v26, and Amos v26. Weighted Averages (3.44 – 3.88) indicated that respondents found the LHIMS effective, efficient, and satisfied using the LHIMS for service delivery. Health professionals' satisfaction with the use of the LHIMS was significantly influenced by variables such as work experience (OR=0.563, 95% CI=0.415-0.763), status of training (OR=0.652, 95% CI=0.454-0.937), training duration (OR=0.606, 95% CI=0.416-0.883), and computer proficiency (OR=0.767, 95% CI=0.588-1.00). Structural Equation Modelling showed a significant positive association between satisfaction and efficiency (b=0.120, s.e. =0.030, p=0.000), effectiveness and satisfaction (b=0.254, s.e.=0.031, p=0.000), and effectiveness and efficiency (b=0.118, s.e.=0.034, p=0.001). Also, results from the qualitative revealed technology, technical, and human-related challenges associated with using the LHIMS. Despite these bottlenecks, the study concludes that LHIMS has positively enhanced healthcare delivery in Ghana, particularly improving service efficiency, effectiveness and satisfaction which significantly contributes to progress towards attaining Goal 3 of the SDGs and the Universal Health Coverage (UHC).

KEYWORDS

Efficiency

Effectiveness

Satisfaction

Electronic Health Record System

Lightwave Health Information Management System

Health Service Delivery

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DEDICATION

To my parents and siblings.

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LIST OF ABBREVIATIONS AND ACRONYMS

CAPI	Computer-Assisted Personal Interview
CFA	Confirmatory Factor Analysis
CSUQ	Computer System Usability Questionnaire
EHR	Electronic Health Record
GUI	Graphic User Interface
HITECH	Health Information Technology for Economic and Clinical Health
ICT4AD	Information Communication Technology for Accelerated Development
IPD	In-patient Department
ISO	International Organisation for Standardisation
KMO	Kaiser-Meyer-Olkin
LHIMS	Lightwave Health Information Management System
MOH	Ministry of Health
NHIA	National Health Insurance Authority
MPCU	Model of Personal Computer Utilisation
OPD	Out-patient Department
SDLC	System Development Life Cycle
SEM	Structural Equation Modelling
SUM	Single Usability Metric
SUS	System Usability Scale
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action

TPB	Theory of Planned Behaviour
UX	User Experience
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

Background to the Study

The World Health Organisation (WHO) recognises Health Information Systems as one of the six fundamental components of every health system, as they provide reliable data for decision-making (WHO, 2008; Adler-Milstein et al., 2015). Relatedly, these systems are crucial for achieving Universal Health Coverage (UHC) and the Global Development Agenda, contributing to Sustainable Development Goal 3, which focuses on health and well-being, and Goal 9, which highlights the importance of industry, innovation, and infrastructure (Asi & Williams, 2018; Kruk et al., 2018; Wesonga & Kulohoma, 2020). Consequently, the World Health Organisation (WHO) launched its global digital health strategy for 2020–2025, endorsed by the Seventy-third World Health Assembly under decision WHA73(28) in 2020. The strategy aims to assist countries in developing and strengthening national digital health strategies, addressing resource gaps, and enhancing the global digital health network (WHO, 2020).

In Africa, medical information recording has evolved over the years; from the period of cave recordings, where records were stored on tablets of stone to an age where the paper system was introduced (Christian, 2015). Before the late 20th century, a paper-based record management system was the predominant means of preserving health information and other data (Clarke et al., 2020). Although paper-based records can be adapted to each healthcare provider's needs without requiring any technical changes, the

emergence of the Electronic Health Record (EHR) system has rendered paper-based records less effective in healthcare delivery (Clarke et al., 2020).

Given the limitations of the paper-based approach, electronic health records are currently the preferred option (Azliza bt Nik Ariffin et al., 2018; Clarke et al., 2020; Liao & Lin, 2020). Several African nations, including South Africa, Tanzania, Malawi, and Rwanda, have embarked on the implementation of a National Electronic Health Record (EHR) system. These implementations focused on home-based care, HIV and AIDS care, injury surveillance, tertiary care, and maternal and reproductive health (Jawhari et al., 2016; Katurura & Cilliers, 2018; Kavuma, 2019). The deployment of these EHR systems in parts of Africa has aided medical personnel in gaining access to quality information. It has also increased healthcare quality, work productivity, and patient experiences (Ayers et al., 2009; Nandikove et al., 2018; Waithera et al., 2017)

In Ghana, the Health Sector Information Communication Technology (ICT) Policy and Strategy Charts were published by the Ministry of Communication in 2005. The strategic chart was guided by Ghana's Information Communication Technology for Accelerated Development (ICT4AD) Policy to enhance ICT usage in the health sector and increase healthcare delivery (Ministry of Health, 2005). In response to this, some healthcare facilities established Electronic Medical Record (EMR) systems such as the Hospital Administration Management System (HAMS), and Patient Health Information System (PHIS). Unfortunately, these systems were electronic medical records designed only for solo practice and not electronic

health record systems which support data exchange and interoperability across multiple facilities (Ministry of Health, 2010; Ministry of Health Ghana, 2019).

In 2010, the Ghana Ministry of Health formulated a National eHealth Strategy to facilitate the implementation of a National Electronic Health Record (EHR) system (Ministry of Health, 2010). Subsequently, in 2017, the Ministry initiated the Lightwave Health Information Management System (LHIMS) deployment in Ghana's Central Region as a pilot project. The Lightwave Health Information Management System (LHIMS) is a web-based digital health platform designed to enhance healthcare delivery through efficient data management and communication. Utilising a star topology network, LHIMS operates from a centralised server room with access points at the facilities that are deployed, ensuring robust network connectivity. It also operates on a Virtual Private Network using a Wide Area Network (WAN) to share data across facilities. Key features of LHIMS include an electronic patient record that allows for real-time access and updates of patient records, significantly improving appointment scheduling processes to reduce waiting times.

The LHIMS platform's interoperability facilitates seamless integration with other healthcare systems using a "global search", ensuring continuous data exchange and enhanced care coordination through real-time updates. Additionally, clinical decision support tools, such as automated alert systems for abnormal test results, aid healthcare providers in making informed decisions, while access to clinical guidelines ensures evidence-based care delivery. LHIMS also offers data analytics tools that help in identifying trends and generating customisable reports for various stakeholders, including

healthcare providers and policymakers. Each facility deployed on the LHIMS is equipped with computing devices, including desktops, laptops, Chromebooks, and tablets, which connect via Local Area Network and Wi-Fi access points. Security protocols, including encryption and role-based access control, protect patient data and ensure compliance with health regulations.

According to the Ministry of Health, the implementation of LHIMS yields numerous benefits, such as improved patient care through enhanced data management, increased operational efficiency by streamlining workflows, and enhanced collaboration among healthcare providers through improved communication and data sharing. Also, the LHIMS is expected to expedite admission, discharge, and transfer processes and be incorporated into the National Health Insurance Scheme's claims management system for billing. In light of this digital transformation strategy adopted by the Government of Ghana, it is strongly argued that the LHIMS will aid in improving overall health service delivery in terms of efficiency, effectiveness, as well as satisfaction, and address the challenges that led to the establishment of the LHIMS.

Statement of the Problem

Over the last two decades, the World Health Organisation (WHO) has made substantial efforts to promote the adoption of National Electronic Health Record (EHR) systems for effective healthcare delivery across the globe. The adoption of EHR systems offers significant benefits, including improved efficiency, enhanced patient care and safety, accessibility of information, decision support, cost savings, and patient engagement (Kumar & Mostafa,

2020; Tsai et al., 2020; Salleh et al., 2021). These advantages contribute to more effective and patient-centred healthcare delivery.

However, there are notable limitations in their implementation and usability, particularly in Africa compared to developed countries (Akhlaq et al., 2016; Kumar & Mostafa, 2020). The usability of EHR systems presents significant challenges, which ultimately impact the satisfaction, efficiency, and effectiveness of healthcare providers (Jawhari et al., 2016; Kavuma, 2019). Moreover, inadequate infrastructure, frequent power outages, and network failures further complicate the implementation of EHR systems in the African context (Msiska et al., 2017; Azliza bt Nik Ariffin et al., 2018). These infrastructural constraints hinder the seamless functioning and accessibility of EHR systems, posing additional hurdles to their successful adoption and utilisation (Azliza bt Nik Ariffin et al., 2018).

Although numerous authors have highlighted the advantages of Electronic Health Record (EHR) systems, it is important to note that in Ghana, some health facilities have not been able to fully reap the benefits of these systems (Achampong, 2012; Akhlaq et al., 2015; Kavuma, 2019). This discrepancy can be attributed to various reasons including the type of EMR adopted, as certain EMR applications have gained more recognition than others in Ghana (Akhlaq et al., 2015; Attafuah et al., 2022). Several barriers, such as poor data reporting and usability challenges have negatively impacted the effectiveness of EMRs in Ghana (Achampong, 2012; Akhlaq et al., 2016; Kavuma, 2019; Attafuah et al., 2022). Additionally, the presence of computers and laptops equipped with EMR programmes in healthcare facilities varies depending on the financial capabilities of each healthcare facility.

For that matter, healthcare facilities in Ghana have adopted different EMR systems based on their preferences and financial capabilities (Gyamfi et al., 2017; Shapiro & Kamal, 2022). These factors have contributed to disparities in the utilisation and outcomes of EMRs among different healthcare institutions in Ghana. Again, the information systems used by healthcare facilities in Ghana had a fragmented approach, and the underlying architecture of these systems did not support interoperability and exchange of information (Acquah-Swanzy, 2015). Consequently, healthcare professionals working in one hospital are unable to send or access patient records from other hospitals (Ministry of Health Ghana, 2017). The health sector challenges with EMR are made more difficult by the constant changes to health information systems (Attafuah et al., 2022). Many hospitals have gone through multiple transitions in their health information systems within a short period.

These instances led to the introduction of the Lightwave Health Information System as a National Electronic Health Record system, which was piloted by the Ghana Ministry of Health in the Central Region. According to the literature (Dalky, 2018; Meyerhoefer et al., 2018; Rahal et al., 2019; Williams et al., 2019), when there are changes in the Electronic Health Record (EHR) system, it impacts satisfaction, effectiveness and efficiency and often the challenges associated with transitioning from one EHR vendor to another tend to persist until appropriate interventions are implemented (Coustasse et al., 2018). Also, system usability, which encompasses effectiveness, efficiency and user satisfaction is critically important since it contributes to the success of EHR system implementation (ISO, 2019).

The existing studies (Boadu et al., 2021; Essuman et al., 2020; Yusif et al., 2020) that have evaluated Electronic Health Records focus on pre-implementation issues pertaining to other EMR systems. In contrast, some qualitative studies (Acquah-Swanzy, 2015; Gyamfi et al. 2017) have identified post-implementation issues concerning the HAMS and Open-EMR. However, in the study conducted by Asare et al. (2020) that examined the effectiveness of LHIMS implementation at the Cape Coast Teaching Hospital, other vital usability metrics such as satisfaction and efficiency (as defined by ISO, 2019), and challenges were not considered, despite their significance in determining the overall success of implementation. Another study by Joo (2010) assessed the interdependency of these three usability metrics, but it focused on a Library Information System rather than LHIMS. As a result, there exists a gap in the literature when it comes to investigating the interdependency among usability constructs specifically within the context of LHIMS and further research is needed to bridge this gap.

Additionally, Electronic Health Record (EHR) systems are continuously growing and incorporating new functionalities through system updates. In light of this, it becomes essential to assess the impact of these advancements, particularly in the context of the LHIMS platform. While other Electronic Health Record Systems (EHRs) are implemented in various countries, the LHIMS piloted by the Ministry of Health stands out as Ghana's first National Electronic Health Record System, introduced by the Ministry of Health (Ministry of Health Ghana, 2017). Lastly, although 21 health facilities were deployed during the pilot phase, some facilities have discontinued the use of LHIMS. This raises concerns about the need to understand the

utilisation of LHIMS for health service delivery in the Central Region, making it essential, critical, and timely. This study therefore sought to assess the effectiveness, efficiency and satisfaction in the use of LHIMS among healthcare professionals. It also investigated challenges encountered by the healthcare professional in their attempt to use the LHIMS for healthcare delivery.

Questions which therefore arise are: to what extent do health professionals perceive the LHIMS as an efficient tool for enhancing health service delivery, and in what specific areas has it demonstrated the most significant impact? how satisfied are healthcare providers with the overall experience of using LHIMS in their day-to-day operations, and what key factors contribute to their satisfaction? How effective has the implementation of LHIMS been in improving the quality and timeliness of healthcare services, and what measurable outcomes have been observed since its adoption? What are the challenges and limitations health professionals face when utilising LHIMS for service delivery, and how do these obstacles affect its overall functionality and success?

Objectives of the Study

The main objective of the study was to assess the Lightwave Health Information Management System (LHIMS) for health service delivery in the Central Region of Ghana. Specifically, the study sought to

1. examine health professionals' efficient use of the LHIMS for health service delivery;
2. analyse health professional's satisfaction with the use of LHIMS;

3. determine the effectiveness of the use of LHIMS by health professionals;
4. test the interdependency among satisfaction, efficiency, and effective use of the LHIMS;
5. explore the challenges associated with the use of the LHIMS for service delivery.

Hypothesis

The expectation is that Electronic Health Record (EHR) systems contribute to the improvement of health service delivery. According to Job et al., (2013), the Elektronische DateneRfassung (EdeR) software was found to enhance efficiency by reducing the time spent on accessing patient history and relevant examination results. However, earlier contrasting findings (Menachemi & Collum, 2011) suggest that EHR systems could lead to workflow disruptions and temporary productivity losses. Given the divergent results from these studies, for example, further research is necessary to assess whether the Lightwave Health Information Management System (LHIMS) enhances efficiency in service delivery in Ghana.

In addition to the disparities observed in the outcomes of some studies, the International Organisation for Standardisation (2019) identifies three primary dimensions that predict Electronic Health Record (EHR) usability. These dimensions include effectiveness, efficiency, and satisfaction. Williams et al. (2019) proposed a hypothesis that links efficiency with user satisfaction in the context of EHR systems. Additionally, Copley et al. (2019) found significant variations in workflow efficiency and satisfaction among pediatric orthopaedic surgeons when using EHR. Socio-demographic variables are

considered highly significant in the utilisation of EHR, as highlighted by Bae & Encinosa (2016). Similarly, according to Al-Rayes et al. (2019) medical specialisation, age, and work experience have a significant impact on medical physicians' utilisation of the EHR system.

Contrarily, Shanafelt et al. (2016) put forward the hypothesis that healthcare workers, particularly medical doctors, generally experience dissatisfaction with the use of Electronic Health Records (EHR). However, in Ghana, the Lightwave Health Information Management System (LHIMS) is utilised by various healthcare professionals, including laboratory technicians, health information officers, and nurses/midwives, in addition to medical doctors. Therefore, it is crucial to examine how different professional groups utilise LHIMS and understand the interplay among the three dimensions of usability. In line with this, the study proposed the following hypotheses:

1. Socio-demographic factors (age, sex, education, and work experience), professional characteristics (profession type and training institution), and computer proficiency (training and computing skills) significantly influence the efficient use of LHIMS.
2. Socio-demographic factors, professional characteristics, and computer proficiency significantly influence health professionals' satisfaction with using LHIMS.
3. Socio-demographic factors, professional characteristics, and computer proficiency significantly influence the effective use of LHIMS for health service delivery.
4. The three EHR usability metrics (effectiveness, efficiency, and satisfaction) are interdependent.

Significance of the Study

This research focused on assessing the usability of the Lightwave Health Information Management System (LHIMS). The study investigated the system's efficiency, effectiveness, user satisfaction, and challenges. The findings are relevant to the Ministry of Health and the Ghana Health Service. The study provided valuable insights that could inform policy decisions. Consequently, the study's outcomes would aid the Ministry of Health and its affiliated agencies that utilise the LHIMS, in developing suitable strategies to enhance user experience when interacting with the LHIMS to deliver health services in Ghana.

The findings of this study hold practical value for clinicians and other healthcare staff, offering insights into the factors influencing the utilisation of the LHIMS across different levels of care. By understanding these factors, healthcare professionals can enhance their proficiency and optimise their utilisation of the LHIMS. This, in turn, could increase outpatient numbers reduce patient waiting times, and improve overall healthcare services. Furthermore, this study contributed to the existing body of knowledge in the field, particularly regarding LHIMS usability in Ghana. As there is limited literature available on this topic, the research material generated by this study can be consulted as a resource for literature reviews by individuals interested in studying the Lightwave Health Information Management System (LHIMS) in Ghana in particular.

The Organisation of the Study

The study is organised into ten chapters. Chapter one serves as an introduction to the study, providing information about the background,

problem statement, objectives, research hypothesis, significance, and organisation of the study. Chapter two delves into the conceptual and theoretical underpinnings of Electronic Health Records (EHR) systems. It explores various relevant concepts and theories that provide a foundation for understanding the effectiveness, efficiency, and satisfaction aspects of EHRs. Additionally, the chapter introduces the Lightwave Health Information Management System (LHIMS) as a subject for analysis.

Chapter three presents an empirical literature review focused on Electronic Health Record (EHR) systems. It synthesises existing research and studies related to the efficient, effective, and satisfactory use of EHR systems. Additionally, the interdependencies among effectiveness, efficiency, and satisfaction in the context of EHRs are analysed. The Chapter provides valuable insights into the challenges associated with EHR system adoption and usage. Chapter four presents the methodology employed in the research study. It outlines the research philosophy, study design, data sources, study population, sampling methods, data collection instruments, ethical considerations, data processing, and analytic techniques used. The chapter provides a comprehensive understanding of how the study was conducted and how the data were collected and analysed.

Chapter five focuses on the assessment of the efficient utilisation of the LHIMS in the context of health service delivery by health professionals. Chapter six is dedicated to the in-depth analysis of health professionals' satisfaction regarding the utilisation of the LHIMS for health service delivery. Chapter seven deals with issues relating to the effective use of the LHIMS for health service delivery by health professionals. Chapter eight discusses the

interdependency among effectiveness, satisfaction, and efficient use of the LHIMS by health professionals. Chapter nine focuses on exploring and analysing the challenges associated with the use of the LHIMS for health service delivery. Chapter ten provides a comprehensive summary, conclusion, and set of recommendations based on the findings and analysis conducted throughout the study.

CHAPTER TWO

CONCEPTUAL AND THEORETICAL PERSPECTIVES ON ELECTRONIC HEALTH RECORDS SYSTEM

Introduction

Numerous theories and models have been put forth in both technological and medical literature to elucidate the role of technology in the provision of healthcare services. This chapter provides an overview of relevant literature that explores concepts, theoretical perspectives, and frameworks on Electronic Health Record (EHR) systems in the context of health service delivery. The concepts reviewed are effectiveness, efficiency, and satisfaction. The theoretical perspective discussed comprises the Theory of Planned Behaviour and the Technology Acceptance Model. The International Organisation for Standardisation (ISO) 9241-11 Framework for Usability was reviewed.

Conceptual Issues

The following section entails a discussion of concepts that are critically relevant to the study. The concepts under discussion include effectiveness, efficiency, and satisfaction. These concepts clarify and define the scope of the research. They provide the framework for comprehending the study topic, research design, data gathering, analysis, and interpretation of study findings (Frith, 2019).

Effectiveness

Effectiveness, as a concept, denotes creativity and productivity (Harper, 2011), and it finds application in various fields, including

management and health (Salleh et al., 2021). In the field of human-to-computer interaction, effectiveness is defined by the accuracy and completeness of users' tasks while utilising a system (ISO, 1998). Indicators proposed for assessing effectiveness encompass work domain saturation, task completion, accuracy, decision-making, and outcome quality (Parveen, 2018; Frith, 2019; International Organisation for Standardisation, 2019). Conceptualising effectiveness involves considering indicators such as work domain saturation, data gathering, data sharing within a facility, alerts on errors, enhanced decision-making, better care coordination, improved job performance, and enhanced continuity of care (ISO, 2019).

Effectively utilising an EHR system has profound implications for healthcare delivery. The system's proficiency in data gathering ensures timely and thorough patient information collection, forming the basis for a comprehensive and accurate health record. Seamless data sharing within a facility promotes secure exchange among healthcare providers, fostering collaboration and informed decision-making. Real-time alerts on errors act as a crucial safeguard, swiftly identifying and rectifying discrepancies, upholding data integrity, and ensuring patient safety. The EHR system empowers enhanced decision-making by providing healthcare professionals with robust and up-to-date patient information.

Furthermore, the system contributes to better care coordination, streamlining communication and fostering a cohesive approach that improves overall treatment outcomes. It also enhances job performance by boosting efficiency and accuracy in tasks, thereby increasing productivity. Ensuring

enhanced continuity of care, the EHR system provides uninterrupted access to patient records across settings, facilitating a seamless flow of information for consistent and coordinated care, and ultimately elevating healthcare standards. The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, enacted in the US, proposes three-staged criteria for assessing EHR effectiveness (Yuan et al., 2019). These stages involve the use of a certified electronic health record system for data collection, gathering, and sharing; the application of a certified electronic health record to advance clinical practices and improve care coordination, and lastly, the use of a certified electronic health record to achieve better health outcomes through decision-making.

Efficiency

Efficiency is the ability to avoid wasting materials, energy, money, efforts and time whilst doing something or producing a desired result (Conrad, 1983). In broader terms, efficiency is said to be the peak level of performance that uses the least number of inputs to achieve the highest amount of output (Banton, 2019). Within the healthcare domain, efficiency is described by Menachemi and Collum (2011) as the avoidance of wasting healthcare resources, which encompasses medical supplies, tools and equipment, ideas, and human resources. The International Organisation for Standardisation (ISO) (2019) recognises efficiency as a vital dimension of usability, wherein it pertains to the resources employed in achieving system assessment results. Typical resources include time, human labour, expenses, and materials (ISO, 2019).

Efficiency is evaluated through various metrics such as specified tasks, the number of trials for completion, and time spent on the task. Input rate, usage patterns, and error prevention are also utilised to assess Electronic Health Record (EHR) efficiency (Calder-Sprackman et al., 2021). In the evaluation of the Lightwave Health Information Management System (LHIMS), efficiency is conceptualised based on indicators including quick task execution, reduced mental effort, learnability, familiarity, reduced documentation time, simplicity, easy mistake recovery, timely handling of patient treatment/services, and reduced waiting time.

In the field of health informatics, Frith (2019) argue that efficiency measures should focus on assessing the ease of learning and using health IT, as user-friendly Electronic Health Record (EHR) systems contribute to more efficient operations. Additionally, the ability to recall or be familiar with a system's interface, enabling users to quickly locate system items and key functionalities without third-party assistance, is considered a crucial efficiency measure (Scott et al., 2016).

Satisfaction

Satisfaction is an intangible, elusive and multifaceted concept with numerous meanings and applications (Wahyudi et al., 2017). It is widely applied in various fields, including computer science, sociology, psychology, marketing, and entertainment, among others (Aimee, 2019). According to the International Organisation for Standardisation (2019), satisfaction is the degree to which a user's physical, cognitive, and emotional responses align with their needs and expectations when using a system, product, or service.

Thus, satisfaction involves the utilisation of various indicators (Kimman et al., 2017). Measurement of satisfaction encompasses indicators such as user preferences for system features and functions (Copley et al., 2019).

Additionally, feedback on content, features, outcomes, or software interactions, along with an overall experience rating on practice workflow and speed, are taken into account (FrØkjaer et al., 2000; Daniel & Berinyuy, 2010; Copley et al., 2019). In this study, satisfaction is further refined through specific indicators, including system usefulness, information relevance, accuracy, ease of information retrieval, interface quality, consistency, clarity of screen items (font size), flexibility, speed, and reliability (Frith, 2019; ISO, 2019; Lewis, 1995). Designing useful systems has been a primary goal of user-centred design and is a key measure of satisfaction. Information usefulness pertains to the relevance and suitability of information generated by the LHIMS for its intended purpose. Simplicity in retrieving information refers to users' ability to access required information without assistance, with an expectation of accuracy reflecting real-world situations.

Interactive software, including LHIMS, requires user/system interfaces that are useful, intuitive, and consistent, featuring clear and adjustable font sizes. The industry standard emphasises intuitive interaction through graphical icons, enhancing usability and user satisfaction. System flexibility involves adapting to potential changes, allowing users to customise the interface to meet specific needs. Speed is crucial in Electronic Health Record (EHR) systems, as prolonged response times can lead to dissatisfaction and reduced productivity. System reliability assesses the likelihood of the LHIMS

functioning properly over time without requiring maintenance, ensuring smooth and intended operation (Khairat et al., 2020).

Theoretical Perspectives and Models

Theories have become important elements of social science research in recent times. They are collections of ideas, definitions, and propositions that explain or forecast certain occurrences or circumstances by exhibiting changeable connections (Kivunja, 2018). The theory of Planned Behaviour, the Technology Acceptance Model and the International Organisation for Standardisation Framework were reviewed.

Theory of Planned Behaviour

The theoretical underpinning of the electronic health record system, including the Lightwave Health Information Management System (LHIMS), is rooted in the Theory of Planned Behaviour (TPB). The theory of planned behaviour (Ajzen, 1985, 1991) is an extension of the theory of reasoned action (TRA) introduced by Fishbein and Ajzen (1975). The Theory of Reasoned Action (TRA) suggests that attitudes and subjective norms influence individuals' intentions to perform a behavior, and these intentions are correlated with actual behavior. While the TRA is effective at predicting volitional behaviors, it struggles with behaviors not fully under an individual's control, such as exercising despite high motivation but being hindered by environmental factors like lack of facilities or equipment. This limitation may arise from the multiple factors influencing intention, which complicate the prediction of behavior.

The later addition of perceived behavioural control to the TRA has helped to account for additional variance in predicting behavioural intentions and behaviours and has extended the theory to successfully explain actions or behaviours that are not completely under individuals' volitional control (Ajzen, 1991). PBC is a construct describing how easy or difficult the performance of the behaviour is (Ajzen, 1991). Perceived behavioural control is related to Bandura (1977) self-efficacy concept, which refers to perceptions of personal ability, but also comprises an external component, which refers to perceptions of control over environmental constraints (perceived control) (Conner & Armitage, 2018; Terry & O'Leary, 1995).

According to TPB, attitudes toward and intentions to perform a task are influenced by behavioural beliefs and normative concepts (Ajzen & Madden, 1986). Behavioural beliefs refer to an individual's beliefs about the outcomes of a behaviour, while normative beliefs involve perceptions of whether significant others expect or approve of the behaviour (Murdaugh et al., 2018). Attitudes, subjective norms, and internal factors collectively shape the theory, and attitudes and subjective norms are key determinants of behaviour. In the context of the study assessing LHIMS for health service delivery in Ghana's Central Region, attitudes toward LHIMS, subjective norms (including opinions of others and the availability of technology infrastructure), and perceived ease of use will influence behaviour and system usage.

Positive views and ease of use perceptions are likely to promote the adoption of the EHRS, thereby impacting health service delivery in the region.

Despite the utility of TPB, the study is not significantly affected by its potential gaps. The Technology Acceptance Model (TAM), developed by Davis (1989), emerged as an extension of TPB to address some of its limitations. The technology Acceptance Model specifically focuses on the adoption of technology and incorporates perceived ease of use and perceived usefulness as key determinants of user acceptance. Therefore, the study's emphasis on perceived ease of use aligns with the TAM, ensuring a more comprehensive understanding of electronic health record system adoption within the healthcare context in Ghana.

Depending on the target behaviour, environment, population, attitudes and subjective norms predict behaviour differently. Attitudes and subjective norms predict action more than objective norms (Murdaugh, Parsons & Pender, 2018). Reasoned action assumes that attitudes and subjective standards can be changed with enough effort. Healthcare professionals' initiatives that target outcomes and subjective norms can alter outcome values. Patients' views of normative expectations from others and their desire to conform may also be influenced by healthcare providers (Murdaugh, Parsons & Pender, 2018).

The main critique of the TPB is that some of the theory's propositions are patently false. In particular, the mediation assumptions in the TPB conflict with evidence. Also, others argue that TPB may not account for actions that require specific opportunities, abilities, circumstances, or resources. Additionally, attitudes and behaviour may not always be directly linked, especially when the activity requires little mental effort (Afarikumah, 2014).

In the context of the study, assessing the LHIMS for health service delivery in Ghana's Central Region. Their attitudes towards the LHIMS and subjective norms, including the opinions of others and the availability of adequate technology infrastructure, will influence their behaviour and usage of the system. Positive views and perceived ease of use will promote the adoption of the EHRS, ultimately impacting health service delivery in the region.

Technology Acceptance Model/Theory

The Technology Acceptance Model (TAM) is one of the models that underpins the use of EHR. The TAM is a popular paradigm for understanding how people accept and use technology (Kalayou et al., 2020). It was developed by Davis in 1989 to model computer-acceptance behaviour among individuals in the United States of America (Nandikove et al., 2018). The TAM is an adaption of Ajzen and Fishbein's (1980) Theory of Planned Behaviour. The Technology Acceptance Model is composed of three major elements that drive user motivation. These are perceived usefulness (PU), perceived ease of use (PEU), and technological attitudes (Sadoughi et al., 2019). Two of these components, perceived usefulness and perceived ease of use, are regarded as the primary determinants that directly or indirectly determine behavioural intentions to use or embrace new technology (Anastasiou et al., 2014; Becker, 2016; Kivunja, 2018).

External variables such as a person's age, sex, educational level, training, financial support, motivation, leadership, legalities, and intended use in the TAM influence a person's desire to use health information systems (Jeyakodi & Herath, 2016). External influences have an impact on perceived

ease of use (E) and perceived usefulness (U). Perceived ease of use and perceived usefulness have an impact on a person's attitude towards use (A). The behavioural intention to utilise the actual system (EHR) is influenced by the attitude towards use (A) (Granic & Marangunic, 2019).

Davis (1989) posits that perceived usefulness (U) is the degree to which a person believes that using a certain system will improve his or her job performance. It reveals whether a piece of technology is appropriate for the task at hand. The degree to which a person believes that using a certain technology will be simple is referred to as perceived ease of use (Al-Rayes et al., 2019). Obstacles can be overcome if the technology is user-friendly. A complex interface discourages use. Social influences also shape attitudes, and perceptions of usability may vary by age and gender.

In clinical settings, TAM has frequently been used to evaluate the utilisation of hospital information systems (Melas et al., 2011). A study by Abdekhoda et al. (2016) among physicians in Iran used the TAM to predict the use of electronic medical records and found a positive and significant correlation between EMR use and perceived usefulness as well as perceived ease of use. Also, in a study in Taiwan by Liu and Cheng (2015), the TAM model was used to investigate the critical factors influencing physicians' acceptance of mobile EHR using a dual-factor model. The study found that perceived threat significantly impacted physicians' perceptions of usefulness and their intention to use. It also confirmed that perceived ease of use and perceived usefulness were significant enablers. Additionally, perceived

mobility significantly influenced perceived ease of use, perceived usefulness, and perceived threat.

Several studies have expressed inadequacies/weaknesses of TAM to address the nexus between technology and the actual adoption and use of technology. Findings showed weaknesses of TAM in explaining users' behaviour (Lim et al., 2016; Ajibade, 2019). It was further argued that the TAM model could not sufficiently predict the acceptance of information communication technology (ICT) while another model was solicited to predict the acceptance of technology (Hojjati & Khodakarami, 2016). Evidence from the literature indicated that the TAM is not able to provide comprehensive precursors to mobile use, or social influence and conditions that facilitate behaviour (Napitupulu, 2017; Torres, & Gerhart, 2017).

Further argument indicated that, although many studies have increased the popularity of the TAM model, Chandio et al. indicated that this model is insufficient to explain users' adoption and use of new technology especially in the context of e-government (Chandio, Burfat, Abro, & Naqvi, 2017). Furthermore, one of the arguments and criticisms of the TAM model is the notion that the model could explain individual behaviour. However, it was reported that the Technology Acceptance Model is not robust enough to explain user's behaviour about buying, rejecting or accepting to use technology (Hai & Alam Kazmi, 2015). A study found that while perceived usefulness is a key predictor in the TAM model, this is not always the case, particularly with entertainment technologies like online games. In such cases, users typically engage to relax or "kill time," meaning the perceived

usefulness does not influence their use. Instead, the focus is on leisure and relaxation (Hsu & Lu 2004).

In this current study, the TAM was adapted to examine the influence of socio-demographic characteristics such as age, sex, years of work experience and health professional's category on the use of the LHIMS. The model's weakness is that behavioural intention is subjective and thus best assessed qualitatively. Once again, the model is limited to individual use of an IT system rather than organisational (Nandikove et al., 2018). However, this limitation does not affect the study since the research adapts only external variables and perceived ease of use to explain socio-demographic characteristics and challenges associated with the use of LHIMS respectively.

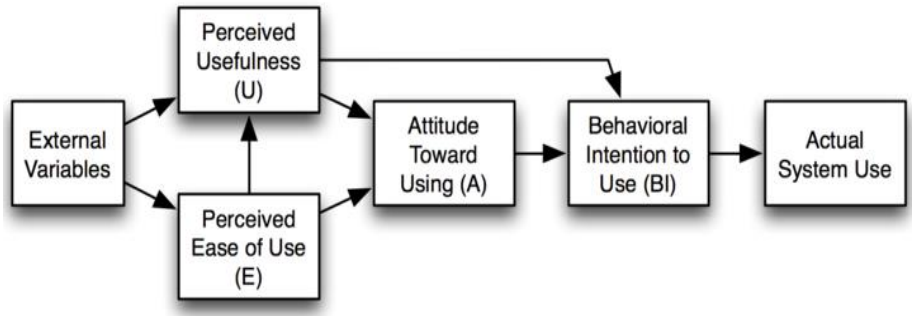

Figure 1: Technology Acceptance Model
Source: Davis (1989)

International Organisation for Standardisation 9241-11 Usability Evaluation Framework

For more than three decades, the concept of usability has been reflected in many software engineering quality models. McCall first characterised usability in 1977, when he incorporated it into the traditional

quality frameworks. McCall's approach to usability divides it into three categories: operability, training, and efficacy. Nunnally and Bernstein (1994) described software usability as an indirect concept, inferred from observable measures such as perceived effectiveness, user satisfaction, and performance. In addition to standards like ISO and frameworks by Nielsen & Molich (1990), Kirukowski & Corbett (1993), and Seffah et al. (2006), other usability measurement frameworks (FrØkjaer et al., 2000; Coursaris, 2004; Sockolow et al., 2015) have been developed. However, the ISO framework, which focuses on efficiency, effectiveness, and satisfaction, remains one of the most widely adopted models for measuring usability (Oliveira et al., 2013; Moumane et al., 2016; Montazeri et al., 2020).

In this study, the International Organisations for Standardisation (ISO) 9241-11 Framework for usability is adapted to examine the use of the LHIMS by health professionals in the context of the Ghanaian health care system. The International Organisation for Standardisation established in 1947 and is based in Geneva is a non-governmental international organisation comprised of national standard bodies that develop and publish a diverse range of proprietary, industrial, and commercial standards (Kenton, 2020). The ISO 9241-11 framework was developed by this organisation. ISO 9241-11 establishes the framework for comprehending and applying the concept of usability to situations in which people operate with interactive systems. It assesses the quality of a user's interaction with a product or system, whether that product or system is a website, a software program, mobile technology, or any other user-operated device (ISO, 1998, 2019).

ISO 9241-11 outlines four key components that impact a product's usability: users, tasks, equipment (hardware, software, materials), and physical and organisational environments. Usability is assessed based on three metrics: effectiveness, efficiency, and satisfaction. There are no universal rules for selecting or combining these measures, as their importance varies depending on context and purpose. The chosen measures and their detail should align with the objectives of the stakeholders involved. Effectiveness measures relate to how well user goals are achieved, while efficiency connects effectiveness to the resources expended, including mental effort, time, materials, and costsFurthermore, satisfaction assesses how satisfied users are with the product and their attitudes towards its use (ISO, 1998).

Authors advocate for more widespread use of International Organisation for Standardisation (ISO) guidelines and techniques to guide usability evaluations (Svanæs et al., 2008; Bevan, 2009). As such, Joo (2010) assessed the relationships among efficiency, effectiveness, and satisfaction using graduate students who searched for resources on the Yonsei University Digital Library. The study used ISO 9241-11 to operationalise the effectiveness, efficiency, and satisfaction. From the findings, all three usability elements (effectiveness, efficiency, and satisfaction) were highly correlated with one another. The correlation between effectiveness and satisfaction was much stronger than the other parts of the correlation. Also, Montazeri et al. (2020) in a cross-sectional study, evaluated the Health Information System (HIS) installed in hospitals affiliated with the Kerman University of Medical Sciences.

The study focused on the presentation of information on the Health Information System's user interface based on ISO 9241 recommendations. It emerged from the study that, the information presented in the user interfaces of Hospital Information Systems was relatively satisfactory.

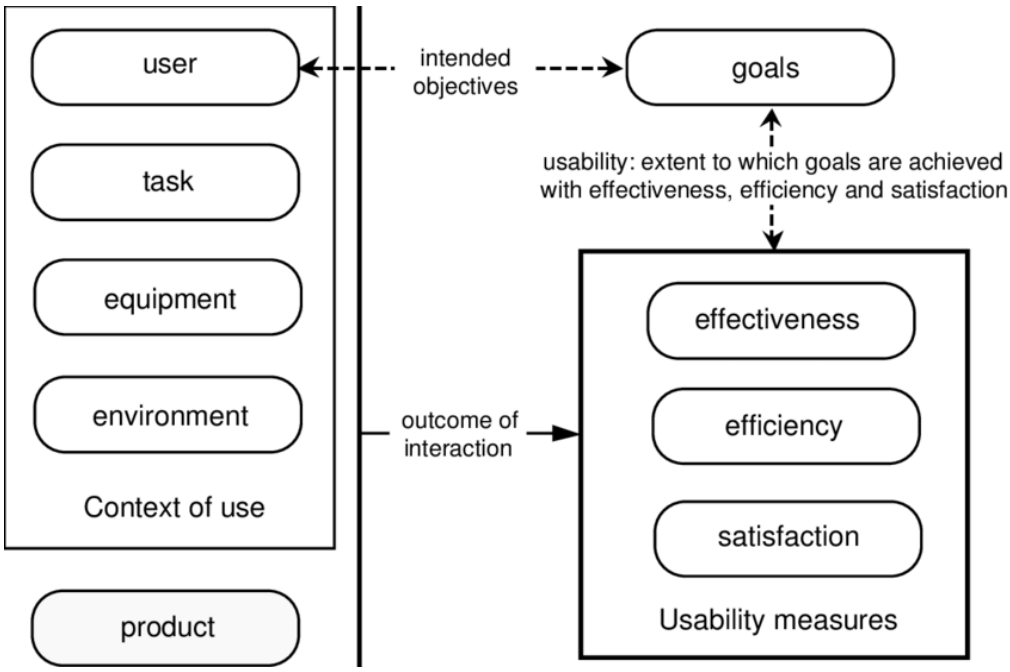

Figure 2: Usability Evaluation Framework of International Organisation for Standardisation 9241-11
Source: International Organisation for Standardisation (1998)

To obtain a more complete picture of an application's usability, researchers are recommended by FrØkjaer et al. (2000) and Georgsson and Staggers (2016) to assess the full set of recommended measures on effectiveness, efficiency, and satisfaction by ISO. In that vein, this study adapts these 3 domains of usability from the ISO 9241-11 framework and techniques together with the theories to assess health professional's satisfaction with the LHIMS, analyse the efficient use of the LHIMS, measure the effective use of LHIMS and the influence of

external factors (socio-demographic characteristics, professional characteristics and training/general computing skill) on the use of LHIMS for health service delivery, by health professionals, in health facilities, in the Central Region.

CHAPTER THREE

ELECTRONIC HEALTH RECORD SYSTEMS FOR HEALTH SERVICE DELIVERY

Introduction

This chapter provides a comprehensive review of the empirical literature concerning Electronic Health Record (EHR) systems and their impact on health service delivery. The analysis is centred around several key dimensions, beginning with an examination of the efficiency of EHR implementation. This encompasses studies evaluating the speed, accuracy, and overall operational efficiency of health service delivery facilitated by EHR systems. Additionally, the chapter explores user satisfaction with the adoption and utilisation of EHR, considering the perspectives of healthcare professionals and end-users to gauge the system's user-friendliness, accessibility, and overall satisfaction levels.

The discussion further delves into the effective use of EHR, examining how well healthcare providers leverage these systems to enhance patient care, streamline processes, and improve overall healthcare outcomes. Furthermore, the interdependency among efficiency, effectiveness, and satisfaction in the context of EHR is scrutinised to understand the intricate relationships and potential synergies between these critical factors. The chapter also critically addresses the challenges associated with the use of EHR for health service delivery. By synthesising existing literature, it explores common obstacles and impediments faced during EHR implementation, ranging from technical issues to user resistance and data security concerns.

Efficient Use of Electronic Health Record System

In the fast-paced world of modern medicine, technology has played a pivotal role in reshaping healthcare practices globally. One such advancement that has gained widespread recognition is the shift from paper records to the implementation of Electronic Health Records (EHRs) (Chen, Guo & Tan, 2019). The transition from traditional paper-based records to digital systems has been praised for its ability to enhance efficiency, as evidenced by studies conducted by Alanazi, Butler-Henderson, Alanazi (2020), and Wachter (2016). Their study suggests that the implementation of Electronic Health Record (EHR) systems has brought about greater convenience for healthcare providers in managing patient charts compared to the conventional paper-based method, which was often time-consuming, and prone to misinterpretations and errors leading to inefficiencies (Alanazi, Butler-Henderson, & Alanazi, 2020; Wachter, 2016).

The implementation of Electronic Health Records (EHR) has led to significant efficiency improvements in healthcare practices. Clinicians have reported enhanced work efficiency through the utilisation of frequently used EHR functions (Smith et al., 2020). Furthermore, the adoption of EHRs has resulted in improved workflow efficiency and reduced turnaround times in laboratories, eliminating previously time-consuming tasks associated with paper-based record systems (Jones et al., 2018; Patel et al., 2019). Notably, specialist physicians' time spent with each patient remained unchanged post-EHR implementation (Brown et al., 2017), while nurses experienced a substantial decrease in administrative task time (Garcia et al., 2021).

Clinicians and staff have also noted enhanced efficiency through faster information retrieval within EHRs and reduced documentation time, facilitated using EHR templates (Johnson et al., 2019; White et al., 2018). Studies analysing EHR usage data indicated that clinicians completed their notes sooner post-EHR implementation compared to the pre-EHR period (Adams et al., 2020), and there was a decreasing trend in the proportion of clinicians agreeing that EHRs prolonged patient visits (Taylor et al., 2016). Overall, nurses have expressed positive perceptions regarding the use, system quality, and satisfaction with EHRs (Clarke et al., 2020).

Stoumpos et al. (2023) highlighted several benefits of EHRs, emphasising their role as digital archives storing patient records, which enhances the efficiency of healthcare management by providing centralised access to authorised personnel. In another study, Kruse, Stein, Thomas, and Kaur (2018) demonstrated a marked improvement in overall healthcare outcomes resulting from EHR adoption, attributing efficient utilisation of EHR systems to factors such as usability, user-friendliness, and seamless technology integration into healthcare workflows. They emphasised that user-friendly EHR systems contribute to enhanced efficiency, accessibility, accuracy, documentation, interoperability, data analytics, patient engagement, and cost savings within healthcare settings.

Despite the advantages linked to Electronic Health Records (EHR) implementation, notable concerns arise regarding specific inefficiencies, especially prevalent in Africa. These inefficiencies entail delays in data entry and inaccuracies in input by healthcare practitioners, thereby impacting the efficiency and utility of EHR systems (Odekunle et al., 2018). Studies and

theories have pinpointed reasons for these inefficiencies, indicating that socio-demographic characteristics of health professionals such as age, sex, educational qualification, and professional type can influence the effective use of EHR systems (Davis, 1989; Khairat et al., 2019).

Khairat et al. (2019) found that female doctors were more efficient with EHRs and experienced less stress compared to male doctors, challenging the stereotype that men are better at using technology (Fischer et al., 2018). This aligns with the Technology Acceptance Model (TAM), which suggests that perceived usefulness (PU), perceived ease of use (PEU), and technological attitudes are key drivers of user motivation (Anastasiou et al., 2014; Becker, 2016; Kivunja, 2018). Perceived usefulness and ease of use are primary factors that influence the intent to adopt new technology (Anastasiou et al., 2014; Becker, 2016; Kivunja, 2018).

Beyond the Technology Acceptance Model (TAM), empirical evidence from the literature (Katurura & Cilliers, 2018; Odekunle et al., 2018; Africa Centres for Disease Control and Prevention, 2020) underscores specific challenges faced by healthcare practitioners in Sub-Saharan Africa regarding Electronic Health Record (EHR) adoption. These challenges include limited access to technological infrastructure, inadequate training resources, and concerns regarding data security and privacy, all of which hinder the efficient utilisation of electronic health record systems.

In Ghana, the efficient use of Electronic Health Record (EHR) systems is a growing area of interest as the country strives to modernise its healthcare infrastructure and improve patient care delivery. A study by Achampong (2022) revealed that healthcare professionals in Ghana view EHR

systems positively. However, the realisation of these benefits faces significant obstacles within Ghanaian healthcare facilities, particularly limited technology accessibility, impeding widespread adoption and effective integration of EHR systems. Insufficient infrastructure and resources further hinder the seamless incorporation of electronic systems into the healthcare workflow.

Previous research (Boadu et al., 2021; Essuman et al., 2020; Gyamfi et al., 2017) has primarily focused on pre-adoption and readiness aspects. While a few studies (Achampong, 2012; Akhlaq et al., 2016; Tekelab et al., 2019) have conducted systematic reviews but did not specifically examine the efficient use of EHRs, highlighting the importance of conducting this study to fill this gap in the literature. This current study aims to assess the Lightwave Health Information Management System (LHIMS) and explore differences in its efficient use by health professionals in Ghana.

Satisfaction with the Use of the Electronic Health Record System

The advent of electronic health record (EHR) systems has revolutionised healthcare globally, offering convenience and accessibility to healthcare providers (Cronin et al., 2020). Yet, the assessment of EHR system satisfaction has garnered significant interest due to divergent findings across research studies (Russo et al., 2018; Khairat et al., 2019; Schopf et al., 2019). Positive outcomes associated with EHR systems have been reported, indicating higher satisfaction levels among healthcare professionals (Schopf et al., 2019). These systems have played a pivotal role in facilitating the collection, storage, and generation of accurate and comprehensive information, meeting the diverse needs of stakeholders within health systems (Khairat et al., 2019). Moreover, EHRs offer a graphical user interface (GUI)

that significantly influences user satisfaction by providing care providers with swift access to information, thereby ensuring uncompromised system usability.

Studies have highlighted the significance of EHR system usefulness as a key element of user satisfaction (Laumer et al., 2017; Meyerhoefer et al., 2018; Bauer et al., 2020). Laumer et al. (2017) suggest users' EHR systems were satisfied since the system offers relevant and valuable information consequently, more satisfying to use. Additionally, the speed and reliability of EHR systems significantly impact user satisfaction, with users preferring systems that are responsive and reliable. Bauer et al. (2020) found EHRs to facilitate satisfactory workflow and reduce frustrations associated with system downtime or slow performance. The flexibility of EHR systems, including customisation options and adaptability to different user needs and workflows, contributed to user satisfaction as indicated by Fraser et al. (2022).

Their study further suggests that EHR systems were perceived as more user-friendly and accommodating of diverse preferences (Fraser et al. 2022). Furthermore, users value EHR systems that provide high-quality, accurate, and up-to-date information, as systems with poor information quality may lead to distrust and dissatisfaction among users. This is because, efficient information retrieval and accuracy of information retrieval are crucial for user satisfaction, as users prefer systems that allow quick and accurate access to patient data, supporting timely decision-making and care delivery (Copley et al., 2019). Also, interface quality, encompassing visual design, navigation, and ease of use, significantly influences user satisfaction, with intuitive interfaces

with clear layouts and functionality enhance user experience and satisfaction with EHR systems (Tsai et al., 2020).

Nevertheless, multiple studies have shed light on significant dissatisfaction among healthcare providers utilising Electronic Health Records (EHRs). In Norwegian hospitals, Schopf et al. (2019) found that 72% of physicians reported experiencing work interruptions and delays due to frozen or crashed EHRs at least once a week, with 22% facing this problem daily. Furthermore, dissatisfaction among physicians extended to the management of referrals and certain aspects of prescription drug management within the EHR system (Russo et al. (2018). Some dissatisfaction with EHR systems stems from the fact that they are primarily designed by computer experts rather than health professionals (Wynn & Clarkson, 2018). This discrepancy in expertise results in varying levels of creativity and understanding of healthcare diagnostic methods between the two groups. Consequently, certain EHR systems may not effectively align with physicians' preferences and needs, rendering them unattractive to healthcare providers.

In addition to the complexity and poor design of EHR systems affecting user satisfaction, evidence suggests that certain personal factors also influence user satisfaction with EHRs. Khairat et al. (2019) found higher satisfaction levels among female physicians compared to their male counterparts, as female physicians demonstrated greater ease in operating EHRs and recorded higher information accessibility. Al Otaybi, Al-Raddadi, and Bakhamees (2022) discovered that age, gender, nationality, specialty, and attendance at electronic medical records system training were statistically significant factors associated with user satisfaction.

In their study, senior users aged 50 and over expressed higher satisfaction levels compared to younger age cohorts. In the same study, female users of EHR also exhibited higher satisfaction than their male counterparts, and general practitioners reported higher EHR satisfaction than other practitioners. Healthcare workers who participated in the training reported greater satisfaction compared to non-participants, while non-nationals had higher satisfaction levels than nationals. However, region and computer experience did not show any statistical association with user satisfaction.

In Ghana, a qualitative study conducted by Attafuah et al. (2022) provides valuable insights into the challenges faced by health leaders regarding the implementation of electronic health records (EHR) systems in Ghanaian hospitals, several aspects of the study warrant critique and further investigation. The reliance solely on qualitative findings may limit the depth of understanding of the identified challenges. While qualitative data are rich in detail and context, they may lack generalisability and may not provide a comprehensive understanding of the extent of the identified issues regarding the satisfaction of healthcare workers across different hospitals using the Lightwave Health Information Management System (LHIMS) in Ghana for health services delivery.

Effective Use of Electronic Health Record System

The modern healthcare landscape across the world heavily relies on information, with Electronic Health Record (EHR) systems acting as vital circulatory systems for the flow of this crucial data. As emphasised by Blumenthal (2010), EHRs play a pivotal role in delivering best-in-class care, making them indispensable for doctors and healthcare institutions. One of the

primary advantages of well-implemented EHR systems, as highlighted by Campanella et al. (2016), is their potential to elevate healthcare quality significantly. EHR systems demonstrate notable effectiveness in various healthcare work domains, adeptly managing patient records, appointments, prescriptions, and administrative tasks. Research indicates that these systems streamline workflows, alleviating paperwork burdens on healthcare professionals (Adler-Milstein et al., 2017).

Furthermore, EHR systems enable thorough data gathering by capturing intricate patient information, medical histories, diagnostic results, and treatment plans. This centralised data collection facilitates accurate documentation of patient encounters, fostering improved clinical decision-making and care continuity (Linder et al., 2007; Yuan et al., 2019). EHR systems facilitate the seamless exchange of patient information across diverse healthcare settings, promoting interoperability and data shareability among healthcare providers. Enhanced data shareability is shown to improve care coordination, reduce duplicate testing, and bolster patient safety by granting clinicians access to pertinent clinical information at the point of care ((Kaipio et al., 2020; Adler-Milstein et al., 2018).

Also, incorporating clinical decision support tools like alerts and reminders, EHR systems aid healthcare providers in identifying and mitigating potential errors in patient care. Studies demonstrate that these alerts enhance medication safety, prevent adverse drug events, and promote adherence to clinical guidelines (Allen-Graham et al., 2018; Yuan et al., 2019). Additionally, EHR systems promote better care coordination. This leads to improved care transitions, reduced medical errors, and heightened patient

satisfaction by ensuring relevant clinical information is shared among providers involved in a patient's care (Rittenhouse et al., 2020).

While the use of Electronic Health Record (EHR) systems offers numerous advantages, some EHR systems have complex interfaces and workflows that can be challenging for healthcare providers to navigate. For instance, EHR systems have been linked to physician burnout and potential weakening of the doctor-patient interaction during care (Campanella et al., 2016). Supporting evidence from The Harris Poll (2017) suggests that primary care physicians express concerns about the effectiveness of Electronic Health Record systems. Physicians in the study noted that EHRs did not meet their expectations regarding workflow, and patient-provider interaction was affected during care.

Additionally, research by Salleh, Rosni, and Zakaria in 2021 emphasises the significant impact of system quality on healthcare practitioners' effective utilisation of Electronic Health Records (EHRs). Adedeji, Irinoye, Ikono, and Komolafe (2018) found that various factors such as age, gender, and social elements like internet access and power availability influence the effective use of EHR systems. However, they identified a critical barrier to successful EHR adoption among healthcare workers, which is the lack of adequate training. In contrast, Msiska et al. (2017) did not find a correlation between differences in Electronic Health Record (EHR) utilisation and variations in age, gender, or previous computer experience in their study. The contradictory findings on Electronic Health Record (EHR) implementation underscore the significance of ongoing research and

evaluation in comprehending the intricacies of EHR adoption and its impact on healthcare delivery.

Interdependency among Effectiveness, Efficiency, and Satisfaction

The ISO 9241-11 Standard outlines three essential components of usability: effectiveness, efficiency, and satisfaction (ISO, 1998). These components serve as fundamental criteria for evaluating the usability of electronic health record (EHR) systems. Frith (2019) stress the importance of incorporating these components into the measurement of EHR system usability. While numerous studies have investigated usability measures, much attention has been directed towards examining the correlations among effectiveness, efficiency, and satisfaction. Nevertheless, divergent perspectives exist regarding these correlations, as evidenced by research from scholars such as Williams et al. (2019), Hornbaek & Law (2017), Copley et al. (2019), Frøkjær, Hertzum & Hornbæk (2000), Sauro & Kindlund (2015), and Frkjr, Hertzum & Hornbk (2000). These varying viewpoints contribute to the ongoing discourse surrounding the multifaceted nature of usability assessment in the context of EHR systems.

In their study, Hornbæk and Law (2017) found a significant association between the usability of health services, however, the intensity of these associations was somewhat lower than expected. Additionally, Joo (2010) found in his study that these three usability measures had a high association with each other. On the other hand, Frøkjær et al. (2000) reported that usability measures of effectiveness, efficiency, and satisfaction should be taken separately and not necessarily anticipated to correlate. Nilsson and Følstad (2012) have also maintained an argument that the relationship between

effectiveness and efficiency should be seen as a requirement rather than being a variable in usability studies. It has been argued that analysis of correlations among usability metrics may aid in improving our understanding of how usability can be measured in addition to addressing these discrepancies in results (Hornbæk, 2006).

Users' total experience with interactive systems depends on usability factors including satisfaction, effectiveness, and efficiency. Williams et al. (2019) acknowledge an association between perceived efficiency and EHR satisfaction. In a study on electronic health record systems, Copley et al. (2019) discovered considerable correlations in practice workflow efficiency and satisfaction among paediatric orthopaedic surgeons. As a result, usability research is crucial to advancing our understanding of the user experience (UX), which is crucial for the usability of an interactive system (Nilsson & Følstad, 2012).

The degree of correlation between these usability factors, which are primarily viewed as variables in usability research (Sauro & Lewis, 2009; Sauro & Kindlund, 2005; Hornbæk & Law, 2007), is the subject of contemporary controversy. The empirically supported, single usability metric (SUM) was introduced by Sauro and Kindlund (2005). SUM is established on the principles of a quantitative methodology in which the effectiveness, efficiency, and satisfaction of usage are combined into a single score. The three primary usability factors have strong relationships, which is a central principle of SUM. The Human-Computer Interaction (HCI) community disagrees with this claim, as demonstrated by a meta-study by Hornbæk and Law (2007). Ultimately, they found that the relationships between efficiency,

effectiveness, and satisfaction are weak, even weaker than what Sauro and Kindlund observed.

Challenges Associated with the Use of Electronic Health Record Systems

Globally, digital health is known to hold immense potential for transforming healthcare delivery and improving patient outcomes including improved care, record mobility, reduced costs, and efficient record keeping (World Health Organisation 2008; World Health Organisation & Pan American Health Organisation 2017). However, implementing EHRs can be challenging, especially in developing countries where the continent grapples with various technological challenges. Available literature presents the challenges that affect the efficiency, effectiveness and satisfaction associated with the use of the EHR. These are infrastructural-related, human-related and technological-related challenges.

Infrastructural-related

The challenges surrounding the implementation of electronic health record (EHR) systems vary greatly worldwide, with particularly complex issues emerging in regions like Africa, and specifically in countries such as Ghana. In contrast to developed nations such as the United States, the United Kingdom, Norway, Denmark, and Australia, where healthcare infrastructure benefits from substantial government support, developing countries often grapple with a scarcity of resources and weak infrastructure (Sood et al., 2018).

Developing countries face numerous challenges in implementing EHR systems, primarily due to a shortage of Information and Communication Technology (ICT) resources. This scarcity includes a lack of computers,

inadequate healthcare infrastructure, and limited access to necessary technological tools, severely impeding the successful adoption and utilisation of EHR systems within healthcare facilities. The absence of these essential resources creates significant barriers to effectively incorporating EHR systems into healthcare practices, hindering the potential benefits they can provide in terms of streamlining processes, improving patient care, and enhancing overall healthcare delivery (Bedeley & Palvia, 2014).

Additionally, many healthcare organisations encounter challenges such as outdated hardware and software. These limitations can lead to system slowdowns, downtime, and overall system instability, impeding effective EHR utilisation. Interoperability remains a critical concern in EHR implementation due to the absence of standardised data formats and communication protocols, which hinder seamless data exchange between different EHR systems and other health information technologies. This fragmentation compromises care coordination, data sharing, and interoperability across healthcare settings, undermining the potential benefits of EHR adoption.

Transitioning from paper-based records to electronic systems involves complex data migration and integration processes, which often result in challenges such as data loss, corruption, and inconsistencies. Integrating EHR systems with existing health IT infrastructure, such as laboratory systems or billing systems, presents technical hurdles that must be addressed. Moreover, challenges related to scaling EHR systems to support increasing data volumes, user populations, and expanding functionalities arise. Rigid EHR architectures may struggle to adapt to evolving clinical workflows and regulatory requirements, limiting their effectiveness and usability over time.

Ensuring the security and privacy of patient health information is paramount, requiring healthcare organisations to implement robust security measures, including encryption, access controls, and audit trails. Compliance with regulatory requirements, such as HIPAA, adds complexity to maintaining data security and privacy, necessitating ongoing attention and investment. Additionally, deploying and maintaining EHR systems require substantial financial resources, and budget constraints and competing priorities within healthcare organisations can limit investments in EHR infrastructure, resulting in suboptimal system performance and delayed upgrades. Adequate resource allocation is essential for addressing infrastructural challenges and ensuring the long-term sustainability of EHR systems.

The glaring infrastructure deficit in developing countries like Ghana has been underscored as a major obstacle in numerous empirical studies (Achampong, 2022; Idowu et al., 2022). These studies consistently highlight the indispensable role of robust ICT infrastructure in bolstering the effectiveness of healthcare information technology solutions, including EHRs. Without adequate ICT resources, healthcare professionals in developing countries struggle to implement and utilise EHR systems to their full potential, limiting their ability to access and manage patient data, track medical histories, and collaborate with colleagues effectively.

Furthermore, the absence of reliable internet access presents a significant barrier to EHR implementation in Ghana (Achampong, 2022). The internet serves as a vital conduit for accessing vast troves of health-related information, which is indispensable for both individuals and healthcare organisations alike. While Internet accessibility is gradually improving in

many parts of Africa, challenges related to connectivity and service availability persist, thwarting the seamless integration of EHR systems into healthcare practices.

Human-related

Implementing electronic health record (EHR) systems faces numerous human-related challenges, as evidenced by empirical literature from global and sub-Saharan Africa (Sieck et al., 2020; Tsai et al., 2020; Pool et al., 2024). User resistance and acceptance present significant barriers to EHR adoption among healthcare professionals. Concerns about workflow disruption, increased workload, and perceived loss of control over patient care often led to resistance (Tsai et al., 2020). Factors such as perceived usefulness, ease of use, and training adequacy influence acceptance rates (Sieck et al., 2020). Inadequate training and education programs hinder EHR implementation by impacting user competency and confidence. Comprehensive and ongoing training is crucial for healthcare staff to effectively utilise EHR functionalities (Tsai et al., 2020).

Integrating EHR systems into existing clinical workflows poses a substantial challenge. Mismatches between EHR workflows and clinical practices result in inefficiencies, frustration, and resistance among healthcare providers (Cho et al., 2021). Healthcare professionals often perceive EHR data entry as time-consuming and burdensome, affecting productivity and satisfaction. Optimising data entry interfaces and providing support for documentation tasks can alleviate this challenge (Tsai et al., 2020). Poorly designed user interfaces hinder user satisfaction and system usability. Involving end-users in the design process, conducting usability assessments,

and iteratively refining interface designs can enhance user experience and system acceptance.

Aside from the poor design of user interfaces, demographic characteristics further compound these challenges associated with the use of electronic health record systems, with age, educational background, and prior technology experience playing significant roles. Older healthcare professionals, unfamiliar with technology from their upbringing, may struggle more in adapting to EHR systems compared to their younger counterparts accustomed to digital tools. Similarly, individuals with lower levels of formal education or training may find it challenging to comprehend the complexities of EHR platforms, hindering their seamless integration into clinical practice (Pool et al., 2024). The importance of addressing these human-related challenges is paramount, emphasising the critical need for comprehensive training programs tailored to the diverse learning needs of healthcare professionals.

Technological-related

Electronic Health Record (EHR) systems have revolutionised healthcare delivery by digitising patient information and streamlining clinical workflows. However, their implementation is not without obstacles. This review synthesises empirical literature to examine the multifaceted challenges hindering the successful adoption and utilisation of EHR systems, with a focus on power interruptions, technological infrastructure deficiencies, financial constraints, interoperability issues, privacy and security risks, and usability concerns.

Power interruptions are a widespread challenge in implementing Electronic Health Record (EHR) systems globally. Uninterrupted Power Supply (UPS) is vital for continuous EHR operation, yet many developing countries struggle to provide stable electricity, leading to disruptions in EHR usage (Achampong, 2022). In Africa, including Ghana, ongoing load-shedding exercises exacerbate significant power interruptions, compromising patient care (Achampong, 2022). Furthermore, an unstable Local Area Network (LAN), insufficient network bandwidth, and inadequate server capacity pose another obstacle to EHR implementation, limiting real-time data access and updates (Sittig & Singh, 2019). Information distortion following updates presents an additional challenge, undermining the reliability of patient data stored in EHR systems (Achampong, 2022).

In numerous regions across Africa, deficient technological infrastructure contributes to inadequate access to reliable electricity and internet connectivity. This instability hampers accessing and updating patient data in real time, crucial for efficient EHR systems (Sittig & Singh, 2019; Gupta, 2018). Financial constraints serve as a significant global barrier to EHR adoption. High initial investment and maintenance costs deter healthcare providers, especially in rural areas with limited financial resources (Ash & Bates, 2005; Kilgore, 2020). Sub-Saharan Africa faces challenges due to substantial setup costs, affecting EHR implementation (Adler-Milstein et al., 2014; Reisman, 2017). Budget limitations impede deploying alternative power solutions and essential resources, complicating the sustainability of digital EHR systems (Akanbi et al., 2012; Ash & Bates, 2005; Kilgore, 2020).

Interoperability remains an ongoing challenge in EHR usage, worsened by the lack of standardisation and cultural barriers in healthcare systems (Rathert et al., 2018; Dutta & Hwang, 2020; Li et al., 2021). Varied EHR systems hinder seamless interoperability among healthcare providers, while inconsistent data formats obstruct information exchange, negatively affecting patient care and data sharing. Moreover, some healthcare providers selectively share patient health records for competitive advantages, hindering interoperability (Adler-Milstein and Pfeifer, 2019). The sensitive nature of patient information in EHRs exposes privacy and security risks, challenging healthcare institutions to maintain patient confidentiality (Chen et al., 2020; Haque et al., 2020). Ensuring robust security measures is crucial, as inadequate cybersecurity and data breaches can undermine patient trust. Usability concerns, as highlighted by El Mahalli's study (2019), impact EHR adoption, emphasising the importance of system adaptability and clarity of instructions. Complex EHR interfaces with nested menus and multiple screens hinder health workers, making system mastery burdensome.

Conceptual Framework

The study employs a conceptual framework that visually represents a real-world scenario and offers a simplified depiction of the system (Strassburger, 2015). The adoption of this framework was essential for contextualising the thesis problem within real-world contexts. Following a comprehensive literature review, the framework was developed from existing theories, models, and empirical literature to steer the study and validate its hypotheses. Moreover, it facilitated an exploration of the interdependency

among the three domains of usability in LHIMS for health service delivery, defining Efficiency, Satisfaction, and Effectiveness as key domains.

Socio-demographic factors such as age, sex, education, and work experience were conceptualised as external factors influencing the perceived usefulness of electronic health record systems, drawing from Davis' Technology Acceptance Model (Davis, 1989). The International Organisation for Standardisation (1998) proposed efficiency, satisfaction, and effectiveness as latent constructs for assessing EHR usability, adapted for this study. Efficiency in this context refers to health professionals' ability to swiftly perform tasks with EHR, reduce patient waiting time, recover from mistakes easily, and use the system with minimal mental effort, including their capacity to document, input, retrieve, store, and send information during patient care without external assistance.

Satisfaction, within the conceptual framework, encompasses various factors such as system usefulness, speed, reliability, flexibility, information quality, ease of information retrieval, accuracy, interface quality, consistency, and clarity of screen items, all contributing to users' overall satisfaction. Effectiveness implies that the LHIMS contains all necessary components and can replicate the daily activities performed by professionals during health service delivery. Meaningful utilisation of the system's functionalities indicates effective EHR utilisation. Additionally, the framework identifies challenges in LHIMS usage, including technical (hardware and software), technological (power interruption, unstable network, and information distortion after updates), and human factors (inadequate training and computer literacy).

The study further explores the relationship between socio-demographic characteristics and the three usability domains, as hypothesised by Khairat et al. (2019), suggesting that female physicians exhibit greater efficiency in EHR usage, while male physicians report higher perceived EHR workload stress and frustration. EHR use is linked to physician satisfaction with their practice, and efficiency is associated with higher overall satisfaction (Menachemi and Collum, 2011). The connection between efficiency and effective EHR use in health service delivery shows that EHR systems improve efficiency by reducing time spent retrieving patient history and examination results.

The study's conceptual framework visually outlines hypotheses, showing that socio-demographic factors, profession type, and training/computer skills impact efficiency, effectiveness, and satisfaction with LHIMS usage. The study also suggests that the three usability domains—effectiveness, efficiency, and satisfaction—are independent. The framework below illustrates this approach.

CHAPTER FOUR

METHODS OF DATA COLLECTION AND ANALYSIS

Introduction

Research methodology constitutes a critical section of any scientific study. It has been argued that this component is the 'heart' of research on which the output is dependent (Bradshaw et al., 2017). Generally, it details the research orientation as well as the processes and techniques that are conducted to collect and analyse the data. The accuracy and appropriateness of the methods employed are usually linked to the underpinning philosophical orientation and theoretical assumptions to suggest the validity and quality of the results and conclusions of any study (Thwaites, 2016). This chapter presents the research philosophy, design, and population of the present study. It also describes the sampling procedures, instruments used, the ethical protocols that were followed, methods of data collection, the challenges that were encountered and how they were addressed. Finally, how the data were processed, managed, analysed, and presented are discussed in this chapter.

Research Philosophy

Philosophies used in social sciences research vary, but the dominant ones are positivism, interpretivism, pragmatism and critical theory (Kaushik & Walsh, 2019). Positivism, with its emphasis on empirical observation and measurement, offers clear strengths in its pursuit of objectivity, predictability, and generalisability in research findings. However, its weaknesses lie in its tendency towards reductionism, potentially oversimplifying complex social phenomena, as well as its disregard for subjective experiences and values, leading to a lack of depth in understanding human behaviour.

Interpretivism, on the other hand, provides a rich exploration of subjective experiences and meanings within specific cultural contexts, but its subjectivity raises questions about the reliability and generalisability of findings. Critical theory encourages critical reflection on power structures and aims for social transformation but struggles with subjectivity, potential bias, and challenges in empirical validation. Ultimately, the choice among these philosophies depends on the research question, context, and the researcher's values and priorities.

This study was guided by the pragmatist philosophical orientation. Pragmatism's strength lies in its flexibility, problem-solving orientation, and integration of multiple perspectives. This orientation directed the study to explore the objectives of the study and proffer ways to address LHIMS implementation gaps and challenges, and further, to improve the utilisation of the LHIMS (Creswell & Plano-Clark, 2011). Both positivist and interpretivist paradigms were utilised in the exploration of the Lightwave Health Information Management System.

Positivism was employed to investigate the efficient use of the system, its effectiveness in improving health professionals' satisfaction, and to assess the interdependency that exists among efficiency, effectiveness, and satisfaction. Meanwhile, interpretivist paradigms were chosen to delve deeply into the challenges faced by system users, aiming to uncover nuanced insights into their experiences and perspectives. By employing both paradigms, the research aimed to provide a comprehensive understanding of the Lightwave system from both quantitative and qualitative perspectives, enriching the analysis and enhancing the validity of the findings.

Study Design

The study used two main designs: a cross-sectional design and a phenomenological design. The cross-sectional design was chosen for the quantitative aspect, providing a snapshot of variables without external influence. This approach was suitable as it allowed observation of variables in their natural state, without manipulation (Wang & Cheng, 2020). Additionally, the cross-sectional design of the study was beneficial as it provided a snapshot of data at a single point in time, eliminating the need to track changes over time. This design allowed for the collection of data on health professionals' satisfaction, and the effective and efficient use of the Lightwave Health Information Management System (LHIMS) for health service delivery. Consequently, the study offered a comprehensive examination of these variables within a specific timeframe, providing valuable insights into the current state of LHIMS utilisation and its impact on health professionals' experiences.

The phenomenology qualitative design on the other hand was used for the qualitative arm of the study. This approach was chosen to delve into and describe the common meaning of numerous people's lived experiences with a concept or phenomenon, as outlined by Creswell (2013). In this current study, the phenomenology design was employed to examine the phenomenon of Electronic Health Records (EHR) and to explore the health professionals' lived experiences regarding the challenges encountered in using the Lightwave Health Information Management System (LHIMS) for health service delivery in the Central Region. By utilising phenomenology, the research sought to uncover the deeper, subjective insights and perceptions of health

professionals, thus providing a richer understanding of the challenges they face in utilising LHIMS for healthcare delivery. This qualitative approach allowed for a detailed exploration of the intricate nuances of individuals' experiences, contributing to a more holistic analysis of the phenomenon under investigation.

Sources of Data

The study utilised primary data and the data was collected from 10 health facilities in the Central Region. Both quantitative and qualitative data were collected. The quantitative data was collected by conducting a survey. In-depth interviews were also conducted to collect the qualitative data. The data were collected from Unit Heads (Prescribers, Nurses/Midwives, Pharmacists and Auxiliary staff) of the health facilities using the LHIMS of the region.

Study Population

The population for the study is all health professionals at health facilities in the Central Region of Ghana that have adopted LHIMS. However, the accessible population is limited to only health professionals who met the inclusion and exclusion criteria in the 10 health facilities using the LHIMS (Table 1). This population encompassed prescribers (including doctors and physician assistants), nurses (both general nurses and nurse assistant clinical), midwives, diagnostics staff (including laboratory, x-ray/radiology/ radiography, and physiotherapy personnel), as well as medical records personnel (encompassing health information and biostatistics), and dispensary staff (including pharmacists, dispensing technicians, and pharmacy assistants) who utilised the LHIMS for health service delivery within these facilities.

Inclusion Criteria

To be eligible respondents/participants must meet the following inclusion criteria:

i. must be using the LHIMS for at least six months or more
ii. must be a head of unit or
iii. must be using the LHIMS for service delivery

Exclusion Criteria

The following criteria must be met to be excluded:

i. Respondent/participants must be using the LHIMS for less than six months
ii. not being head of a unit nor
iii. not using the LHIMS for service delivery

Table 1: Staff Distribution Across Ten Health Facilities in the Central Region

Table 1 below presents the number of staff members per category extracted from the LHIMS. It provides an overview of the distribution of personnel across various professional categories within the 10 healthcare facilities.

	Prescribers	Nurses/Midwives	Medical Record	Dispensary	Diagnostics	
	Category 1	Category 2	Category 3	Category 4	Category 5	Total
Cape Coast Teaching Hospital	560	599	32	53	79	1323
Winneba Trauma Hospital	22	202	11	4	15	254
Metropolitan Hospital, Cape Coast	14	179	11	7	9	220
Saltpond Municipal Hospital	7	162	11	11	7	198
Ajumako Hospital	7	115	5	5	5	137
Abura-Dunkwa Hospital	6	123	8	5	4	146
Ankaful Leprosarium	8	114	4	1	3	130
Swedru Hospital	17	199	7	9	10	242
Kasoa Polyclinic	11	77	5	2	17	112
Adisadel Urban Health Centre	1	48	4	1	2	56
Total Population	653	1818	98	98	151	2818
Total Sample Estimated	263	733	40	40	61	1136

Source: Desk Review, 2021

Sample Size Determination

To identify the suitable respondents for the survey, a sample frame, and the total number of health professionals suitable for the study were derived from health facilities (see Table 1). The sample size was, subsequently calculated using the Rose et al. (2015) formula. This formula is commonly employed in the field of management. However, in the field of health, Adu-Gyamfi et al. (2019) utilised this formula to estimate the sample size for a study on occupational health and safety among auto-artisans in Suame Magazine-Kumasi, Ghana. This precedent enables me to apply the same formula in the present study to estimate the sample size for health facilities utilising the LHIMS for health service delivery. Mathematically, the formula is written as

$$n = \frac{Z^2 \, x \, P \, (1 - P)}{C^2}$$

Where;

- Z denotes the Z value (e.g., 1.96 for a 95 per cent confidence level)
- P is the percentage of the population expressed as a decimal. A population proportion of 59% was estimated by Essuman et al. (2020) in a study assessing health professionals' utilisation of ICT in the Eastern Region of Ghana. This current study therefore adopted 59% as the proportion of the population exhibiting the characteristics of interest.
- C is the confidence interval, expressed as decimal (e.g., 04 = +/- 4 percentage points)

$$n = \frac{1.96^2 \, x \, 0.59 \, (1-0.59)}{(0.030)^2} = \frac{0.92928304}{0.0009} = 1032.53 \approx 1033$$

The estimated sample size (n) was 1033. Due to the regular changes in health professionals' work routine, a 10 per cent attrition rate was calculated on the estimated sample size (Essuman et al., 2020). Again, 10 per cent was added to make room for incomplete instruments (Essuman et al., 2020). In total, a sample size of 1136 was generated.

Response Rate

The study achieved a response rate of 1,126, representing 99.1%. The high response rate was attained through a multifaceted approach that encompassed several key strategies. Firstly, a recognisance survey was carried out, involving all relevant facilities and stakeholders. In addition to the recognisance survey, support and approval letters were obtained from the Ministry of Health, Institutional Review Boards, and Department of Population and Health, University of Cape Coast and submitted to all facilities in person. Regular updates and information about the study's objectives and significance were shared through staff WhatsApp platforms, ensuring that health professionals were well-informed and aware of the study's importance.

The data collection process was planned in shifts—morning, afternoon, and night to ensure total representation. This approach enabled the inclusion of diverse perspectives and minimised any potential bias associated with specific time frames. Lastly, a crucial aspect that contributed to the high response rate was the in-person data collection method. Employing eight well-trained research assistants facilitated a successful data-gathering process. Their expertise and interpersonal skills created a conducive environment for participants to provide their inputs comfortably.

Sampling

A stratified probability sampling technique was employed to select the 1126 respondents from the 10 health facilities understudy. Each of the 10 health facilities utilising LHIMS for service delivery was regarded as a distinct stratum. Proportion allocation for each stratum (health facility) was determined using the formula:

= (Sample Size)/(Total Population) X Stratum Size

=1136/2818 X 1325

The formula is iterated to calculate a proportionate allocation based on the stratum size (accessible population). Table 2 depicts the proportionate allocation for each stratum (health facility)

Table 2:Proportionate Allocation of Health Facilities Based on Accessible Population

Facility	Accessible Population	Proportionate Allocation
Cape Coast Teaching Hospital	1323	533
Winneba Trauma Hospital	254	102
Cape Coast Metropolitan Hospital	220	89
Saltpond Municipal Hospital	198	80
Ajumako District Hospital	137	55
Abura-Dunkwa Hospital	146	59
Ankaful Leprosarium	130	52
Swedru Government Hospital	242	98
Kasoa Polyclinic Centre	112	44
Adisadel Urban Health Centre	56	24
Totals	2818	1136

Source: Desk Review, 2021

Within each stratum, health professionals were categorised based on their utilisation of the LHIMS for clinical activities. Doctors and Physician Assistants comprised the first category, as they extensively used the LHIMS for tasks such as diagnosis, ordering, and prescribing medications. Nurses and Midwives formed the second category, also utilising the LHIMS for clinical

purposes and health service delivery, albeit with less emphasis on prescribing compared to doctors and physician assistants. The third category encompassed the Auxiliary staff, including medical records, staff at the dispensary, and diagnostics personnel, who primarily focused on managing patient treatment processes and fulfilling requests and orders using the LHIMS.

Table 3: Distribution of Health Professionals Across Categories in Various Healthcare Facilities

Facility	Category 1	Category 2	Category 3	Accessible Population
Cape Coast Teaching Hospital	560	599	164	1323
Winneba Trauma Hospital	22	202	30	254
Metropolitan Hospital, Cape Coast	14	179	27	220
Saltpond Municipal Hospital	7	162	29	198
Ajumako Hospital	7	115	15	137
Abura-Dunkwa Hospital	6	123	17	146
Ankaful Leprosarium	8	114	8	130
Swedru Hospital	17	199	26	242
Kasoa Polyclinic	11	77	24	112
Adisadel Urban Health Centre	1	48	7	56
Total Population	653	1818	347	2818
Health Professionals sampled after fieldwork	253	733	140	1126

Source: Desk Review, 2021

To determine the proportion of health professionals to be recruited per stratum, the formula "(Estimated sample size / total population size of all facilities) x the number of health professionals in each category" was utilised, with the population size for each facility and category specified in Table 3. Following Turner's (2020) recommendation, a simple random number generator in Microsoft Excel 360, employing the function "=RAND

BETWEEN (bottom, top)" were adopted to recruit respondents. Although stratified sampling offers advantages, it poses challenges in fulfilling all its assumptions, such as accurately categorising every member of the population into subgroups. However, in this study, population size and subgroupings were clearly defined based on staff population per professional category obtained from the facilities.

Number of Participants Selected for Qualitative

The qualitative arm of the study interviewed 30 Unit Heads from the facilities using the LHIMS. The non-probability purposive sampling technique (Expert sampling) was employed to sample 30 Unit Heads from the study population. The study included six prescribers, eight nurses/midwives, and sixteen auxiliary staff. The unit heads were uniquely positioned to provide insights into the management and use of the LHIMS at the facility. They had access to specific details not available to other professionals and often represented their subordinates in consultative meetings.

Purposive sampling was therefore used to select them as key informants. During the interview process, once no new information or insights emerged, the point of saturation was reached, and the in-depth interview was concluded, as enough information had been gathered regarding the use of the LHIMS (Bradshaw et al., 2017). This procedure was supported by Shenton (2004) and Elmusharaf (2018) that in qualitative research, 5 to 30 people could be a sufficient sample size to reach saturation.

Data Collection Instrument

In any research study, the data collection instrument plays a pivotal role in gathering essential information that contributes to the investigation's

objectives (Simon, 2020). The study adopted both quantitative and qualitative sets of data instruments, and these are the questionnaire and in-depth interview guide respectively.

Questionnaire

Two sets of standardised and validated instruments were utilised for the study. The first set was adapted from the Computer System Usability Questionnaire (CSUQ) developed by International Business Machines (IBM) (Lewis, 1995) to assess satisfaction with computer usability. This questionnaire comprises three components: system usefulness, information quality, and interface quality. It consists of 19 standardised items rated on a 7-point Likert scale, with an option for "Not Available (N/A)." The CSUQ demonstrates a high level of internal consistency, with an overall coefficient alpha of 0.95. Previously, the CSUQ has been employed to evaluate physicians' satisfaction with EMR system effectiveness, efficiency, responsiveness, and learnability (Jaspers et al., 2008), as well as health information systems in Nigerian teaching hospitals (Ojo, 2017).

For this current study, ten question items were selected from the CSUQ, while Questions 1, 3, 4, 5, and 6 were excluded as they were not relevant to this study. The terminology "system" or "computer system" within the questionnaire was replaced with "LHIMS" to accurately reflect the focus of this study. Additionally, the option "Not Available" or "N/A" was removed from the questionnaire, as it was originally designed to assess various EHR systems in the United States with differing functionalities. Given that this study evaluated only one EHR system (LHIMS), the questionnaire items were carefully chosen and rephrased to align with current practices in Ghana.

The second tool adapted for this study is the IsoMetricsL questionnaire version 2.01e (Günther Gediga & Düntsch, 1999). It is designed based on ISO 9241/10 to assess the usability of software products and to gather usability data for both summative and formative evaluations (Günther Gediga & Düntsch, 1999). There are 90 question items on the questionnaire. The instrument originally featured options rated from 1 to 5, with 1 representing predominantly disagree and 5 predominantly agree, these five options have been refined to range from strongly disagree to strongly agree for enhanced clarity and comprehension in this current study. This current study focuses on only one software (LHIMS) and all questionnaires were related to the use of the LHIMS in the Ghanaian context. Additionally, the term "software" has been replaced with "LHIMS" for specificity. The option "No opinion" has been omitted since the adapted questions are directly relevant to the study. Sections prompting respondents to provide examples and scenarios have been excluded.

Additionally, 13 question items measuring “efficiency” and 11 question items for the “effectiveness” construct were obtained from the IsoMetricsL questionnaires. The final questionnaire for this study was divided into portions. The first section required the respondents to provide data on sociodemographic, professional characteristics and general use of computing. The second section captured data on the efficient use of the LHIMS. The third section solicited data on satisfaction with the use of LHIMS, and the fourth section asked questions on the effective use of LHIMS by health professionals (see Appendix A)

In-depth Interview Guide

An interview guide was developed to elicit data from the unit heads at the 10 health facilities using the LHIMS for their operations. Questions were adapted from an interview guide developed by the Michigan Public Health Institute on Electronic Health Record Implementation (Michigan Public Health Institute, 2011). It contains questions and probes for health facility administrators, clinical staff, implementers, and office staff across a healthcare system. Some of the items on the interview guide adapted were users' perceptions of electronic health records. The instrument contains questions on the general use of Electronic Health Records, privacy and security, interoperability, system complexity, high start-up cost, workflow changes, literacy and skill in technology, and reliability and stability of Software, hardware, and computing networks. The interview guide covered all these areas including usability and financial challenges (see Appendix B)

Data Collection

Arguably, data collection methodology underpins the main essence of research. It is out of the data collected that findings can be generated to refute or affirm existing knowledge, or/and introduce new ones as basic or applied research (Taherdoost, 2021). The entire data collection exercise for this study was categorised into three main stages. These are the pre-field, fieldwork, and post-field stages.

Pre-field Stage

The pre-field stage comprised all the activities that were engaged in, and conducted before the actual data was collected from respondents and participants from the facilities. These included ethical clearance, recruitment

and training of field assistants, and permission and administration of consent forms.

Ethical Clearance

Research ethics are important for integrity in the sciences, human rights, and dignity. These values ensure that participating in research is voluntary, informed, and safe for the respondents (Hendee, 2009). Research is less credible if a researcher refuses to follow research ethics since it will be difficult for other researchers to trust the findings (Fleming & Zegwaard, 2018). Given this, ethics is being recognised as an important component of all social science research. For that matter, ethical concerns were greatly regarded and embraced by this study. In doing so, standardised procedures were followed to obtain ethical approval.

The Population and Health Department of the University of Cape Coast approved the study's topic. Approval to conduct the study was obtained from the Ministry of Health, as they oversee the LHIMS implementation in Ghana. Ethical Clearance and approval letters were obtained from the Ghana Health Service Ethics Review Committee (GHS-ERC:011/07/21) and the Cape Coast Teaching Hospital-IRB (CCTHERC/EC/2021/095). During fieldwork, respondents were administered informed consent forms and participant information sheets. The informed consent form explains the purpose of the study, assures confidentiality and anonymity, emphasises voluntary participation, and highlights possible risks and benefits of participating. Respondents who met the inclusion criteria and agreed to participate were provided with informed consent. After consenting, the

research assistant administered the questionnaires, while I adhered to the same ethical procedures when conducting interviews with unit heads.

Recruitment and Training of Field Assistants

Due to the spread of health institutions in the Central Region and the size of the sampled respondents, eight research assistants were recruited to help with data collection. Among the eight research assistants, three had completed master's degrees and five of them had completed their first degrees and lived in the Central Region, specifically, Cape Coast, Ajumako, Saltpond, Mankessim, Winneba and Weija at the time of the data collection. The selection of the research assistants was based on their knowledge of the region, expertise, and capacity to observe ethical concerns at the healthcare institutions. Another criterion used to select the research assistants was their experience in fieldwork and data collection. The research assistants received a 5-day training. During the five-day training program, research assistants were equipped with essential skills across various areas. Day 1 training focused on providing research assistants with an overview of the research activity.

The assistants were introduced to the research methodology, research design, data collection techniques and the use of the Computer Assisted Personal Interview (CAPI) as well as ethical considerations. The training regarding ethical issues included seeking informed consent, respecting privacy, anonymity, and confidentiality, as well as recognising emotional distress in participants, such as mood swings. Day 2 concentrated on equipping assistants with knowledge of survey instruments (questionnaires) and data management.

Day 3 training emphasised data inputting, data extraction and synchronising data using the Kobo collect tool. Day 4 provided training on communication and paying attention to body cues as well as posture. Day 5 which was the last day of training, the research assistants gained knowledge on time management and COVID-19 protocols. Given that research assistants may face physical, psychological, and social risks while carrying out their duties, they were trained on facility entry protocols by going through the unit heads or any senior member present to seek permission before engaging the respondents.

Pre-testing

Prior to data collection, the questionnaire and interview guide were pre-tested for face and content validity, reliability, and appropriateness. The instruments for the study were pre-tested at the St. Gregory Catholic Hospital. The facility was chosen because it used the LHIMS and was the only quasi-institution permitted by the head of the facility to take part in the study. One hundred questionnaires were administered for the pretesting of the instruments. After the pretesting, Cronbach's Alpha scores were determined to indicate the reliability of the various question items in the questionnaire.

The questionnaire had an overall reliability (Cronbach's Alpha) co-efficient of 0.946 which met the recommended threshold of 0.7 by Hair (2014). In the instrument, "satisfaction" with 10 question items also obtained a reliability score of 0.906. The construct "efficiency" obtained a score of 0.887 and lastly, the "effectiveness" construct had a reliability score of 0.872 with the 11 question items. In all, 34-item questions with response ratings ranging from "Strongly Disagree" to "Strongly Agree" were used in soliciting data

from the 1,126 health professionals (Prescribers, Nurses and Midwives, Medical Record Staff, Diagnostics, and staff at the Dispensary) in the Central Region.

For the qualitative aspect of the study, seven interviews were conducted as part of the pre-testing also at the St. Gregory Catholic Hospital. The conversations were tape-recorded and afterwards transcribed verbatim. To verify that the responses appropriately reflected the meaning of the questions, the transcripts were compared to the original intentions of the questions on the interview guide. The final interview guide included new questions about inventory, distortion of information after updates and mismatched number of medications noted during pre-testing.

Fieldwork Stage

The fieldwork stage encompasses the gathering of field data. This process includes various components such as collecting data, establishing data collection procedures, ensuring quality control and assurance for survey data, and maintaining trustworthiness.

Data Collection Procedure

The data collection began when facilities approved the study. The data collection lasted for one month and a half months. The survey data was obtained using Computer-Assisted Personal Interviews (CAPI). This device was used because it relieved the researcher from entering the data into the SPSS manually, hence the CAPI data were automatically imported into the SPSS version 26 to enable analysis. During data collection, each research assistant administered around 140 questionnaires. The average duration for administering the questionnaire was 45 minutes. As the research assistants

collected survey data at each facility, the principal investigator (myself) concurrently conducted in-depth interviews with the unit heads at various health facilities. The average duration for the qualitative interview was an hour.

Furthermore, due to the coronavirus pandemic, strict protocols were adhered to to ensure the safety of both respondents and research assistants. For instance, before conducting interviews, all participants and researchers were provided with face masks and face shields. Continuing with the data collection, the health professionals (respondents) were requested to select a convenient location, and strict adherence to a 6-foot social distance was maintained, following the guidelines set by the Centres for Disease Control and Prevention (CDC, 2020) during the pandemic.

It is important to note that the study presented no physical, social, or psychological risks to the respondents. Also, the Ghana Health Service Ethics Review Committee guidelines for researchers during the COVID-19 pandemic were duly followed by ensuring that research assistants and research limited human contact. Also, the study abided by the safety measures proposed by the Ethics Review Committee and ensured that the researchers and respondents washed their hands diligently and put on nose masks throughout the engagement.

Survey Data Quality-Control and Assurance

In research, making optimal decisions necessitates the use of high-quality data, which accurately represents real-world phenomena. I followed meticulous quality control and assurance processes. These included identifying and scrutinising irregularities through data summarisation,

eliminating outdated information, and conducting thorough data cleaning (Fleming & Zegwaard, 2018). Given that survey data can be susceptible to distortion throughout its lifecycle due to external factors and human influence, special attention was devoted to safeguarding all aspects of the data collection process and study procedures. This was done diligently to prevent any adverse impact on the quality of the survey results.

In-depth Interview Data Trustworthiness

Trustworthiness in in-depth interview data can be achieved through evidence, which mostly depends on transparency. Therefore, to realise trustworthiness in IDI data, ensured that the study was transparent, honest, and above all, provided verifiable evidence of its practices. In this way, others can be assured that the study paid attention to data integrity, authenticity, accuracy, reliability, and accessibility over the stretched time frames (Thwaites, 2016). Upon transcribing and organising the recorded interviews into themes, the findings were shared with the participants to ensure the accuracy and authenticity of the data, reflecting the true essence of the situations discussed.

Post-fieldwork Stage

The post-field stage involves various activities conducted after fieldwork. These included data analysis for qualitative and quantitative data gathered during fieldwork and data management.

Data Analysis

Two forms of data analysis were employed in accordance with the data sets that were collected from the field. These are the quantitative data analysis and the qualitative data analysis. Different methods and approaches were

conducted under each arm of the data analysis to arrive at the results needed to achieve the objectives formulated. Below are the measurement strategies adopted for each of the objectives (*see* Table 4)

Table 4: Measurement Strategies and Analysis Methods for Study Objectives

The table summarises the measurement strategies and analysis methods for five objectives. Objectives 1 to 4 use quantitative methods (weighted average and ordinal logistic regression), while Objective 5 uses qualitative analysis (thematic analysis).

Objective	Measurement Strategy	Analysis
OBJ1	Quantitative	Weighted Average & Ordinal Logistic Regression
OBJ2	Quantitative	Weighted Average & Ordinal Logistic Regression
OBJ3	Quantitative	Weighted Average & Ordinal Logistic Regression
OBJ4	Quantitative	Weighted Average & Ordinal Logistic Regression
OBJ5	Qualitative	Thematic Analysis

Source: Desk Review, 2021

Quantitative Analysis

Data for the quantitative analysis stemmed from hypotheses postulated in the study. Among the hypotheses postulated in the study is that there is a statistically significant association between socio-demographic characteristics and the 3-usability domain of LHIMS (satisfaction, efficiency, and effectiveness) . Also, the study hypothesised that there is an interdependency among the 3-usability domain of EHR use at a confidence interval of 95% and an alpha value of .05. In performing this analysis, SPSS version 26 was used for data processing. Amos version 21 was used to perform structural equation modelling by testing for interdependency among effectiveness, efficiency, and

satisfaction. The results were presented using descriptive statistics analysis (weighted average scores), bivariate analysis (chi-square test) and multivariate analysis (ordinal logistic regression analysis).

To determine the average weighted score for all the indicators under *effectiveness, efficiency, and satisfaction*, a 5-point Likert scale ranging from Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), and Strongly Agree (SA) were assigned weights of 1, 2, 3, 4 and 5 respectively. The Weighted Mean formula from Manyange, Abuga and Ongabi (2015) was employed to compute the weighted average scores. The formula was mathematically written as Weighted Average (WA) = wx / w, where w represents the weights and x represents the values. After the computation, the weighted average scores were interpreted based on the following parameters: 1.0 – 1.79 = Strongly Disagree; 1.80 – 2.59 = Disagree; 2.60 – 3.39 = Neutral; 3.40 – 4.19 = Agree; 4.20 – 5.00 = Strongly Agree (Manyange, Abuga & Ongabi, 2015).

For the bivariate and multivariate analysis, Principal Component Analysis (PCA) was used as a dimension reduction technique to obtain a factor score for each of the dependent variables (effectiveness, efficiency, and satisfaction). In the IBM Statistical Package for the Social Sciences, the result was further examined using the orthogonal rotation approach (Varimax). The Kaiser Meyer Olkin (KMO) measure of sampling adequacy was greater than 0.5 for all measured constructs. Bartlett's sphericity test was significant (p 0.05), and the construct's eigenvalue was greater than 1, accounting for more than 50% of the variance in every construct with individual item loads greater than 0.4.

I further employed Brooke's (1986) System Usability Scale to categorise the dependent variables to make the factor score reflect a natural setting. Respondents with a factor score of less than 30% were categorised as "low," those with scores above 30% but not more than 70% were defined as "moderate," and those with a score of more than 70% were classified as "high". This categorisation made it possible to run a chi-square test for the bivariate analysis and ordinal logistic regression analysis for the multivariate using the proportion of odds (Odds Ratio) to interpret the differences in the use of LHIMS.

Ordinal Logistic Regression (ORL) was employed on the assumption that the dependent variables were measured on an ordinal level. This was adopted to evaluate the influence of respondents' socio-demographic factors (age, sex, educational qualification, and years of work experience), professional characteristics (professional type and institution of training), and Training/computing proficiency (status of training before the use of LHIMS, duration of the training and computer proficiency) on all the dependent variables (effectiveness, efficiency, and satisfaction). A confidence interval of 95% and a p-value of 0.05 were used to determine the level of significance. Also, Structural equation modelling was used as a multivariate statistical analysis technique to analyse structural relationships among the dependent variables. Using the confirmatory factor analysis (CFA) approach and maximum likelihood as a dimension reduction technique, the study assessed the interdependency among the 3 dependent variables (effectiveness, efficiency, and satisfaction).

Qualitative Data Processing and Analysis

The thematic analysis framework of Colaizzi (1978) was adopted, involving a manual and deductive coding approach. This approach was used to analyse the fifth objective of the study, which examined the challenges related to the use of the LHIMS. The interviews were conducted with unit heads from hospitals utilising the Lightwave Health Information Management System for service delivery. Each interview was transcribed verbatim, and significant statements were extracted from the transcripts. The meanings of these statements were formulated and clustered into themes that emerged from both the empirical literature and the interview guide. These themes were integrated into an exhaustive description that captured the essence of the participants' experiences. The exhaustive description was reviewed to ensure accuracy and depth. To validate the findings, the results were presented back to the participants for confirmation, ensuring their insights were authentically represented.

Data Management

In discussing or reporting data, no names or other identifying information were used in both the quantitative and qualitative data gathered. I securely stored all files and data collected in an iCloud. The paper records were shredded. Also, the tablet computers for the quantitative data collection were password-protected to prevent unauthorised individuals from accessing the information collected. After data collection was completed, the tablets were formatted to factory settings. To maintain confidentiality, especially with the qualitative arm of the study, no one other than myself had access to the tapes containing the interviews conducted with the Unit Heads from the

various health facilities. The audio recordings were stored on iCloud with password protection known only by the researcher. The transcriptions of the recordings were also password-protected and stored in iCloud. The information was deleted from iCloud a month after the study was submitted to the School of Graduate Studies.

Study Limitation

The study on LHIMS deployment in the Central Region is not without limitations. The deployment of the LHIMS in the region was a pilot project (Phase 1), and the results may differ in the regional-level implementation (Phase 2). The study only focused on post-implementation usability issues and did not assess pre-implementation issues. Also, as the deployment of LHIMS is a Government of Ghana Flagship Program, participants may have felt hesitant to share negative feedback, but the interviewer encouraged participants to express both benefits and challenges, which were seen in the data. The study explored the views of health professionals and unit heads on the use of LHIMS for health service delivery but did not include the cost of implementation, building of network infrastructure, or software usability testing. A generalisation of the study's findings should be exercised with caution due to contextual differences in health institutions.

CHAPTER FIVE

EFFICIENT USE OF THE LIGHTWAVE HEALTH INFORMATION MANAGEMENT SYSTEM FOR HEALTH SERVICE DELIVERY BY HEALTH PROFESSIONALS

Introduction

It has been theorised by Davis (1989) in the Technology Acceptance Model that external factors such as age, gender and organisational factors influence the perceived usefulness of Electronic Health Record Systems. Also, Al-Rayes et al. (2019) hypothesised that physicians' use of the EHR system is significantly influenced by their age, work experience, and medical speciality. In this chapter, descriptive statistics (weighted mean) are computed to determine the average weighted score for all the indicators under efficiency. Also, bivariate analysis (chi-square) and multivariate (ordinal logistic regression) analyses are conducted to test the study's hypotheses. As part of assessing the differences in the efficient use of LHIMS by respondents, this chapter tests the following hypotheses from the literature reviewed.

H_1: socio-demographic characteristics (age, sex, educational qualification, and years of work experience) influence the efficient use of LHIMS by respondents.

H_2: professional characteristics (professional type and institution of training) influence the efficient use of LHIMS by respondents.

H_3: training and computer proficiency (training status, duration of training and computer proficiency) influence the efficient use of LHIMS by respondents.

Descriptive Statistics of Respondents' Efficient use of LHIMS

This section analyses respondents' efficient use of LHIMS for health service delivery in the Central Region. The weighted mean formula was used to calculate the weighted average scores, with weights of 1-5 assigned to the Likert scale. The interpretation of the weighted average scores was based on a specific set of parameters, ranging from strongly disagree to strongly agree, as outlined by Manyange, Abuga and Ongabi (2015). Table 4 displays the descriptive statistical analysis of the efficient use of the LHIMS by the respondents.

The result, as seen in Table 4 indicates that the respondents were able to use the LHIMS without written instructions or assistance from a colleague (3.52). According to respondents, LHIMS aided in providing appropriate care to the patients (3.45), the system helped them to execute the task quickly (3.78) and commanded the LHIMS to perform tasks as simple (3.74). Additionally, respondents acknowledged that using the LHIMS required less mental effort (3.79) and it was easy learning to operate the LHIMS (3.64). Also, respondents agreed that LHIMS reduced documentation time (3.63), the system was simple to use (3.71), it helped handle patient treatment/service on time (3.68) and using the LHIMS lessened a patient's time at the Unit (3.55) (see Table 5).

Table 5: Descriptive Statistical Analysis of the Efficient Use of LHIMS by Respondents

Statement	SD	D	N	A	SA	Weighted Average	Interpretation
	1	2	3	4	5		
I can use the LHIMS without written instructions	47	135	247	574	123	3.52	Agree
Using the LHIMS helps me provide the appropriate service for the patient	52	169	267	501	137	3.45	Agree
It is easy to get the LHIMS to do what I want it to do	29	98	206	595	198	3.74	Agree
I can complete a task quickly using the LHIMS	28	76	227	584	211	3.78	Agree
Interaction with the LHIMS requires less mental effort	22	75	216	616	197	3.79	Agree
Learning to operate the LHIMS was easy for me	31	116	253	549	177	3.64	Agree
LHIMS requires fewer steps to accomplish a task	38	132	247	562	147	3.58	Agree
I am familiar with the items on the screen of the LHIMS	42	124	217	581	162	3.62	Agree
An increased time is required to enter patient information	37	137	213	561	178	3.63	Agree
LHIMS is simple to use	28	106	213	598	181	3.71	Agree
I can recover from mistakes quickly and easily when using the LHIMS	22	54	252	611	187	3.79	Agree
Using the LHIMS gives me more control to handle patient treatment/service on time	33	105	229	583	176	3.68	Agree
Using the LHIMS reduces the time spent by a client at the Unit	61	149	209	519	188	3.55	Agree

Source: Agyemang, 2021

Weighted Average = $\sum wx / \sum w$
Interpretation: 1.0 – 1.79 = Strongly Disagree; 1.80 – 2.59 = Disagree; 2.60 – 3.39 = Neutral; 3.40 – 4.19 = Agree; 4.20 – 5.00 = Strongly Agree

Bivariate Analysis of the Efficient use of the Lightwave Health Information Management System by Respondents

As part of this chapter, a bivariate analysis was run to assess the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification, and years of work experience*), professional characteristics (*Professional type and type of institution attended*) and Training/Computer proficiency (*training status, duration of training and computer proficiency*) on the efficient use of the Lightwave Health Information Management System (LHIMS).

Socio-demographic Characteristics and Efficient Use of LHIMS

It has been argued in the literature that the socio-demographic characteristics of individuals influence their use of software or applications (Khairat et al., 2019a; Williams et al., 2019). In order to investigate the association between respondents' sex, age, educational background, and years of work experience and the efficient use of the LHIMS, a chi-square test was conducted. The relationship between sex and efficient use of the LHIMS was statistically significant at χ^2 (2, N=1126) =7.68, P-value =.022. For female respondents, 32.3 per cent were highly efficient in using the LHIMS while for male respondents, 26.4 per cent were efficient in using the LHIMS for health service delivery.

However, a chi-square test indicated no statistically significant association between respondents' ages and the efficient use of the LHIMS at χ^2 (4, N=1126) = 2.694, P-value=.610. The test revealed that 27.8 per cent of respondents aged 20 to 29 years were highly efficient using the LHIMS. For respondents aged 30 to 39 years, 32.1 per cent were highly efficient using the

LHIMS. Lastly, for respondents aged 40 and above, 31.4 per cent were efficient in using the LHIMS for health service delivery.

Another test was run to assess the efficient use of LHIMS regarding respondents' educational qualification, a chi-square test indicated a statistically significant relationship between the educational qualification of respondents and the efficient use of the LHIMS at χ^2 (4, N=1126) = 15.60, P-value=.004. The test revealed that for respondents who were certificate holders, 27.7 per cent were highly efficient in using the LHIMS and for those with Diplomas/HND, 36.3 per cent were efficient using the LHIMS. Lastly, for respondents with degree qualifications, 25.2 per cent were efficient in using the LHIMS for health service delivery.

Aside from the respondent's educational qualification, a chi-square test revealed a statistically significant association between the work experience of respondents and the efficient use of LHIMS at χ^2 (4, N=1126) = 10.03, P-value=.040. For the respondents with 1 year and below experience, 26.8 per cent were highly efficient in using the LHIMS. Among the respondents with 2 to 5 years of work experience, 28.9 were highly efficient in using the LHIMS while 37.6 per cent of respondents with 6 years and above experience were highly efficient in using the LHISM for health service delivery (see Table 6).

Table 6:Bivariate Analysis of Socio-demographic Characteristics and Efficient Use of the LHIMS

Variable	Efficiency			*p*
	Inefficient	Moderately Efficient	Highly Efficient	
Sex	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Female	186 (26.9%)	282 (40.8%)	223 (32.3%)	.022
Male	148 (34.0%)	172 (39.5%)	115 (26.4%)	
Age				
20 - 29	160 (30.0%)	225(42.20%)	148 (27.80%)	.610
30 - 39	148 (29.20%)	196 (38.70%)	163 (32.10%)	
≥ 40	26 (30.20%)	33 (38.40%)	27 (31.40%)	
Educational Qualification				
Certificate Holder	43 (33.1%)	51 (39.2%)	36 (27.7%)	.004
Diploma/HND	125 (27.4%)	166 (36.3%)	166 (36.3%)	
Degree	166 (30.8%)	237 (44.0%)	136 (25.2%)	
Years of Work Experience				
≤ 1 year	120 (32.8%)	148 (40.4%)	98 (26.8%)	.040
2 to 5 years	157 (30.0%)	215 (41.1%)	151 (28.9%)	
≥ 6 years	57 (24.1%)	91 (38.4%)	89 (37.6%)	

Source: Agyemang, 2021

Professional Characteristics and Efficient Use of LHIMS

Kaipio et al. (2020) postulate that there are significant differences between nurses' and physicians' experiences of the usability of EHR systems. Consequently, a chi-square analysis was conducted examining the association between a respondent's professional type the institution where the professional was trained (training institution) and the efficient use of LHIMS. The test (see Table 6) revealed a statistically significant association between professional type and the efficient use of the LHIMS at χ^2 (4, N=1126) =15.77, P-value =.003. For prescribers (medical doctors and physician assistants), 20.2 per cent were highly efficient in using the LHIMS. Also, 32.7 per cent of nurses and midwives were highly efficient in using the LHIMS

while 34.0 per cent of the auxiliary staff (dispensing staff, medical records, physiotherapy, x-ray, and laboratory) were highly efficient in using the LHIMS for health service delivery.

Table 7: Bivariate (crosstabulation) Analysis of Professional Characteristics and Efficient use of LHIMS by Respondents

Variable	Efficiency			*P*
	Inefficient	Moderately Efficient	Highly Efficient	
Professional Type	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Prescribers	86 (34.0%)	116 (45.8%)	51 (20.2%)	.003
Nurses and Midwives	212 (29.0%)	281 (38.4%)	239 (32.7%)	
Auxiliary	36 (25.5%)	57 (40.4%)	48 (34.0%)	
Training Institution				
MOH training Institution (NMTC, CoH, Community)	187 (29.7%)	261 (41.5%)	181 (28.8%)	.543
University	147 (29.6%)	193 (38.8%)	157 (31.6%)	

Source: Agyemang (2021)

In addition, a chi-square test was conducted to examine the relationship between the training institution of the respondents and the efficient use of LHIMS. According to the test, there was no statistically significant correlation between the respondents' training institutions and how efficiently they used the LHIMS at χ^2 (2, N=1126) =.176, P-value =.543. The test revealed that 28.8 per cent of respondents trained at professional training institutions (Nursing and midwifery training college, college of health and community training school) were highly efficient in using the LHIMS while among respondents who attended university, 31.6 per cent were highly efficient in using the LHIMS for health service delivery (see Table 6).

Training/computer Proficiency and the Efficient Use of LHIMS

According to Ngusie et al. (2022), perceived technology self-efficacy, computer literacy, and EHR training are all linked to healthcare practitioners' preparedness to adopt and use electronic health record systems. In this current study, a chi-square test of independence is conducted to assess the association between respondents' training status before the use of the LHIMS, duration of the training and computer proficiency and the efficient use of LHIMS. From the findings, there is a statistically significant relationship between the status of training and the efficient use of LHIMS at χ^2 (2, N=1126) =9.10, P-value =.011. Of respondents who received training before the use of the LHIMS, 28.6 per cent were highly efficient while 41.8 per cent of respondents who did not receive training before the use of the LHIMS were highly efficient.

The duration of training of respondents did not show a statistically significant association with the efficient use of the LHIMS at χ^2 (6, N=1126) =7.67, P-value =.263. The test showed that of the respondents who were never trained, 27.0 per cent were highly effective using the LHIMS. For respondents who received training for 1 to 2 days before the use of the LHIMS, 31.5 per cent were highly efficient using the LHIMS. For respondents trained for 3 to 4 days, 28.5 per cent were highly efficient in using the LHIMS. And lastly, for professionals trained for 5 days or more, 28.6 per cent were highly efficient in using the LHIMS for health service delivery.

Table 8: Bivariate (Crosstabulation) Analysis of Training/Computer Proficiency and LHIMS Efficiency for Health Service Delivery by Respondents

Variable	Efficiency			*p*
	Inefficient	Moderately Efficient	Highly Efficient	
Training	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Yes	303 (30.2%)	414 (41.2%)	287 (28.6%)	.011
No	31 (25.4%)	40 (32.8%)	51 (41.8%)	
Duration of Training				
Never Trained	34 (27.9%)	55 (45.1%)	33 (27.0%)	.263
1 to 2 days	178 (28.6%)	248 (39.9%)	196 (31.5%)	
3 to 4 days	66 (36.9%)	62 (34.6%)	51 (28.5%)	
5 days or more	56 (27.6%)	89 (43.8%)	58 (28.6%)	
Computer proficiency				
Beginners	83 (34.6%)	112 (46.7%)	45 (18.8%)	.000
Advanced Users	251 (28.3%)	342 (38.6%)	293 (33.1%)	

Source: Agyemang (2021)

A chi-square test of association revealed a statistically significant relationship between computer proficiency and efficient use of LHIMS at χ^2 (2, N=1126) =18. 44, P-value < .001. The results from the study show that among respondents who rated themselves as "Beginner", 18.8 per cent were highly efficient in using the LHIMS while among the respondents who rated themselves as "advanced users" of a computer, 33.1 were highly efficient in using the LHIMS for health service delivery (See Table 8).

Multivariate Analysis of the Efficient Use of LHIMS by Respondents

Multivariate analysis was performed to assess the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification, and years of work experience*), professional characteristics (*professional type, place of training, and institution of training*) and

Training/computer proficiency (*training status*, *duration of training and computer proficiency*) on the efficient use of the LHIMS.

In Model 1, ordinal logistic regression analysis was fitted to assess the relationship between respondents' socio-demographic characteristics (age, sex, educational qualification, and years of work experience) on the efficient use of the LHIMS. The test revealed that the sex of the respondent, educational qualification of the respondent and years of work experience of the respondent significantly influenced the efficient use of LHIMS. However, the age of the respondents did not statistically predict the efficient use of LHIMS. Hence, the age of the respondent was dropped at model 1 while sex, educational qualification and work experience were retained in the model.

In Model 2, controlling for sex, educational qualification, and years of work experience of the respondent ordinal logistic regression was fitted to assess professionals' characteristics (professional type and training institution the respondent attended). The test revealed a statistically significant association between the professional type and the efficient use of LHIMS. However, there was an interaction (multicollinearity) between professional type and educational qualification. As a result, the predictor variable "professional-type" was dropped from the model as well as the training institution of the respondent since it had no statistically significant association with the efficient use of LHIMS.

Table 9: Ordinal Logistic Regression Analysis Socio-demographic, Professional Characteristics, and Efficient Use of LHIMS by Respondents

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Socio-Demographic			
Sex			
Female	1.286 (1.021, 1.62) *	1.276 (1.013, 1.609) *	1.199 (0.947, 1.518)
Male	1.00	1.00	1.00
Educational Qualification			
Certificate	0.96 (0.67, 1.374)	0.92 (0.641, 1.321)	0.879 (0.611, 1.265)
Diploma/HND	1.336 (1.052, 1.698) *	1.288 (1.01, 1.641) *	1.245 (0.976, 1.589)
Degree +	1.00	1.00	1.00
Work Experience			
≤ 1 year	0.621 (0.458, 0.842) *	0.622 (0.458, 0.844) *	0.628 (0.462, 0.852) *
2 to 5 years	0.714 (0.537, 0.95) *	0.721 (0.541, 0.96) *	0.724 (0.544, 0.965) *
≥ 6 years	1.00	1.00	1.00
Training/ Computer Proficiency			
Status of Training			
Yes		0.691 (0.48, 0.994) *	0.715 (0.496, 1.031)
No		1.00	1.00
Computer proficiency			
Beginner			0.689 (0.525, 0.904) *
Advanced Users			1.00

Source: Agyemang, 2021

*** = p-value ≤ 0.05; OR=Odds Ratio; CI=Confidence Interval; 1.00=Reference category; Sample (N) = 1126**

In model 3, accounting for sex, educational qualification, work experience and training of professionals before EHR use, ordinal logistic regression was fitted to assess computer proficiency and the efficient use of the LHIMS. The test revealed that sex, educational qualification, and training before the use of LHIMS were all not statistically significant except for years of work experience and computer proficiency. Even though sex and educational qualification were not statistically significant in the final model, for sex, female respondents were (OR=1.20, 95% CI= [0.947 - 1.518]) more likely to use the LHIMS as highly efficient as compared to male respondents. For educational qualifications, respondents who were certificate holders had lower odds (OR=0.88, 95% CI= 0.96 [0.611-1.265]) as compared to the respondents who were degree holders in using the LHIMS efficiently. Contrarily, the respondents with diploma/HND qualifications were (OR=1.25, 95% CI= 0.96 [0.976 - 1.589]) more likely to use the LHIMS efficiently than the respondents who had degree qualifications.

For years of work experience and computer proficiency, the test revealed a statistically significant association in the efficient use of LHIMS by respondents. For work experience, respondents with 1 year and below experience was 37.2 per cent less likely to be highly efficient in using the LHIMS as compared to professionals who had 6 and above years of work experience. Again, respondents with 2 to 5 years of work experience, were 27.6 per cent less likely to be highly efficient in using the LHIMS as compared to the respondents who had 6 and above years of work experience. For computer proficiency, professionals who are ‘beginners’ in general computing, their odds of being highly efficient in the use of the LHIMS were

lower (OR=0.689, 95% CI= 0.96 [0.525 - 0.904]) as compared to professionals who were “advanced users” of a computer (see Table 9).

Discussion of Findings

According to the Ministry of Health (2017), many developing countries, including Ghana, would struggle to meet all the global targets required to improve the health sector. As a result, a national e-health system, the Lightwave Health Information Management System (LHIMS), was necessary for the health sector to improve service efficiency and function as the country's Electronic Health Record (EHR) and a bio-surveillance system (Ministry of Health, 2017). Findings from the study revealed that the LHIMS enhances service delivery efficiency. Health professionals who participated in the study indicated that using the LHIMS lessened a patient's time spent at the unit and facilitated quick task execution as well as assisted in giving the patients proper care.

Admittedly, these results are consistent with the 2005 and 2010 National E-Health Strategic Policy's objective (Ministry of Health, 2005; MOH, 2010) and with the international standard, HealthIT.Gov (2019) suggests that an EHR system should offer quick access to patient records and efficient job execution in addition to providing accurate, full, and up-to-date patient information at the point of care. The findings show that the LHIMS has these features and is now deployed and used widely within the health sector of Ghana. However, results from Donovan’s (2019) literature report inefficiencies of EHRs adoption such as system users being permanently connected to a computer and using multi-click diagnostic chart navigations which make the use of EHR systems by health professionals undesirable. In

the case of the LHIMS, findings indicated the contrary. The reasons that may account for the differences in literature may be due to several factors including the type of EHR software deployed, the design of the system interface and personal factors including age, sex, work experience, training before system use and type of profession (Shanafelt et al., 2016; Lanier et al., 2018).

Shanafelt et al. (2016) argue that several factors influence the efficient use of EHR systems. According to the Technology Acceptance Model by Davies (1989), external factors such as age, gender, and organisational factors are theorised to influence the perceived usefulness (efficiency) of an EHR system. As a result, this current study hypothesised that health professionals' efficient use of the LHIMS is influenced by socio-demographic characteristics (age, sex, educational qualification, and years of work experience), professional characteristics (staff category, place of training, and institution of training), and computer self-efficacy.

The results of the multivariate analysis for socio-demographic characteristics (age, sex, educational qualification, and years of work experience) of health professionals and the efficient use of Electronic Health Records revealed that age, sex and educational qualification had an insignificant effect on the efficient use of EHR. However, years of work experience was the only socio-demographic characteristic that was found to have a statistically significant influence on the efficient use of LHIMS. The results are in agree with findings from Adedeji et al. (2018); Khairat et al. (2019) and Bae and Encinosa (2016). Adedeji et al. (2018) in their study found a significant association between the use of EHR and age, availability of computer systems, years of working experience and training of users. The

results of their study are in contrast with that found in this study except in terms of years of work experience which was found to have no significant effect on efficiency in the use of EHR among health professionals.

Khairat et al. (2019) in their study examined how doctors' performance, efficiency, perceived workload, happiness, and usability of the electronic health record (EHR) differed depending on their age, gender, professional function, and years of experience with the EHR. They found some differences in efficiency among male and female physicians. The data showed that female physicians are more efficient in using electronic health records (EHRs) as they used the EHR's general search bar and filters, which resulted in a more efficient search, and this means that differences in sex among health professionals play a role in their efficient use of EHR. This finding contrasts with the one obtained in this study. However, even though sex, in general, was found to have no significant effect on the efficient use of EHR, the results, show that females in practice will be able to use the LHIMS more efficiently as compared to their male colleagues. This somewhat contrasting analysis may be due to the bivariate analysis which showed that the sex of health professionals has an association with their efficient use of EHR.

Bae and Encinosa (2016) revealed that age and years of work experience matter in the efficient use of an EHR system. They suggested that older physicians who have more years of experience in the field were better at integrating EHR into clinical practice as compared to younger physicians with just a few years of work experience. Their study, therefore, provides support for the finding that years of work experience have played a major role in the

efficient use of LHIMS by health professionals but contrasts with the finding that the age of health professionals does not affect how efficiently they use EHR. These findings indicate that not all external factors (age, sex, and education) in the technology acceptance model by Davies (1989) may predict differences in the efficient use of the LHIMS, and the variation in the literature is dependent on the type of EHR software adopted.

In addition to social demographic characteristics, the multivariate analysis on professional characteristics and efficient use of the LHIMS yielded results indicating an insignificant association between the type of professionals and the institution where health professionals received their training and their efficient use of the LHIMS. Nevertheless, the bivariate analysis between professional type and efficiency in the use of the LHIMS revealed a significant association. This indicated that the professional characteristics of health professionals did not significantly influence the efficiency of their LHIMS usage, even when accounting for other variables like age, sex, education, and years of work experience. Comparable results were reported in the study by Nandikove et al. (2018), where researchers found no significant differences among professional types in their utilisation of the EHR system in Kakamega County, Kenya.

The multivariate analysis of training/computer proficiency showed that computer proficiency had a significant effect on the efficient use of LHIMS whereas training was found to have no significant effect. This means that without computer proficiency, health professionals cannot use the LHIMS efficiently. However, whether they receive training on how to use EHR systems or not does not enhance their efficiency by much. Contrarily, Butcher

(2019) found different results on training and professional type. According to Butcher (2019), health professionals who received training in EHR systems used relatively less time working in the EHR systems as compared to when they had not received any training.

The study explored the relationship between training and efficiency in using the LHIMS among health professionals. The bivariate analysis initially indicated a significant relationship, but the multivariate analysis showed no statistically significant association between the two variables. Despite this, it was inferred that training could still enhance health professionals' proficiency in using the LHIMS. The results emphasised the importance of socio-demographic characteristics and computer proficiency in ensuring efficient LHIMS usage. Hospital governing bodies should ensure that health professionals have received general computing courses, especially for young professionals with limited work experience. Effective LHIMS training is essential to avoid inefficiencies in EHR system usage, which can have serious repercussions for patients and institutions.

Furthermore, the study revealed that LHIMS deployment has improved service efficiency, aligning with key Sustainable Development Goals (SDGs) and Universal Health Coverage (UHC) targets. Although training before LHIMS use did not show statistical significance at the multivariate level, computer proficiency and years of work experience did. Hence, it can be implied that health professionals receive both LHIMS-specific and general computing skills training to enhance proficiency. Moreover, experienced health professionals should support their less experienced colleagues in LHIMS usage, contributing to overall efficiency. Tailored IT training based on

professional type can also be beneficial to boost confidence and reduce time spent using the LHIMS. By considering these findings, healthcare institutions can optimise LHIMS utilisation, leading to improved healthcare services and progress towards broader health-related goals (Kadish et al., 2018).

CHAPTER SIX

SATISFACTION WITH THE USE OF THE LIGHTWAVE HEALTH INFORMATION MANAGEMENT SYSTEM FOR HEALTH SERVICE DELIVERY

Introduction

The information system success model by Delone and Mclean (2003) and the International Organisation for Standardisation (ISO) (2019) framework argue strongly that user satisfaction is important, and the success of an information system depends on the satisfaction of the system user. As system users are satisfied, the deployment of the information system is more likely to be sustained (Delone and Mclean, 2003; ISO, 2019). However, regarding user satisfaction, Kaipio et al. (2020) are of the view that there is considerable variation in satisfaction with the use of Electronic Health Record (EHR) systems between nurses and physicians. There is also a correlation between physicians' age, gender, practice type, as well as years of work experience and satisfaction with the use of an EHR system (Khairat et al., 2019).

In this chapter, descriptive statistics (weighted mean) are computed to determine the average weighted score for all the indicators under satisfaction. In the same chapter, bivariate (chi-square) and multivariate (ordinal logistic regression) analyses are conducted. In addition, as part of assessing respondent's satisfaction with the use of the LHIMS for health service delivery, the study tests the following hypotheses from the literature reviewed.

H_1: Socio-demographic characteristics (age, sex, educational qualification, and years of work experience) influence respondents' satisfaction with the use of LHIMS.

H_2: professional characteristics (professional type and institution of training) influence respondents' satisfaction with the use of LHIMS.

H_3: training/computer proficiency (training status, duration of training and computer proficiency) influence respondents' satisfaction with the use of LHIMS.

Descriptive Statistics of Respondents' Satisfaction with the Use of LHIMS

This section analyses respondents' satisfaction with the use of LHIMS using a 5-point Likert scale. The weighted mean formula was used to calculate the weighted average scores, with weights of 1-5 assigned to the Likert scale. The interpretation of the weighted average scores was based on a specific set of parameters, ranging from strongly disagree to strongly agree, as outlined by Manyange, Abuga and Ongabi (2015). Table 9 displays the descriptive statistical analysis of respondents' satisfaction with the use of LHIMS.

From Table 9, majority of respondents were satisfied with how quickly LHIMS gathered information (3.51). Respondents found the LHIMS reliable (3.46) and they were satisfied with the ease at which they could retrieve information via the LHIMS (3.51). Also, respondents were elated with the LHIMS's system flexibility (3.62) and the accuracy of the information the system generated (3.72).

Table 10:Descriptive Statistical Analysis of the Respondents' Satisfaction with the Use of LHIMS

Statement	VD	D	N	S	VS	Weighted Average	Interpretation
	1	2	3	4	5		
I am satisfied with the rate at LHIMS generates information on time	32	150	259	582	103	3.51	Satisfied
I am satisfied with the reliability of the LHIMS	52	146	275	534	119	3.46	Satisfied
It is easy to retrieve the information I need using LHIMS	46	127	282	554	117	3.51	Satisfied
I am satisfied with how flexible the system is	31	117	242	597	139	3.62	Satisfied
I am satisfied with the accuracy of the information generated by the LHIMS	26	88	221	635	156	3.72	Satisfied
I am satisfied with the system quality/usefulness of the LHIMS	24	88	243	591	180	3.72	Satisfied
I am satisfied with the consistency of the system interface	21	73	242	628	162	3.74	Satisfied
I am satisfied with the quality interface of the LHIMS	23	79	258	614	152	3.70	Satisfied
I am satisfied with the speed (minimal wait between screens, minimal boot-up time etc.) of the LHIMS during task execution	23	67	276	608	152	3.71	Satisfied
I am satisfied with the arrangement and clarity of the screen items (font, tables, pop-up list etc.) on the interface of the LHIMS	21	61	221	641	182	3.80	Satisfied

Source: Agyemang, 2021

Weighted Average = $\sum wx / \sum w$

Interpretation: 1.0 – 1.79 = Very Dissatisfied; 1.80 – 2.59 = Dissatisfied; 2.60 – 3.39 = Moderately Satisfied; 3.40 – 4.19 = Satisfied; 4.20 – 5.00 = Very Satisfied

Additionally, the respondents found LHIMS useful/quality (3.72) and acknowledged that there was consistency in the system's interface (3.74). Besides this, respondents indicated that LHIMS had a quality interface (3.70) and the system's speed during task execution was satisfactory (3.71). Lastly, respondents were comfortable with the arrangement and clarity of the screen items on the interface of the LHIMS (3.80) (see Table 10).

Bivariate Analysis of Respondents' Satisfaction with the Use of LHIMS for Health Service Delivery

A bivariate analysis was run to assess the influence of socio-demographic characteristics of respondents (age, sex, educational qualification, and years of work experience), professional characteristics (Professional type and type of institution attended) and Training / Computer proficiency (training status, duration of training and computer proficiency) on respondents' satisfaction with the use of the LHIMS for health service delivery.

Socio-demographic Characteristics of Respondents and Satisfaction with the Use of the LHIMS

It has been argued in the literature that the socio-demographic characteristics of respondents influence their satisfaction with the use of an electronic health record system (Shanafelt et al., 2012; Khairat et al., 2019). As a result, this study performed a chi-square test to assess the influence of socio-demographic characteristics (sex, age, education, and years of work experience) on respondents' satisfaction with the use of LHIMS. From the test, there was no statistically significant association between the sex of respondents and satisfaction with the LHIMS at χ^2 (2, N=1126) = 3.29, P-

value=.192. The results indicated that 32.0 per cent of female respondents were very satisfied while 26.9 per cent of male respondents were very satisfied with using the LHIMS for health service delivery. The test also revealed no statistically significant association between the age of respondents and satisfaction with the use of LHIMS at χ^2 (4, N=1126) = 5.379, P-value=.251. For respondents aged 20 to 29 years, 26.8 per cent were very satisfied with using the LHIMS and for the respondents aged 30 to 39 years, 28.4 per cent were very satisfied. Of the respondents, 40 years and above, 27.8 per cent were very satisfied with using the LHIMS for health service delivery.

Additionally, the chi-square test revealed a statistically significant association between the educational qualification of respondents and satisfaction with the use of the LHIMS at χ^2 (4, N=1126) = 12.77, P-value=.012. For respondents who were certificate holders, 29.2 per cent were very satisfied with using the LHIMS while for respondents with diploma qualifications, 35.7 per cent were very satisfied. However, for respondents who had degree qualifications, 25.4 per cent were very satisfied with using the LHIMS for health service delivery. Again, to test the association between respondents' work experience and satisfaction with the use of the LHIMS, a chi-square test was run and found a statistically significant association between the work experience of respondents and satisfaction with the use of LHIMS at χ^2 (4, N=1126) = 14.02, P-value=.007. For respondents who had 1 year or below years of work experience, 25.4 per cent were very satisfied with using the LHIMS and for respondents with 2 to 5 years of work experience, 30.4 per cent were very satisfied. However, for respondents with 6 or more

years of work experience, 36.3 per cent were very satisfied with using the LHIMS for health service delivery (see Table 11).

Table 11: Bivariate Analysis of Socio-demographic Characteristics and Respondents' Satisfaction with the Use of LHIMS

Variable	Satisfaction			p
	Not Satisfied	Moderately Satisfied	Very Satisfied	
Sex	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Female	226 (32.7%)	244 (35.3%)	221 (32.0%)	.192
Male	154 (35.4%)	164 (37.7%)	117 (26.9%)	
Age				
20 - 29	192 (36.0%)	198 (37.1 %)	143 (26.8%)	.251
30 - 39	161 (31.8%)	178 (35.1%)	168 (33.1%)	
40	27 (31.4%)	32 (37.2%)	27 (31.4%)	
Educational Qualification				
Certificate Holder	43 (33.1%)	49 (37.7%)	38 (29.2%)	.012
Diploma/HND	139 (30.4%)	155 (33.9%)	163 (35.7%)	
Degree	198 (36.7%)	204 (37.8%)	137 (25.4%)	
Years of Work Experience				
1 year and below	138 (37.7%)	135 (36.9%)	93 (25.4%)	.007
2 to 5 years	183 (35.0%)	181 (34.6%)	159 (30.4%)	
6 years and above	59 (24.9%)	92 (38.8%)	86 (36.3%)	

Source: Agyemang, 2021

Professional Characteristics and Respondents' Satisfaction with the Use of the LHIMS

According to Bani-Issa et al. (2016), there are disparities in respondents'' satisfaction with the usage of Electronic Health Records (EHR) systems. For instance, Kaipio et al. (2020) hypothesise that nurses and physicians have different levels of satisfaction with the use of EHR systems. Consequently, a chi-square test of independence was conducted to assess respondents' professional characteristics (Respondents' professional type and

training institution of respondents) and satisfaction with the use of the LHIMS. The test revealed a statistically significant relationship between respondents' professional type and satisfaction with the use of the LHIMS at χ^2 (4, N=1126) = 13.13, P-value=.011. Among prescribers, 21.3 per cent were very satisfied with using the LHIMS for health service delivery. Among nurses and midwives, 33.2 per cent were very satisfied with using the LHIMS for health service delivery. Also, 29.1 per cent of the auxiliary staff were very satisfied with using the LHIMS for health service delivery.

Table 12: Bivariate Analysis of Respondents' Professional Characteristics and Satisfaction with the Use of LHIMS for Health Service Delivery

Variable	Satisfaction			p
	Not Satisfied	Moderately Satisfied	Very Satisfied	
Professional type				
Prescribers	100 (39.5%)	99 (39.1%)	54 (21.3%)	.011
Nurses and Midwives	233 (31.8%)	256 (35.0%)	243 (33.2%)	
Auxiliary	47 (33.3%)	53 (37.6%)	41 (29.1%)	
Training Institution				
MoH Training Institution	205 (32.6%)	239 (38.0%)	185 (29.4%)	.375
Public University	175 (35.2 %)	169 (34.0%)	153 (30.8%)	

Source: Agyemang, 2021

Similarly, a chi-square test was run to examine the training institutions of respondents and satisfaction with the use of the LHIMS. Results from the test indicated no statistically significant association between the training institution of respondents and satisfaction with the use of the LHIMS at χ^2 (2, N=1126) = 1.96, P-value=.375. Even though the results showed that 29.4 per cent of respondents who received training from a professional training

institution were very satisfied. For respondents who had university education, 30.8 per cent were very satisfied with using the LHIMS for service delivery (see Table 12).

Training/Computer Proficiency and Respondents' Satisfaction with the Use of the LHIMS

Even with the most user-friendly software, computer skills are required for EHR use. Employees are better able to make the transition without experiencing substantial difficulties that can derail the rest of the training process when they understand the fundamentals of the hardware and software they will be operating (Alasmary et al., 2014). According to Bani-Issa et al. 2016), training and computing skills are important predictors of user satisfaction with Electronic Health Record (EHR) systems. Consequently, a chi-square test was conducted to assess training/ computer proficiency (status of training before the use of LHIMS, duration of the training, and computer proficiency) and satisfaction with the use of the LHIMS.

The results showed a statistically significant relationship between training and satisfaction with the use of the LHIMS at χ^2 (2, N=1126) = 10.38, P-value=.006. For respondents who received training before the use of the LHIMS, 28.5 per cent were very satisfied while for respondents who did not receive training, 42.6 per cent were very satisfied with using the LHIMS for health service delivery. Also, a chi-square test between the duration of training of respondents before the use of the LHIMS had no statistically significant association with respondents' satisfaction with the use of LHIMS for health service delivery at χ^2 (6, N=1126) = 6.60, P-value=.360. for respondents who never received training, 28.7 per cent were very satisfied

using the LHIMS. Among respondents who received 1-to-2-day (s) training, 29.4 per cent were satisfied with using the LHIMS. Of the respondents who received 3 to 4 days of training, 27.4 per cent were very satisfied and for the respondents who received training for 5 days or more 35.0 per cent were very satisfied with using the LHIMS for health service delivery.

Table 13: Bivariate Analysis of Training/Computer Proficiency and Satisfaction with the Use of LHIMS for Health Service Delivery.

Variable	Satisfaction			p
	Not Satisfied	Moderately Satisfied	Very Satisfied	
Training	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Yes	347 (34.6%)	371 (37.0%)	286 (28.5%)	.006
No	33 (27.0%)	37 (30.3%)	52 (42.6 %)	
Duration of Training				
Never Trained	43 (35.2%)	44 (36.1%)	35 (28.7%)	.360
1 to 2 days	211 (33.9%)	228 (36.7%)	183 (29.4%)	
3 to 4 days	70 (39.1%)	60 (33.5%)	49 (27.4%)	
5 days or more	56 (27.6%)	76 (37.4%)	71 (35.0%)	
Computer Proficiency				
Beginners	87 (36.3%)	106 (44.2%)	47 (19.6%)	.000
Advanced Users	293 (33.1%)	302 (34.1%)	291 (32.8%)	

Source: Agyemang, 2021

Also, from the chi-square test, there was a strong statistically significant relationship between computer proficiency and satisfaction with the use of the LHIMS at χ^2 (2, N=1126) = 16.93, P-value=.000. For respondents who rated their level of computer proficiency as “beginner”, 19.6 per cent were very satisfied with using the LHIMS, 44.2 per cent were moderately satisfied and 36.3 per cent were not satisfied. For respondents who rated their level of computer proficiency as “advanced users”, 32.8 per cent were satisfied with using the LHIMS, 34.1 per cent were moderately satisfied and 33.1 per cent were not satisfied (see Table 13)

Multivariate Analysis of Respondents' Satisfaction with the Use of LHIMS for Health Service Delivery

Multivariate analysis was conducted to assess the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification, and years of work experience*), professional characteristics (*professional type, place of training, and institution of training*) and Training/computer proficiency (*training status, duration of training and computer proficiency*) on satisfaction with the use of LHIMS.

In Model 1, ordinal logistic regression analysis was conducted to assess the relationship between respondents' socio-demographic characteristics (age, sex, educational qualification, and work experience) and their satisfaction with the use of LHIMS. The test revealed that only the educational qualification of the respondent and work experience significantly influenced satisfaction with the use of LHIMS. However, the age of respondents and sex did not statistically predict satisfaction with the use of LHIMS. Hence, the age and sex of the respondent were dropped in model 1 while educational qualification and work experience were retained in the model.

In Model 2, controlling for educational qualification and work experience of respondents, ordinal logistic regression was performed to assess respondents' professional characteristics (respondents' professional type and training institution the respondent attended) and satisfaction with the use of the LHIMS. The test revealed a statistically significant association between the professional type and satisfaction with the use of LHIMS. However, there was an interaction (multicollinearity) between professional type and

educational qualification. As a result, the predictor variable "professional-type" was dropped from the model as well as the training institution of the respondent since it had no statistically significant association with the efficient use of LHIMS. Still at model 2, accounting for educational qualification and work experience, an ordinal logistic regression analysis revealed the training status of respondents before the use of LHIMS and the duration of training statistically predicted respondents' satisfaction with the use of LHIMS.

In the final model (model 3), accounting for educational qualification, work experience, training status of respondents before the use of LHIMS and duration of the training, ordinal logistic regression was fitted to assess computer proficiency and satisfaction with the use of LHIMS. The test revealed that educational qualification, work experience, training status of respondents before the use of LHIMS, duration of the training and computer proficiency were all statistically significant. For educational qualifications, respondents who were certificate holders had higher odds (OR=1.11, 95% CI= 0.96 [0.771 - 1.582]) times likely to be very satisfied using the LHIMS as compared to the respondents who were degree holders. Also, respondents with diploma / HND qualifications were (OR=1.39, 95% CI= 0.96 [1.098 - 1.766]) likely to be very satisfied using the LHIMS as compared to the respondents who had degree qualifications.

For years of work experience, the test revealed a statistically significant association between work experience and satisfaction with the use of the LHIMS. Respondents with 1 year and below work experience had lower odds (OR=0.568, 95% CI= 0.96 [0.420 - 0.768]) of being satisfied using the LHIMS as compared to the respondents who had 6 and above years of

work experience. Also, respondents with 2 to 5 years of work experience had lower odds (OR=0.56, 95% CI= 0.96 [0.415 - 0.763]) of being very satisfied with the use of the LHIMS as compared to the respondents who had 6 and above years of work experience.

For the status of training of respondents and duration of the training, the test revealed a statistically significant association between the status of training before the use of LHIMS and satisfaction with the use of the LHIMS. For professionals who received training before the use of the LHIMS, their odds of being very satisfied were lower (OR=0.652, 95% CI= 0.96 [0.454 – 0.937]) as compared to respondents who did not receive training. Also, the duration of training statistically influenced satisfaction with the use of the LHIMS. The respondents who were never trained had lower odds (OR=0.788, 95% CI= 0.96 [0.519 – 1.197]) of being very satisfied using the LHIMS as compared to the respondents who received training for 5 days or more.

Also, the respondents who had 1 to 2 days of training, their odds of being very satisfied were lower (OR=0.775, 95% CI= 0.96 [0.578 – 1.039]) as compared to the professionals who received training for more than 5 days. The respondents who received 3 to 4 days of training had lower odds of being very satisfied (OR=0.606, 95% CI= 0.96 [0.416 – 0.883]) as compared to the respondents who received training for 5 days or more. For computer proficiency, professionals who are 'beginners' in general computing, had odds of being very satisfied using the LHIMS lower (OR=0.77, 95% CI= 0.96 [0.588, 1.00]) as compared to respondents who were "advanced users" of a computer (see Table 14)

Table 14: Multivariate Analysis of Respondents' Satisfaction with the Use of the LHIMS

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Socio-Demographic			
Educational Qualification			
Certificate	1.232 (0.866, 1.752)	1.154 (0.807, 1.649)	1.105 (0.771, 1.582)
Diploma/HND	1.492 (1.183, 1.880) *	1.447 (1.144, 1.829) *	1.392 (1.098, 1.766) *
Degree +	1.00	1.00	1.00
Work Experience			
≤ 1 year	0.568 (0.420, 0.768) **	0.558 (0.412, 0.756) **	0.563 (0.415, 0.763) **
2 to 5 years	0.696 (0.524, 0.923) *	0.701 (0.528, 0.931) *	0.711 (0.535, 0.944) *
≥ 6 years	1.00	1.00	1.00
Training/computer proficiency			
Status of Training			
Yes		0.652 (0.454, 0.937) *	0.652 (0.454, 0.937) *
No		1.00	1.00
Training Duration			
Never Trained		0.79 (0.521, 1.199)	0.788 (0.519, 1.197)
1 to 2 days		0.778 (0.58, 1.0420)	0.775 (0.578, 1.039)
3 to 4 days		0.606 (0.416, 0.882) *	0.606 (0.416, 0.883) *
5 days or more		1.00	1.00
Computer proficiency			
Beginner			0.767 (0.588, 1.00) *
Advanced Users			1.00

Source: Agyemang, 2021

*** = p-value ≤ 0.05; ** = p-value < 0.01; OR=Odds Ratio; CI=Confidence Interval; 1.00=Reference category; Sample (N) = 1126**

Discussion of Findings

Digitised and electronic patient records have been developed because of developments in information technology that aim to streamline the process of keeping and retrieving such data (Boadu et al., 2021). The Lightwave Health Information Management System (LHIMS) is a versatile system for managing patient records and other medical data. LHIMS's adaptability makes it suitable for EHR management. The descriptive statistics of respondents' responses show that the LHIMS aids in the fast retrieval of accurate information and is also flexible. The system's interface is of good quality and the speed of operation is also good. This finding is contrary to Vanderhook and Abraham's (2017) study which reveals that EHR fails to perform as expected due to technical or sociotechnical elements. The health professionals who use the LHIMS indicate that the system is more helpful than harmful.

From the multivariate analysis performed to evaluate how the socio-demographic characteristics (age, sex, educational qualification, and years of work experience) of health professionals affect their satisfaction with the use of the LHIMS, it was revealed that educational qualification and work experience had a significant effect on their satisfactory use of the LHIMS. This means that their level of education and the number of years they have worked as health professionals affect their satisfaction with the use of Electronic Health Systems (EHR). However, the results revealed that the sex and age of health professionals do not affect their satisfactory use of the LHIMS.

The multivariate analysis performed to examine how health professionals' satisfaction with the use of EHR is affected by their

professional characteristics, revealed that professional type had no significant effect on health professionals' satisfactory use of EHR systems. This may be a result of the different information needs that these categories of health professionals require from Electronic Health Record systems. However, the institution where health professionals received their training was found not to affect their satisfactory use of EHR systems. This means that health professionals can hone their skills so that their abilities, in terms of their medical abilities and the use of technology in health care administration, particularly EHR systems, go beyond their institution of training.

The results of the multivariate analysis on training/ computer proficiency and health professionals' satisfaction with the use of the LHIMS revealed that health professionals' satisfactory use of LHIMS is affected by their training/ computer proficiency. This is especially true because if health professionals do not know how to use computers or are without any training on computer proficiency, their satisfaction with the use of the LHIMS will be quite low. The following studies agree with these findings: Butcher (2019); Kaipio et al. (2020); Bani-Issa et al. (2016); Tilahun and Fritz (2015); Al Otaybi et al. (2022); Schopf et al. (2019). However, Khairat et al. (2019) findings on sex contrast with what is found in this study.

Khairat et al. (2019) found in their study that sex was a determinant of satisfaction with the use of EHR systems. They found in their study that females were consistently and substantially more satisfied than males with the amount of effort necessary to obtain information and accomplish EHR activities, and they had greater levels of satisfaction with the usability, complexity, and burdensomeness of EHRs. These findings contrast that of this

study that the sex of health professionals does not affect their satisfaction with the use of LHIMS-EHR. These differences may have been geographical or variance in the EHR systems used by the individual respondents.

According to Butcher's (2019) research, physicians' satisfaction with the usage of EHR systems improves because of EHR training programs. He revealed in his study that the introduction of training programmes on EHR helps to improve physician satisfaction with the technology while enhancing their efficiency. Kaipio et al. (2020) study supports the finding that professional type affects health professionals' satisfaction with the use of EHR. From their research, they found that doctors were more satisfied with the EHR systems' technical quality and learnability, while nurses were more satisfied with the convenience of use and the ability to collaborate with EHR.

A study by Bani-Issa et al. (2016) found that healthcare practitioners had a high level of overall satisfaction with electronic health records (EHRs). Physicians were found to be the most satisfied with EHRs in the research, while nurses were more satisfied with the influence on drug administration than of any other health-care professional. The results of their research, therefore, show that healthcare professionals are typically pleased with EHR systems as a daily element of their clinical practice. They also identify a lack of basic computer skills, lack of adequate training and lack of trust in the reliability of the system as barriers to the full utilisation of EHR among healthcare professionals. These factors, if present, may lead to higher satisfaction with the use of EHR among health professionals. With basic computer skills and adequate training, healthcare professionals will be able to

improve their efficiency which will in turn lead to increased satisfaction with the use of EHR. These findings are in tandem with those found in this study.

Tilahun and Fritz (2015) in their study on Electronic Medical Record (EMR) system use and user satisfaction reported that overall, health professionals were more dissatisfied with Electronic Medical Record (EMR) systems. They found that the level of dissatisfaction differed among the different categories of health professionals. Physicians were found to be more dissatisfied with the system as compared to nurses. Though they found dissatisfaction instead of satisfaction, the finding that the staff category affects health professionals' satisfaction is supported.

Al Otaybi et al. (2022) in their study examine the satisfaction of healthcare workers with Electronic Medical Records. The results of their study showed that experience with computer use (computer proficiency) had no significant impact on satisfaction with EMR which is in contrast with the finding in this study. They also found that age and training are factors that affect health professionals' satisfaction with the use of EMR systems whereas health professionals prefer the system to the routine paper system. Overall, they found above-average satisfaction with EMR systems among healthcare workers.

Schopf et al. (2019) did a study on how well Electronic Health Record (EHR) supports the clinical tasks of hospital physicians. From their study, it was revealed that physicians were not very satisfied with the technical performance of EHR due to the frequent freezing of computer systems. Overall, their study reveals a low level of satisfaction amongst hospital physicians concerning the use of EHR because they were of the view that

EHR could result in medical errors. However, this may be because these physicians had not received any training on the functionalities of the EHR system and how best to use it. This phenomenon may be curbed by providing health professionals with the requisite training for increased satisfaction with the use of EHR.

From the various literature reviewed on health professionals' satisfaction with the use of Electronic Health Records, it is evident that there are many factors responsible for health professionals' satisfaction or dissatisfaction with EHR. However, quality plays a major role in EHR systems. Therefore, it is important to note that despite socio-demographic characteristics playing a major role in influencing health professionals' satisfactory use of EHR systems, quality can never be replaced if the EHR system is to be long-serving

CHAPTER SEVEN

THE EFFECTIVE USE OF LIGHTWAVE HEALTH INFORMATION MANAGEMENT SYSTEM FOR HEALTH SERVICE DELIVERY BY HEALTH PROFESSIONALS

Introduction

To increase the effectiveness and quality of healthcare institutions, electronic health record (EHR) systems are progressively deployed in the healthcare systems by developing countries (Yehualashet et al., 2015). Various studies show that implementing an EHR system in the health sector has the potential to transform healthcare in terms of cost savings, medical error reduction, service quality improvement, patient safety, decision-making, time savings, and sharing of medical information (Yuan et al., 2019; Melnick et al., 2021). LHIMS is implemented in the Ghanaian health sector to improve data sharing, performance of health care professionals, and improve quality of care and decision making.

As a result, this study assessed the effective use of LHIMS for service delivery. As part of the chapter, descriptive statistics (weighted mean) were computed to determine the average weighted score for all the indicators under the effectiveness latent construct. Also, bivariate analysis (chi-square) and multivariate (ordinal logistic regression) analyses are conducted to test the study's hypotheses. As part of assessing the differences in the effective use of LHIMS by respondents, this chapter tests the following hypotheses from the literature review:

H_1: socio-demographic characteristics (age, sex, educational qualification, and years of work experience) influence the effective use of LHIMS by respondents.

H_2: professional characteristics (professional type and institution of training) influence the effective use of LHIMS by respondents.

H_3: training and computer proficiency (training status, duration of training and computer proficiency) influence the effective use of LHIMS by respondents.

Descriptive Statistics of Respondents' Effective Use of LHIMS

This section assesses the effectiveness of responders' use of the LHIMS. Table 14 shows the descriptive statistical analysis of respondents in the Central Region's effective utilisation of the LHIMS for health service delivery. To calculate the average weighted score for all of the effectiveness indicators, a 5-point Likert scale was used, and the Weighted Mean formula from Manyange, Abuga and Ongabi (2015) was employed. After computation, the weighted average scores were interpreted using a set of parameters.

As can be seen in Table 15, the outcome of the computation indicates that in general, productivity has increased as a result of the LHIMS's utilisation (3.44). The respondents agreed that LHIMS facilitates the sharing of patient information among service providers (3.61) and enhances the collecting/gathering of patient data (3.85). The respondents alluded that LHIMS improves care continuity 3.83 and indicated that LHIMS encourages data exchange among other facilities (3.88).

Table 15: Descriptive Statistical Analysis of the Effective Use of LHIMS by Respondents

Statement	SD	D	N	A	SA	Weighted Average	Interpretation
	1	2	3	4	5		
The use of the LHIMS has improved productivity	51	152	273	546	104	3.44	Agree
LHIMS improves sharing of patient information amongst providers within the facility	19	107	284	605	111	3.61	Agree
LHIMS improves patient information gathering/ collection	16	56	201	661	192	3.85	Agree
LHIMS enhances the continuity of care	20	72	198	621	215	3.83	Agree
LHIMS supports data sharing among other facilities	14	66	168	666	212	3.88	Agree
LHIMS reduces the risk of making errors by alerting users of errors made	44	133	337	493	119	3.45	Agree
The use of the LHIMS improves quality decision making	26	81	284	614	121	3.64	Agree
LHIMS enhances the ability to coordinate /organisation of care	22	55	238	633	178	3.79	Agree
Using the LHIMS has improved my job performance	23	76	248	635	144	3.71	Agree
LHIMS has all the functions I expect within my area of practice	18	63	242	655	148	3.76	Agree
The functions in the LHIMS are well integrated	14	66	168	666	212	3.88	Agree

Source: Agyemang, 2021

Weighted Average = $\sum wx / \sum w$

Interpretation: 1.0 – 1.79 = Strongly Disagree; 1.80 – 2.59 = Disagree; 2.60 – 3.39 = Neutral; 3.40 – 4.19 = Agree; 4.20 – 5.00 = Strongly agree

Again, the respondents said LHIMS decreases the chance of mistakes by alerting users about errors (3.45) and the adoption of the LHIMS has increased decision-making during the time of care (3.68). LHIMS improves the capacity to coordinate and organise care (3.79) and using the LHIMS has resulted in enhanced work performance (3.71). Additionally, respondents indicated that LHIMS provides all the functions and features they anticipated within their field of work (3.76) and the functions and features are well integrated (3.88) (see Table 15).

Bivariate Analysis of the Effective Use of the Lightwave Health Information Management System by Respondents

To test the study's hypothesis, a bivariate analysis was run to assess the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification and years of work experience*), professional characteristics (*Professional type and type of institution attended*) and Training / Computer proficiency (*training status, duration of training and computer proficiency*) on the effective use of the Lightwave Health Information Management System (LHIMS).

Socio-demographic Characteristics and Effective Use of LHIMS

It is hypothesised that EHR systems boost the health system and clinical care by enabling readable and structured medical records and access to clinical information about individual patients (Yehualashet et al., 2015). Also, in Davis' (1986) Technology Acceptance Model (TAM), he argued that external characteristics of individual system users such as age, sex, education,

and so on impact EHR usability. This current study using a chi-square test assessed the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification, and years of work experience*) and the effective use of LHIMS for health service delivery.

The test revealed a statistically significant association between the sex of respondents and effective use of the LHIMS at χ^2 (2, N=1126) = 8.34, P-value= .659. Among female respondents, 30.7 per cent found LHIMS very effective for service delivery while among male respondents, 29.0 per cent indicated that LHIMS was very effective. Age as a respondent's socio-demographic characteristic had a statistically significant association with the effective use of LHIMS at χ^2 (4, N=1126) = 17.637, P-value=.001. For professionals aged 20 to 29 years, 30.7 per cent indicated that LHIMS was very effective for service delivery while for the respondents aged 30 to 39 years, 35.9 per cent said LHIMS was very effective, and for the respondents aged 40 years and above, 31.4 per cent were of the view that LHIMS was very effective for health service delivery.

Additionally, there was a statistically significant association between the educational qualification of respondents and the effective use of LHIMS at χ^2 (4, N=1126) = 9.885, P-value=.042. For respondents who were certificate holders, 23.8 per cent found the LHIMS very effective while 33.9 per cent of respondents who had diploma / HND found the LHIMS very effective. Of the respondents with a degree qualification, 28.2 per cent found the LHIMS very effective for service delivery.

Table 16: Bivariate Analysis of Socio-demographic Characteristics and Effective Use of LHIMS by Respondents

Variable	Effectiveness			p
	Ineffective	Moderately Effective	Very Effective	
Sex	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Female	207 (30.0%)	272 (39.4%)	212 (30.7%)	.659
Male	126 (29.0%)	183 (42.1%)	126 (29.0%)	
Age				
20 – 29	176 (33.0%)	228 (42.8%)	129 (24.2%)	.001
30 – 39	132 (26.0%)	193 (38.1 %)	182 (35.9%)	
≥40	25 (29.1%)	34 (39.5%)	27 (31.4%)	
Educational Qualification				
Certificate Holder	49 (37.7%)	50 (38.5%)	31 (23.8%)	.042
Diploma/HND	130 (28.4%)	172 (37.6%)	155 (33.9%)	
Degree	154 (28.6%)	233 (43.2%)	152 (28.2%)	
Years of Work Experience				
≤1 year	124 (33.9%)	147 (40.2%)	95 (26.0%)	.001
2 to 5 years	157 (30.0%)	219 (41.9%)	147 (28.1%)	
≥ 6 years	52 (21.9%)	89 (37.6%)	96 (40.5%)	

Source: Agyemang, 2021

Lastly, a chi-square test revealed a strong statistically significant association between the work experience of respondents and effective use of the LHIMS at χ^2 (4, N=1126) = 19.093, P-value=.001. The test showed that, for respondents who had 1 year of experience, 26.0 per cent said LHIMS was very effective while for respondents who worked 2 to 5 years, 28.1 per cent found the LHIMS very effective, and respondents with 6 or more years of work experience, 40.5 per cent found the LHIMS very effective (see Table 16).

Professional Characteristics and Effective Use of LHIMS

From the literature, EHR systems are designed to improve the effectiveness of medical practices (Yehualashet et al., 2015; Odei-Lartey et al., 2020). Therefore, systems must improve job performance, decision making and overall use of the system by physicians and support staff. Khairat et al. (2019) hypothesises that with task performance and effective use of the EHR system by physicians, there are no statistically significant differences between men and women using the EHR system. In Ghana, LHIMS is utilised by several health professionals and not only physicians. As a result, this current study assessed whether professional type (physician, nurses/midwives and auxiliary staff) and training institution of respondents influenced the effective use of the LHIMS for health service delivery.

The chi-square test of independence found a statistically significant association between professional status and the effective use of the LHIMS at χ^2 (4, N=1126) = 20.560, P-value= .000. for prescribers (doctors and physician assistants), 29.6 per cent found the LHIMS very effective for service delivery while 32.7 per cent of nurses and midwives found the LHIMS very effective, and 34.0 per cent of auxiliary staff found the LHIMS very effective for health service delivery. For respondents training institution and effective use of LHIMS, a chi-square test revealed no statistically significant association at χ^2 (2, N=1126) = 1.556, P-value= .459. Among respondents who were trained at the Ministry of Health Training Institution, 29.6 per cent found the LHIMS very effective while the respondents who were trained at the public university,

30.6 per cent found the LHIMS very effective for service delivery (see Table 17).

Table 17: Bivariate Analysis of Professional Characteristics and Effective Use of LHIMS by Respondents

Variable	Effective			*p*
	Ineffective	Moderately Effective	Effective	
Professional Status				
Prescribers	179 (28.5%)	264 (42.0%)	186 (29.6%)	.000
Nurses and Midwives	154 (29.0%)	281 (38.4%)	239 (32.7%)	
Auxiliary	36 (25.5%)	57 (40.4%)	48 (34.0%)	
Training Institution				
MoH Training Institution	179 (28.5%)	264 (42.0%)	186 (29.6%)	0.459
Public University	154 (31.0%)	191 (38.4%)	152 (30.6%)	

Source: Agyemang, 2021

Training/ Computer Proficiency and the Efficient Use of LHIMS

Training is an essential component in implementing health information technology (Kernebeck et al., 2022). Health Information Technology training can influence professionals' willingness and capacity to effectively use EHRs. Wali et al. (2020) studied that training is related to the greater effective usage of advanced electronic health record features like templates. Many contemporary practitioners acquired their medical education before information technology became widely available, and as a result, they lack both fundamental computer skills and the specific skills required to operate an EHR effectively (Bredfeldt et al., 2013; Khairat et al., 2019b). This current

study using a chi-square test of independence establishes whether there is an association between training/computer proficiency and effective use of the LHIMS for service delivery.

The chi-square test revealed a statistically significant association between training status and effective use of LHIMS at χ^2 (2, N=1126) = 14.786, P-value= .001. For respondents who received training before the deployment of the LHIMs, 28.2 per cent found LHIMS very effective for health service delivery while 45.1 per cent of the respondents who did not receive training prior to the deployment of the LHIMS found the system very effective for health service delivery. Also, a chi-square test revealed no statistically significant association between the duration of the training and the effective use of LHIMS at χ^2 (6, N=1126) = 2.595, P-value= .858. The test showed that 33.6 per cent of respondents found the LHIMS highly effective for service delivery.

For respondents who received training for 1 to 2 days before the use of the LHIMS, 30.7 per cent found the LHIMS highly effective for service delivery. For respondents trained for 3 to 4 days, 25.7 per cent were highly effective in using the LHIMS. Lastly, for professionals trained for 5 days or more, 29.6 per cent were highly effective in using the LHIMS for health service delivery. In addition, a chi-square test of association revealed no statistically significant relationship between computer proficiency and the effective use of LHIMS at $\chi2$ (2, N=1126) = 2.561, P-value= .278. The results from the study showed that 25.8 per cent of respondents who rated themselves as beginners,

Table 18: Bivariate Analysis of Training/Computer Proficiency and LHIMS Effectiveness for Health Service Delivery by Respondents

Variable	Effectiveness			*p*
	Ineffective	Moderately Effective	Effective	
Training	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	
Yes	305 (30.4%)	416 (41.4%)	283 (28.2%)	0.001
No	28 (23.0%)	39 (32.0%)	55 (45.1%)	
Duration of Training				
Never Trained	35 (28.7%)	46 (37.7%)	41 (33.6%)	0.858
1 to 2 days	183 (29.4%)	248 (39.9%)	191 (30.7%)	
3 to 4 days	56 (31.3%)	77 (43.0%)	46 (25.7%)	
5 days or more	59 (29.1%)	84 (41.4%)	60 (29.6%)	
Computer Proficiency				
Beginner	76 (31.7%)	102 (42.5%)	62 (25.8%)	0.278
Advanced User	257 (29.0%)	353 (39.8%)	276 (31.2%)	

Source: Agyemang, 2021

were highly effective in using the LHIMS while among the respondents who rated themselves as "advanced users" of computers, 31.2 per cent were highly effective in using the LHIMS for health service delivery (see Table 18).

Multivariate Analysis of The Effective Use of LHIMS by Respondents

Multivariate analysis was performed to assess the influence of socio-demographic characteristics of respondents (*age, sex, educational qualification, and years of work experience*), professional characteristics (*professional type, place of training, and institution of training*) and

Training/computer proficiency (*training status, duration of training and computer proficiency*) on the effective use of the LHIMS. In Model 1, ordinal logistic regression analysis was fitted to assess the relationship between respondents' socio-demographic characteristics (age, sex, educational qualification, and years of work experience) on the effective use of the LHIMS. The test revealed that the years of work experience of respondents significantly influenced the effective use of LHIMS. However, the age of respondents, sex of the respondents and educational qualification did not statistically predict the effective use of LHIMS. As a result, the variables; the age of respondents, sex and educational qualification were dropped in Model 1 while work experience was retained in the model.

In Model 2, retaining the variable; years of work experience of respondents in the model, educational qualification and training status of respondents were statistically significant. However, professionals' characteristics (professional type and training institution the respondent attended) did not statistically influence the effective use of the LHIMS hence they were excluded from the model. In model 3, accounting for years of work experience, educational qualification of respondents and status of training of respondents before the use of LHIMS, ordinal logistic regression was fitted to assess computer proficiency and the effective use of the LHIMS. The test revealed that years of work experience, educational qualification, and training before the use of LHIMS were statistically significant predictors of respondents' effective use of the LHIMS computer proficiency.

For years of work experience, respondents with 1 year and below experience were 47 per cent (OR=0.530, 95% CI= 0.96 [0.390 - 0.721]) less likely to be highly efficient in using the LHIMS as compared to professionals who had 6 and above years of work experience. Again, respondents with 2 to 5 years of work experience, were 27.6 per cent (OR=0.628, 95% CI= 0.96 [0.471 - 0.837]) less likely to be highly efficient in using the LHIMS as compared to the respondents who had 6 and above years of work experience. In terms of educational qualifications, respondents with certificate-level education had lower odds (OR=0.667, 95% CI [0.463 – 0.960]) of using the LHIMS efficiently compared to degree holders. Conversely, respondents with diploma/HND qualifications had higher odds (OR=1.072, 95% CI [0.845 - 1.359]) of using the LHIMS efficiently than those with degree qualifications. Although computer proficiency did not show a statistically significant association with effective LHIMS use, respondents classified as "beginners" in general computing had lower odds (OR=0.864, 95% CI [0.660 – 1.131]) of being highly efficient in LHIMS use compared to "advanced users" of computers (see Table 19).

Table 19: Multivariate Analysis of the Effective Use of LHIMS by Respondents

Variable		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Work Experience				
	≤ 1 year	0.524 (0.386, 0.712)**	0.527 (0.388, 0.717)**	0.530 (0.390, 0.721)**
	2 to 5 years	0.606 (0.455, 0.807)*	0.625 (0.469, 0.833)*	0.628 (0.471, 0.837)*
	≥ 6 years	1.00		1.00
Educational Qualification				
	Certificate		0.683 (0.476, 0.98)*	0.667 (0.463, 0.960)*
	Diploma/HND		1.095 (0.866, 1.384)	1.072 (0.845, 1.359)
	Degree +		1.00	1.00
Training/Computer proficiency				
Status of Training				
	Yes		0.521 (0.361, 0.753)*	0.528 (0.365, 0.763)*
	No		1.00	1.00
Computer proficiency				
	Beginner			0.864 (0.66, 1.131)
	Advanced Users			1.00

Source: Agyemang, 2021

*** = p-value ≤ 0.05; ** = p-value < 0.01; OR=Odds Ratio; CI=Confidence Interval; 1.00=Reference Category; Sample (N) = 1126**

Discussion of Findings

EHR implementation is necessary for hospitals to fulfil their full potential in terms of operational efficiency and patient care outcomes current age of rapidly expanding e-health technology (Bajwa et al., 2019). The descriptive statistics on the effective use of EHR showed that health professionals' productivity increased as a result of the use of the LHIMS. The collection of patients' data was also enhanced and the chances of making mistakes were reduced to a minimum. The LHIMS was also found to improve healthcare as well as performance. The LHIMS was also found to have all the features anticipated by the health professionals in their respective fields of duty. The LHIMS can therefore be considered a very helpful system to health professionals. Bajwa et al. (2019) in their study agree that the implementation of EHR in health care delivery will lead to enhanced accuracy, speed, and effectiveness.

According to the results obtained from the multivariate analysis on how the socio-demographic characteristics (age, sex, educational qualification, and years of work experience) of health professionals affect their effective use of Electronic Health Records, years of work experience and educational qualification had a significant effect on effective use of LHIMS-EHR. The sex and age of health professionals did not have any significant effect on how effectively they used EHR systems contrarily to the Technology Acceptance Model which indicates that external factors such as age influence the use of computer systems (Davis, 1989). The results mean that health professionals' level of education and the number of years they have been working in the field contribute significantly to how effectively they make use of Electronic Health

Record systems. However, age was found to have a significant association with the effective use of EHR even though it had no significant effect.

The results obtained from the multivariate analysis on professional characteristics and efficiency of EHR showed that professional type and the institutions where health professionals receive their training have no significant effect on how effectively they use the LHIMS. The results indicate that the professional characteristics of health professionals do not in any way affect the effective use of EHR systems. However, the professional type was found to have a significant relationship with the effective use of EHR even though it had no significant effect. The multivariate analysis of training/computer proficiency and the effective use of LHIMS showed that training has a significant effect on how effectively health professionals use EHR. Therefore, without the right training, health professionals cannot use the LHIMS effectively.

Yehualashet et al. (2015) contrasted the finding on age and computer literacy. Adedeji et al. (2018) study was also in contrast with the finding on age and academic qualification. Healthcare quality may be improved by using an EHR system that is effectively implemented, enhancing time efficiency and guideline compliance as well as cutting down on medication prescription errors or adverse events (Campanella et al., 2016). From Adedeji et al. (2018), it can be deduced that prior training is an important factor if users of EHR systems are to use the systems in the most effective manner. Training prepares health professionals for the effective use of EHR systems. Without training, health professionals may use EHR systems in an ineffective manner which will lead to the under-utilisation of the system.

They also found that sex was not a significant predictor of the effective use of EHR which is in line with the findings on sex in this study. Their study again revealed that age has a significant influence on the effective use of EHR systems. It plays a major role in how health professionals use EHR systems for what they intend in healthcare. This finding is in contrast with that of this study on age. They finally also found that academic qualification was no predictor of how effectively EHR systems are used, which is in contrast with that of this study on educational qualification and the effective use of EHR in this study.

The number of years health professionals have been working in the field affects how effectively they use the LHIMS. Yehualashet et al. (2015) in their study revealed that working experience had a significant effect on the effective utilisation of electronic medical records (EMR) systems. They then found sex to have no significant impact on the effective utilisation of EMR which agrees with the study. They also found educational qualification to have no significant influence on the effective use of EMR which is in line with this study. Finally, they found that age and computer literacy have a significant effect on the effective utilisation of EMR systems which is in contrast with this study. Msiska et al. (2017) found that variations in age, sex, and computer proficiency were not associated with variances in the use of EMR in their research on the factors influencing the adoption of electronic medical records systems in line with the findings in this study. Their results also showed that educational level and training have a significant impact on the effective utilisation of EMR systems.

Singh & Muthuswamy (2013); Gagnon et al. (2014); Robinson & Kersey (2018); and Abdulai et al. (2020) all agree with the finding that training significantly affects the effective utilisation of EHR. Policymakers will need to take the working experience and educational qualification of health professionals into consideration when making plans on how best to enhance effectiveness in the use of the LHIMS. In terms of training, policymakers should put in place measures to ensure that health professionals receive comprehensive training before the use of the LHIMS for the effective utilisation of the system. Additionally, the management of the hospital should take into consideration the implementation of intermittent training programmes on the LHIMS, to maximise the effective utilisation of the system.

CHAPTER EIGHT

ESTABLISH THE INTERDEPENDENCY AMONG EFFECTIVENESS, SATISFACTION AND EFFICIENT USE OF THE LIGHTWAVE HEALTH INFORMATION MANAGEMENT SYSTEM BY HEALTH PROFESSIONALS

Introduction

This chapter adopts confirmatory factor analysis and structural equation modelling to assess the interdependency among the 3 main domains (effectiveness, efficiency and satisfaction) of the use of LHIMS. The chapter covers an assessment of measurement models, an evaluation of measurement and structural models and a presentation of findings.

Assessment of the Measurement Model

The covariance-based (CB) method, which is a structural equation modelling method, was used in this study to test hypotheses and examine the relationship among the 3 main domains (effectiveness, efficiency and satisfaction) of the use of LHIMS. CB-SEM is superior to other methods when it comes to providing model fit indices(Mia et al., 2019; Dash & Paul, 2021) and CB-SEM models perform significantly better when applied to factor-based models such as this study (Cheah et al., 2020; Hair et al., 2021). The CB-SEM data analysis was carried out using the Amos 26 software. The model is analysed and interpreted in two stages to assess the validity and reliability of the measurement scales (Hair et al., 2021). They are 1) Evaluation of the measurement model; 2) Evaluation of the structural model.

Evaluation of Measurement Model

In this section, the measurement model was assessed. The study assessed the model's construct validity, discriminant validity, and statistics for

collinearity (VIF). Standardised loadings, Cronbach's Alpha (CA), mean shared variance (MSV), MaxR(H), composite reliability (CR), and average variance extracted (AVE) were used to assess the convergent validity (Hair et al., 2021). The Fornell-Larcker criteria and the heterotrait-monotrait ratio (HTMT) were utilised in the study to assess discriminant validity. The quality of research is evaluated by construct validity and reliability (Flake et al., 2022). They indicate the authenticity of a study's data. According to Flake et al. (2022), validity assesses a scale's capacity to capture the desired concept. The extent to which a test captures what it purports to measure is known as construct validity.

Correlation coefficients between observable variables and latent common factors are known as standardised (factor) loadings. Factor loadings can alternatively be thought of as regression weights or scaled regression coefficients. They precisely identify the weighting that a particular element has in the overall model. It is recommended that the indicator's standardised loading be greater than 0.70. (Hair et al., 2021). Indicators with outer loadings between 0.40 and 0.70 may only be considered for removal if the composite reliability and AVE increase beyond the given threshold value (Hair et al., 2017; 2021). For standardised loadings, majority of the item loadings in Table 19 were greater than the 0.7 thresholds or were within the acceptable range. The validity and reliability of the model were unaffected by the few with standardised loadings of less than 7 (Hair et al., 2021). All the constructs' values for Cronbach Alpha, MaxR(H), and Composite Reliability were greater than 0.7, and all their

Table 20: Outer Model Results for First-order Constructs

Construct/Sub Indicators	Standardised loadings	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)	Mean Shared Variance (MSV)	Maximal Reliability (MaxR(H))
Satisfaction		0.939	0.938	0.602	0.065	0.940
Sat1	0.749					
Sat2	0.744					
Sat3	0.771					
Sat4	0.781					
Sat5	0.815					
Sat6	0.810					
Sat7	0.827					
Sat8	0.689					
Sat9	0.773					
Sat10	0.789					
Efficiency		0.960	0.959	0.646	0.014	0.965
Eff1	0.725					
Eff2	0.768					
Eff3	0.678					
Eff4	0.816					
Eff5	0.874					
Eff6	0.913					
Eff7	0.819					

Construct/Sub Indicators	Standardised loadings	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)	Mean Shared Variance (MSV)	Maximal Reliability (MaxR(H))
Eff8	0.836					
Eff9	0.868					
Eff10	0.858					
Eff11	0.742					
Eff12	0.785					
Eff13	0.731					
Effectiveness		0.933	0.932	0.557	0.065	0.935
Effec1	0.714					
Effec2	0.682					
Effec3	0.816					
Effec4	0.799					
Effec5	0.724					
Effec6	0.755					
Effec7	0.750					
Effec8	0.696					
Effec9	0.754					
Effec10	0.741					
Effec11	0.769					

Source: Agyemang, 2021

AVE values were above the cut-off point of 0.5 (Hair et al., 2017). The analysis showed that the mean shared variance (MSV) is considerably less than the AVE. As a result, these latent variables were shown to have convergent validity (Table 19 and Figure 6). Additionally, a measure known as discriminant validity was developed to determine how fundamentally different two constructs are from one another (Hair et al., 2017). Discriminant validity is a way to figure out if there is a connection between two constructs that, in theory, should not be related. The study used the Fornell-Larcker criteria and heterotrait-monotrait-ratio (HTMT) to assess discriminant validity. The square root value AVE of each construct was compared to the construct-to-construct correlations that were already known to exist and the square root value AVE should be greater than the construct-to-construct correlation (Fornell & Larcker, 1981). According to the findings in Table 20, the square root of AVE values is always bigger than the correlations associated with each scenario.

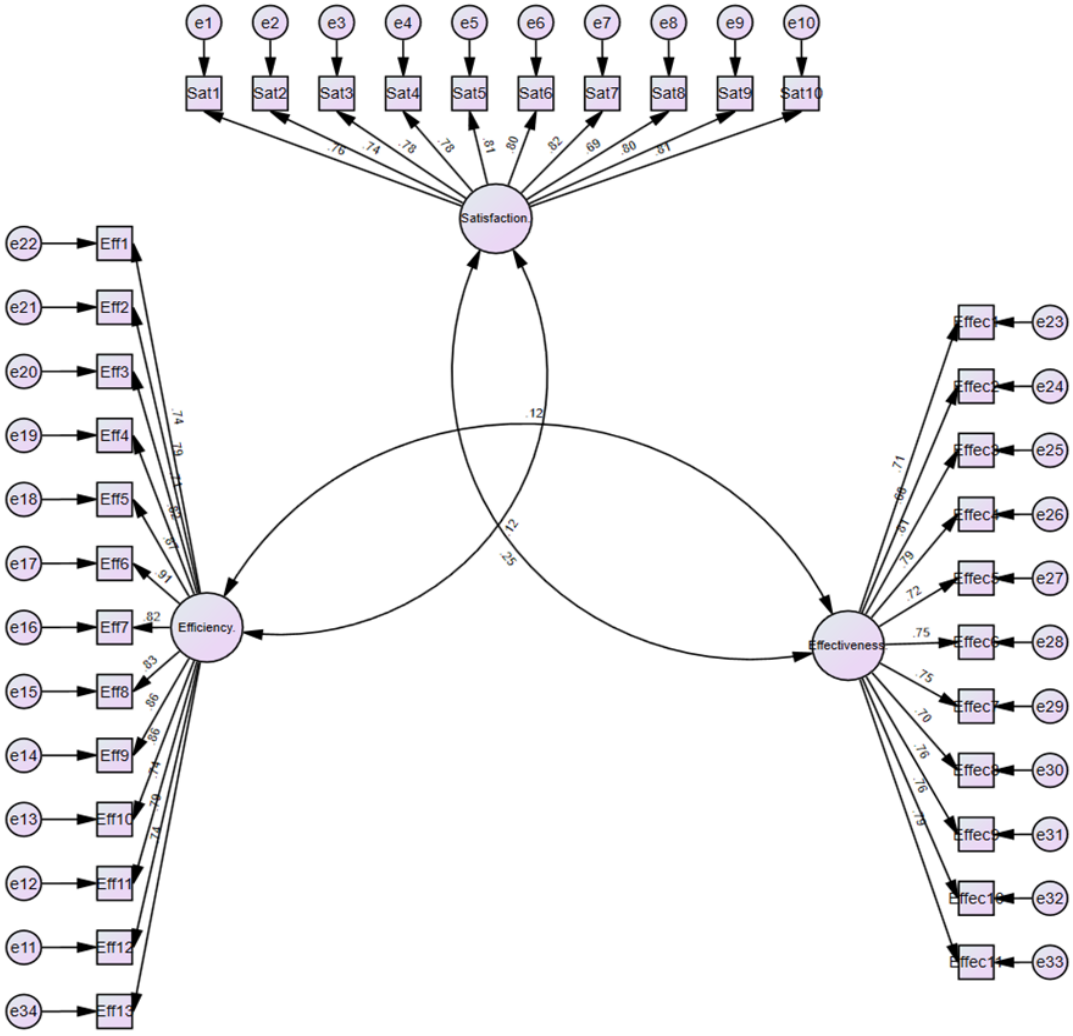

Figure 4: Assessment Model Before Modification
Source: Agyemang, 2021

The HTMT evaluates the degree to which two latent variables are similar (Roemer et al., 2021). Henseler et al. (2015) suggested the heterotrait-monotrait-ratio (HTMT) as a novel method for assessing discriminant validity. HTMT scores close to 1 indicate a lack of discriminant validity. It is based on the multitrait-multimethod (MTMM) matrix, which contrasts correlations to assess discriminant validity (Rönkkö & Cho, 2022). The recommended value for HTMT is 0.85 (Henseler et al., 2015). From table 21, HTMT is within the threshold criteria recommended by Henseler et al. (2015).

Table 21:Discriminant Validity – Fornell-Larcker Criterion

Construct	Satisfaction	Efficiency	Effectiveness
Satisfaction	**0.776**		
Efficiency	0.120	**0.804**	
Effectiveness.	0.254	0.118	**0.746**

Source: Agyemang, 2021

Table 22: Discriminant Validity – Heterotrait-Monotrait-Ratio

Construct	Satisfaction	Efficiency	Effectiveness
Satisfaction.			
Efficiency.	0.118		
Effectiveness.	0.243	0.108	

Source: Agyemang, 2021

Multicollinearity and Common Method Bias

The degree of multicollinearity and the existence or absence of common method bias were both examined. Multicollinearity may exist when two independent variables are significantly correlated (Shrestha, 2020). It could also happen if two independent variables produce results that are equal and repeatable or if an independent variable is computed using information from other variables in the sample. Cheng et al. (2022) and Hair et al. (2017) claim that a complete collinearity test based on Variance Inflation Factor (VIF) values is the most effective technique for detecting multicollinearity in SEM.

According to (Cheng et al., 2022), common method bias is typically observed in research in which data for both independent and dependent variables are obtained from the same subject in the same measurement context utilising the same item context and similar item features. A significant contributing factor is the respondents' capacity to apply response trends uniformly across measures. The likelihood of a severe case of common

method bias (CMB) increases when a homogenous sample is used, such as hospital workers in this study (Aguirre-Urreta & Hu, 2019). Recent research has attempted to address and emphasise the issue of common method bias, which occurs when data are collected from the same sample of individuals (Javed et al., 2017; Jordan & Troth, 2020; Matsuo, 2020; Ismail et al., 2019; Haffar et al., 2023)

In this study, the Variance Inflation Factor (VIF) was used to test for multicollinearity and common method bias (CMB). If a model has a VIF greater than 3.3, which is a sign of pathological collinearity, it may be affected by common method bias. If all VIFs from a thorough collinearity test in the inner model are below 3.3, the model is free of common method bias (Cheng et al., 2022). Findings in table 23 demonstrate that multicollinearity and common method bias are not present.

Table 23: Collinearity statistics - Variance Inflation Factor (VIF)

Construct	Satisfaction	Efficiency
Efficiency	1.015	
Effectiveness.	1.069	1.014

Source: Agyemang, 2021

Evaluation of the Structural Model

This section reports the goodness-of-fit indices for the models for the confirmatory factor analyses (CFA). Kline (2015) suggests at least providing the following indices for structural equation models (SEM): the SRMR, CFI, RMSEA, and chi-square models. The CFA assessed the model using maximum likelihood in Amos version 26 to determine how well the data fit our model. According to Puteh and Azman Ong (2017) and Bentler and Bonett (1980) criteria, it was anticipated that the Chi-Square/Degree of Freedom (CMIN/DF) would be less than 5, the Normed Fit Index (NFI), Tucker-Lewis

Index (TLI), Comparative Fit Index (CFI), and Incremental Fit Index (IFI) would be greater than 0.9, and the Root Mean Square Error of Approximation (RMSEA) less than 0.07 and Standardised Root Mean Square Residual (SRMR) is also expected to be less than 0.08 to be considered. These considerations suggest that the structural model demonstrates a strong fit and high levels of reliability and validity based on these indicators.

Table 24 shows that several of the model fit indicators did not exceed the generally acceptable level, which made the overall model fit of the initial model statistically inadequate for the dataset. Table 23 reported the following values. The chi-square value was 3839.579, the degree of freedom was 524, and the probability value was 0.000. CMIN/DF = 7.327; RMSEA = 0.075 with PCLOSE of 0.000; SRMR = 0.0449; CFI = 0.891; TLI = 0.883; and IFI = 0.891. From the data, indicators such as CFI, NFI and IFI did not meet the threshold of greater than 0.9. Also, CMIN/DF and RMSEA were greater than the acceptable threshold of less than 5 and 0.07. However, the standardised RMR was less than 0.08 which met the recommended value.

The data was then changed following AMOS v26's modification indices function. To optimise the model indicators, the modification indices feature recommended some variables that may be combined (Figure 7). Based on the suggestions, these variables were covaried from the satisfaction construct: Sat1-Sat3, Sat9-Sat10; efficiency construct: Eff1- Eff2, Eff1- Eff3, Eff2- Eff4, Eff3- Eff4; and effectiveness construct Effec10-Effec11.

Table 24: Goodness-of-Fit Indices for the Model

Models	χ^2	Df	χ^2/DF	TLI	IFI	CFI	SRMR	RMSEA
Acceptable values			<5	≥ 0.900	≥ 0.900	≥ 0.900	< 0.08	< 0.07
Before modification indices	3839.579	524	7.327	.883	.891	.891	.0449	.075
After modification indices	2453.257	516	4.754	.930	.936	.936	.0413	.058

Source: Agyemang, 2021

Following these changes, the total model was statistically of good model fit for further analysis, with the following model fit indicator values as shown in table 23: Chi-square = 2453.257, Degree of freedom = 516, Probability level = 0.000, $\chi 2/df$ =4.754, CFI = 0.936, IFI = 0.936, RMSEA = 0.058, TLI = 0.936 and Standardised RMR = .0413.

Presentation of Findings

Pearson's Product Moment Correlation was used to examine the connection between the variables (effectiveness, efficiency, and satisfaction with the use of LHIMS) in the research. The correlation coefficient's range of -1 to 1 indicates strong negative or strong positive correlations as a rule of thumb. The data analysis was carried out in AMOS v26 using the Maximum Likelihood Estimator (MLE). The results of bootstrapping with 5000 subsamples were utilised to assess whether the correlation coefficients are significant. Table 25 presents the hypothesis findings, including the following measures: correlation estimates, Standard Error (S.E), significant values (p-value), and lower and upper boundaries.

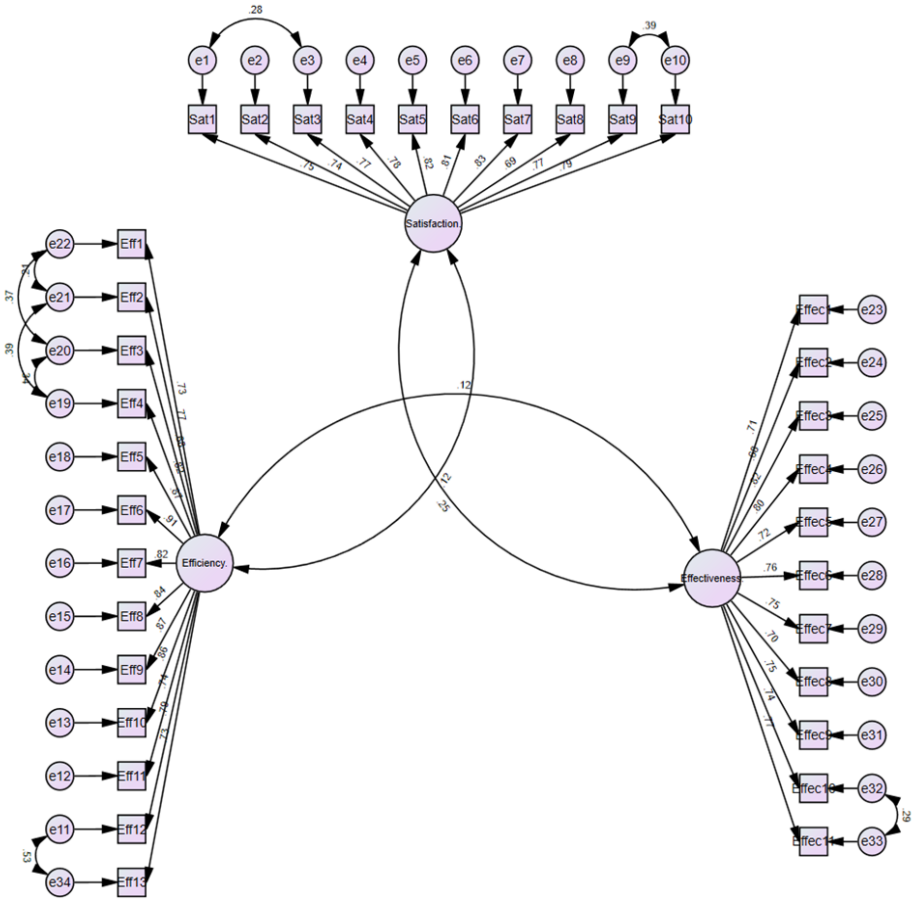

Figure 5: Assessment Model after Modification
Source: Agyemang (2021)

Table 25: Correlation Coefficient Report

Relationship	Estimate	SE	P	Lower	Upper
Satisfaction <--> Efficiency	0.120	0.030	0.000	0.069	0.170
Effectiveness <--> Satisfaction.	0.254	0.031	0.000	0.203	0.304
Effectiveness <--> Efficiency	0.118	0.034	0.001	0.061	0.172

Source: Agyemang, 2021

According to Table 25, satisfaction and efficiency have a substantial positive association (b=0.120, s.e.=0.030, p=0.000). The prediction is also supported by a 95% confidence level for the lower and upper boundary of 0.069 and 0.170, respectively. The unidimensionality of the confidence interval values suggested that the prediction was accurate and not

spurious. Also, effectiveness and satisfaction have a substantial positive association (b=0.254, s.e.=0.031, p=0.000). The prediction is also supported by a 95% confidence level for the lower and upper boundary of 0.203 and 0.304, respectively. The unidimensionality of the confidence interval values suggested that the prediction was accurate and not spurious. Finally, effectiveness and efficiency have a substantial positive association (b=0.118, s.e.=0.034, p=0.001). The prediction is also supported by a 95% confidence level for the lower and upper boundary of 0.061 and 0.172, respectively. The unidimensionality of the confidence interval values suggested that the prediction was accurate and not spurious.

Discussion of Findings

The study assessed the interdependency among effectiveness, satisfaction, and efficient use of the LHIMS by health professionals. The study hypothesised a positive and significant relationship among effectiveness, satisfaction, and efficient use of the LHIMS after a thorough review of the literature. The result of the analysis was in support of the hypothesised relationship. The results revealed a positive and significant relationship between satisfaction and efficient use of the LHIMS, satisfaction and effective use of the LHIMS and effectiveness and efficient use of the LHIMS by health professionals.

Contrary findings were made by Frøkjær et al. (2000). They argued that effectiveness, efficiency, and satisfaction should all be included in usability testing and should be regarded as distinct aspects of usability until domain-specific research indicates otherwise. Additionally, they discovered there was no association between effectiveness, as demonstrated by the quality

of the solution, and efficiency, as represented by job completion time. Again, Nilsson and Følstad (2012) argue that rather than being a variable in usability tests, the relationship between effectiveness and efficiency should be viewed as a need or design issue. However, Hornbæk and Law (2007) found the correlation between effectiveness measures (such as errors) and efficiency measures (like time) was determined to be 0.247 ± 0.059 (Pearson's product-moment correlation with a 95% confidence interval).

Furthermore, the correlation between efficiency and satisfaction (e.g., preference) was found to be 0.196 ± 0.064, while the correlation between effectiveness and satisfaction was 0.164 ± 0.062. These correlations among usability metrics were typically low (Hornbæk & Law, 2007). This current study supports Hornbæk and Law's (2007) position. One way to view the finding is that it only shows a weak link between usability factors. Although the impact sizes are often low to medium, given the variability in the data, they can be viewed as having little practical significance. This approach is in line with this research (Bailey, 1993; FrØkjaer et al., 2000). This implies there is little to no association between usability metrics according to those studies. Under this perspective, findings imply that attempts to restrict usability to a single metric (e.g., Sauro & Kindlund, 2005) are doomed to lose crucial information due to the poor connection across usability factors.

Additionally, even when usability measurements are strongly linked, they nevertheless transmit information in various ways, thus data redundancy is not always a bad thing. When usability measurements converge (correlate), for instance, developers may be more persuaded or inspired to enhance the system. Again, Joo (2010) found that there is a strong correlation between all

three of the study's usability factors efficiency, effectiveness, and subjective satisfaction. A considerably smaller data collection may be the primary source of the high correlation (they had 12 respondents, and this study's data sets cover more than 1136). The study's associations are less significant than those found by Sauro and Kindlund (2005) and Hornbk and Law (2007).

The usability factors were shown to have significant relationships between them by Sauro and Kindlund (2005). In the same study, they had 129 respondents, whereas this current study utilises data sets cover 1126 respondents. Furtherance to this, they used a specific kind of task, as opposed to the varieties this study considered, and they used per-task satisfaction measures. These factors could all contribute to their overestimation of our data relative to theirs, as well as their use of simple measures that are consistently used across studies rather than the realistic variety of measures I have studied (as opposed to administering questionnaires only once per respondent as is the general case in the study's dataset). It is believed that the case for the one-measure usability score is significantly undermined by correlations that are only half as large as those in Sauro and Kindlund's study. Also, Joo (2010) and Sauro and Lewis (2009) discovered that there is a strong correlation between all three of the study's usability factors.

As an alternative, the study might view this as expressing astonishment at finding such a consistent link among researchers. Variables in the major categories of the ISO classification have positive correlations in roughly 75–85% of these reviewed investigations. The obvious claim made by FrØkjaer et al. (2000) that the relationship between usability factors declines as task complexity grows does not appear to hold. The findings of this objective have

implications for policymakers and management in hospitals, both of whom have the purpose of increasing the amount of time employees spend using LHIMS. Policymakers and hospital administration can focus on any one of the three areas (effectiveness, satisfaction, and efficient use of the LHIMS) in situations when there are limited resources to care for all three of the domains, and the effects will still be visible across the other two domains.

CHAPTER NINE

CHALLENGES ASSOCIATED WITH THE USE OF LIGHTWAVE HEALTH INFORMATION MANAGEMENT SYSTEM FOR HEALTH SERVICE DELIVERY

Introduction

The use of any system comes with merits and demerits, and the Lightwave Health Information Management System (LHIMS) launched in 2017 in the Central Region of Ghana also has imbedded challenges. This chapter presents the results and discussion on the challenges associated with the use of the LHIMS for health service delivery. The results are based on the interviews that were conducted with 30 selected head of units at the ten health care facilities in the Central region that were studied.

Results

Socio-demographic Characteristics of Participants

In total, thirty (30) participants were recruited for the study. More than half (18) of the participants were 30-39 years old. Seventeen of them were males nineteen of them were married at the time of the interview. When it comes to years of working experience, twenty-two of the participants had working experience less than 10 years. Professionally, sixteen of the participants fell under auxiliary (such as a pharmacist, laboratory technician, medical records etc.), eight were identified as nurses/midwives and six of them prescribers (medical doctors and physician assistants).

Overview

The thematic analysis of the data obtained from the In-Depth Interviews (IDIs) with participants revealed a range of challenges linked to the

utilisation of the Lightwave Health Information Management System in health service delivery. The resulting themes encompassed technological issues, technical issues, and individual issues. The challenges under each of these themes are outlined below.

Technical Related Challenges

The interviews conducted revealed technical challenges encountered by healthcare professionals when using the Lightwave Health Information Management System (LHIMS). Among these challenges were issues related to hardware, software and power interruption emerged as significant obstacles, hindering the seamless execution of desired tasks. Within this context, three distinct sub-themes have been identified: hardware challenges, software challenges and power interruption. These sub-themes highlight the complexities involved in integrating the LHIMS effectively.

Hardware Related Challenges

The first major theme that emerged as a challenge under technological issues was related to computer hardware. This encompassed a range of issues, including insufficient and malfunctioning computer devices. The satisfaction, efficiency, and effectiveness of the Lightwave Health Information Management System (LHIMS) hinged on the performance of these computer devices. Their availability and optimal condition were pivotal in ensuring efficient operations. During the discussions with the participants, it became evident that the inadequacy of desktop computers and tablets posed challenges in using LHIMS effectively. For instance, nurses and midwives expressed their frustration with the need to queue and manually enter patient details into the LHIMS due to the lack of sufficient computers.

When you come to my unit, there is only one computer available. However, we are about six individuals in this unit, and it is challenging for all of us to share a single device. This hampers our efficiency in service delivery. The need to queue and take turns for data entry significantly delays our service delivery. To be frank, some staff even defer entering patients' information into the LHIMS due to the limited computers available [A midwife in one of the facilities]

The computers we currently have in this facility are insufficient. LHIMS requires a computer to operate, and unfortunately, we do not have enough computers, making it challenging to use the system effectively. It is unrealistic to expect about ten people in a unit to share one computer; such an arrangement is simply not feasible. We need additional computers to fulfil our work requirements properly [A nurse at OPD of one of the facilities]

Furthermore, some participants shared a similar viewpoint regarding the challenges they faced due to computer breakdowns and malfunctioning peripheral devices, such as mouse and keyboard. They expressed that these issues hindered their ability to use the system as intended. According to their feedback, when these devices are not promptly fixed, it creates difficulties in utilising LHIMS effectively, leading to potential lapses in capturing some patients' records on the LHIMS.

We have approximately four computers, and unfortunately, none of them are functioning. Since LHIMS requires a computer to operate, the non-functionality of these devices makes it challenging to use the system effectively [A midwife in one of the facilities]

The computer keyboard is not functioning properly, and the mouse is also causing issues. It is challenging to carry out tasks without a proper keyboard and mouse. These are the challenges we face in using the LHIMS [A nurse manager in one of the facilities]

The delay in repairing broken-down devices emerged as a common challenge identified by participants across various health facilities. They expressed their concern that the extended period it takes to fix these devices forces them to resort to using the paper system. This, in turn, creates an additional burden for users of the system as they have to later transfer the data onto the LHIMS, leading to a double task. Consequently, this perceived challenge was highlighted by several participants. Below are some of the narrations provided:

You see this computer [shows researcher the device], has been inactive for about three months now. When you report it to the administration, they only promise to come and fix it, but nothing happens afterwards. How are we supposed to use LHIMS on a broken device? Besides, the devices are already inadequate, and the broken ones are not fixed promptly either [A nurse in one of the facilities]

Our computers are not fixed when they develop faults. Many devices are broken down, and there are no attempts to repair them. Even when they eventually get fixed, it takes an extended period. All these factors pose challenges to the effective use of LHIMS [A dispensary assistant in one of the facilities]

Software Related Challenges

The second major theme related to technical was software-related challenges. The Lightwave Health Information Management System serves as the primary software for health service delivery across all study facilities. The findings revealed three challenges associated with its use in these settings. Firstly, under the category of software challenges, the primary issue identified was the inconsistency in report generation linked to LHIMS utilisation. During interviews, participants, notably health information officers, reported that LHIMS produced varying results for the same report. Specifically, when generating a report on the number of clients attended to at the Outpatient Department, the system yielded inconsistent outcomes. These experiences were shared:

> *I have reservations about the system's accuracy as some of the data generated after entry appears to contain errors. Specifically, the reported cases for certain diseases, such as malaria, seem to represent only about one per cent of the actual occurrences. Due to these discrepancies, I find myself manually verifying the data at the end of each month, cross-referencing it with the system's provided information to ensure accuracy* [A staff at Health Information Unit of one of the facilities]

> *We have observed disparities in certain reports concerning morbidity at the OPD. The information provided is not entirely accurate. We generate the correct data by cross-referencing with paper records whenever such discrepancies arise* [A staff at Health Information Unit of one of the facilities]

The second challenge in relation to software is the issue of lack of standardisation. The participants, irrespective of their background, indicated that there was a lack of standardisation in data capturing across facilities. They explained that although they all used the LHIMS, some facilities had customised the LHIMS to address the needs of the local facility hence the challenge with standardisation. Lastly, according to the participants, the LHIMS was unable to facilitate patient referrals.

> *It appears that the LHIMS in this facility differs from the one I used at my previous workplace in several ways. There are certain features here but not at my previous health facility and vice versa* [A nurse at one of the facilities].

> *The design of LHIMS in this facility is not the same as in other facilities. They just customised it and picked certain things out. It has been designed to suit the laboratory in this facility* [A staff at the Laboratory Unit of one of the facilities].

> *When LHIMS was initially introduced, it featured three parameters. However, the system is designed to be adaptable, allowing users to customise inputs according to their preferences. Upon realising that LHIMS did not provide the full range of parameters we required, we promptly informed the IT managers. They responded by redesigning the system to meet our specific needs* [A staff at the Laboratory Unit of one of the facilities]

During the interview, another challenge that arose was the inability to utilise LHIMS for referring patients to other facilities also using the LHIMS.

Participants, regardless of their background, expressed the belief that, under normal circumstances, LHIMS should facilitate the execution of referral services between facilities on the LHIMS network. However, at present, this functionality is not operational. Regarding patient referrals, health professionals had to rely on the paper-based system. They would write referral notes and physically hand them over to the referred clients. According to the participants, this limitation represents a major shortcoming of LHIMS. Some of them shared their experiences, narrating the difficulties and inefficiencies they encountered due to this issue.

> *Patients merely provide a referral note, and I am not aware of any option or feature on LHIMS that would allow me to initiate a patient referral to another facility with a simple click. The absence of the necessary creativity to establish such a link is the primary reason why we refer patient by writing on paper* [An optometrist in one of the facilities]

> *Another respondent also said this: Regarding patient referral, we manually include the pertinent details that the prescribers should be aware of on paper. The reason being, LHIMS lacks a specific feature to facilitate referrals. Consequently, we record the information on paper, which is then carried by the patient to the other facility* [A staff at the health information unit in one of the facilities]

The third challenge related to software is the limited system features of the LHIMS. The participants indicated that the system does not provide specific features for some types of professionals and certain diagnoses. Respondents expressed concerns over the list of diagnoses available on

LHIMS and the use of unfamiliar names for certain conditions, making it less efficient to locate specific health conditions within the system. Consequently, they find themselves compelled to choose 'near-diagnoses' or similar disease conditions. Below are some narrations provided by the participants regarding this matter:

> *At times, particularly when inputting a diagnosis, it can be challenging to find the exact option you want within LHIMS. As a result, you may have to select the next best or similar diagnosis from the dropdown options because the precise diagnosis you seek might not be available in the system's dropdown menu* [A physiotherapist in one of the facilities]

> *I am compelled to select near a diagnosis. I find myself forced to choose a diagnosis that is close but not exact. For instance, when a patient visits, LHIMS is meant to assist in selecting the diagnosis and prescribing appropriate medication. However, that does not always happen smoothly. Sometimes, when searching for a specific diagnosis, it is not available in the drop-down menu. In such cases, I must opt for a closely related health condition for the patient; otherwise, the patient cannot access the pharmacy for the prescribed medicine* [An Optometrist in one of the facilities]

There were other issues reported by participants concerning user accounts of some professions on the LHIMS. This challenge was commonly reported among physiotherapists. One of them had this to say:

> *Access to the LHIMS is granted based on your profession, but unfortunately, our profession of physiotherapy is not included in the*

system. As a result, we are forced to enter as medical officers, even though that does not accurately represent our roles [A physiotherapist in one of the facilities]

Similarly, laboratory technicians and radiographers from various health facilities expressed that the LHIMS lacks comprehensive coverage of all the parameters required for a Full Blood Count (FBC). Moreover, they are unable to upload X-ray results onto the LHIMS, resulting in limited data entry capabilities. Two of them shared their experiences as follows:

The LHIMS at our facility lacks the functionality to upload scanned images or films from X-rays directly. While some other facilities have successfully integrated their analysers and the LHIMS software, our facility does not currently have such a setup in place [Radiographer in one of the facilities].

The LHIMS is not used in capturing all laboratory parameters effectively. For example, when conducting a Full Blood Count, numerous essential parameters such as WBC, RBC, and HB are involved, yet the system does not offer a field to capture all of these data comprehensively. Instead, only three parameters—WBC, HB, and platelet—can be inputted. [A staff at a Laboratory Unit of one of the facilities]

Another limited system feature-related challenge is the inability of the LHIMS to autosave information. Users of the LHIMS, regardless of background, complained that they always had to start from scratch anytime there was a power interruption which led to a loss of information. They shared their views that the LHIMS should have the autosave function to improve on

efficiency and satisfaction of system users. The following were experiences shared:

> *In this area, power cuts are frequent, and unfortunately, we do not have a UPS to mitigate their impact. During a blackout, any unsaved information gets lost, forcing us to painstakingly re-input or retype all the data. This repetitive process can be extremely exasperating and time-consuming, often causing frustration and annoyance* [A physiotherapist in one of the facilities]

> *In addition to the delay caused by writing notes in the system, there's the added frustration of losing significant progress during power outages. Imagine typing a whole page of content, only for everything to vanish due to a sudden power cut. It would be beneficial to have an autosave function in place, ensuring that even if the power unexpectedly goes off, the system can retain the entered information and prevent such losses* [A midwife in one of the facilities]

In addition to the LHIMS lacking an autosave feature, discussions with participants have highlighted another issue – the absence of a previewing option before saving client information. This limitation has been a significant challenge for them. Participants especially medical doctors and midwives expressed the need for a previewing option that would enable them to review and read through the entered data before finalising the save. Such a feature is crucial in preventing input errors. Some of the participants shared their experiences, saying:

The system does not permit you to review and confirm the accuracy of the information you have entered before saving it [A midwife in one of the facilities]

The option to preview our entries before saving is completely absent. The system must get updated to incorporate this feature, as it would be immensely beneficial in preventing minor mistakes and errors [A doctor in one of the facilities]

Power Interruption

The utilisation of thermal energy (electricity) is of utmost importance in operating systems that rely on it. The stable and continuous availability of electricity contributes to the efficient functioning of the Lightwave Health Information Management System (LHIMS). Through discussions with various health professionals, it became evident that power outages pose a major challenge in using the LHIMS. Participants regardless of background expressed concerns that whenever there is a power outage, service delivery comes to a halt, and patients may experience delays until an alternative power supply is provided. The reality is that some facilities do not have a standby generator or power plant. Consequently, when the power goes out, they are forced to halt operations as their desktop computers rely on electricity to function. Even facilities equipped with generators may encounter issues such as fuel shortages or delays in turning on the generator by those responsible. Some participants shared their experiences as follows:

My facility has a generator, but unfortunately, we often have to wait for a while until someone goes and turns it on for us. The security

personnel are responsible for turning it on but sometimes they fail to do so promptly [A midwife in one of the facilities]

During power outages, everything comes to a halt. We are left waiting until the power is restored because, without it, we cannot enter patient records into the system. We have no choice but to wait or resort to using paper records, which we later have to input into the system once power is restored. This situation creates double work for us, and it can be quite frustrating [OPD In-charge in one of the facilities]

In addition, some participants voiced their concerns about their facilities not having an Uninterrupted Power Supply (UPS) to sustain or serve as backup power during power outages. A Physiotherapist and a pharmacist shared their experiences as follows:

When the power goes off because we do not have a UPS, if you have not saved your information, you will lose it. As a result, you need to start all over again. Additionally, if there are issues with the generator, the patient might have to wait for about an hour until it starts working again. These are some challenges we face, and it affect the use of the LHIMS [A physiotherapist in one of the facilities]

When the power goes off, having a UPS to retain power is crucial. However, currently, there is no UPS available. Most of the devices are not running on UPS, and as a result, when a power outage occurs, it has a significant impact on the system. This situation poses a major challenge for us [A pharmacist in one of the facilities]

Technological Issues

During data analysis, an emerging theme related to technology surfaced. These challenges included an unstable local area network (LAN) and information distortion after updates. Below are the challenges presented in detail:

Unstable Local Area Network

Participants also highlighted network interruptions as another technological-related challenge. They explained that LHIMS relies on local area connections for accessibility and utilisation, and any disruption in the service makes the delivery of health services challenging. In certain facilities, health professionals mentioned that it became difficult to access the LHIMS during the daytime. Some facilities were only able to use the LHIMS at night while they relied heavily on paper records. These were the experiences shared by some of the participants.

> *There are times when the network works perfectly throughout the night, but there is no access during the day. Just imagine attending to numerous clients during the day, and the network only becomes available at night. Those who came during the day would not be captured in the system, creating a significant gap in patient records* [A midwife in one of the facilities]

While some health professionals reported that a slow network posed challenges to the effective and efficient use of LHIMS, facilities with a high number of patients revealed that slow network speed resulted in delays in service delivery, leading to long queues. Certain participants mentioned resorting to the paper system and later entering clients' information into the

LHIMS. Moreover, some also noted that network speed slows down during the day and especially when it rains. Some participants expressed their experiences as follows:

> *Most of the time, the network becomes slow, and there are instances when you have to move around to find a stable network connection. I have personally experienced this situation before. There was a time when I had to leave my office and walk around until I found a better network speed to access LHIMS and serve medication to patients* [A nurse at the Eye Clinic in one of the facilities]

> *The network is much faster at night compared to the daytime. Throughout the whole day, the speed of the network can be very frustrating; it is notably slow. My colleagues have mentioned that it works faster at night. However, the question arises: how many people come to the hospital at night? Only a few people do* [A midwife in one of the facilities]

Distortion of Information After Updates

Updates can prevent security issues and improve compatibility and program features. Software updates are necessary to keep computers, mobile devices and tablets running smoothly - and they may lower security vulnerabilities. However, discussions with participants indicated that system updates sometimes lead to loss of information from the LHIMS and distort patients' records.

> *There are instances when system updates lead to the distortion of information in the system. Upon checking, you may find that certain*

stored information is no longer accessible due to the update that was performed. [A pharmacist in one of the facilities]

There are times when updates are implemented, and therefore, the information on the system gets messed up. For example, you may see drugs physically present on the counter, but when you check the system, it incorrectly indicates that there are no drugs available [A pharmacist in one of the facilities]

Human Factors

Using a specific system requires users to possess certain skills and expertise. From the analysis, an important theme emerged, indicating that service providers lacked the necessary skills and expertise, which was a barrier to the effective and efficient utilisation of LHIMS. Two major challenges were identified: inadequate training received on the use of the LHIMS and computer illiteracy among service providers.

Inadequate Training on the LHIMS

Inadequate skills on the side of users can pose significant challenges. During discussions with participants, it became evident that many of them either received no training on LHIMS or the training they received was insufficient. Most participants reported that they were trained for only a day, which they considered inadequate. Some of them expressed their experiences as follows:

We do have training, but it does not happen frequently. Moreover, the training provided is a general session for everyone, and it only lasts for a single day. However, one of the challenges we face is that we do

not receive further training after new updates are implemented [A staff at medical record unit of one of the facilities]

They only came to introduce the LHIMS to us and showed us how to enter data into it. Unfortunately, we did not receive any significant training on how to use it effectively [An optometrist at one of the facilities]

Computer Illiteracy

Participants not only attributed the challenges they faced in using the LHIMS to inadequate training but also recognised computer illiteracy as a barrier to its utilisation. Despite receiving training, those who were 50 years an above found it difficult to use the LHIMS because they lacked prior knowledge and skills in computing. Some of them expressed their experiences as follows:

Regarding age, I believe so because those who were born before the computer era may face certain challenges when using LHIMS. Perhaps, they lack the necessary computer skills that would enable them to use LHIMS effectively [An optometrist in one of the facilities]

All the workers in our facility, except for an elderly woman (50 years above), can use LHIMS. She finds it difficult to operate the LHIMS most likely due to her age and lack of computer knowledge and skills [A midwife at ANC in one of the facilities]

The use of LHIMS is affected because not all the prescribers are proficient in IT. As a result, the elderly prescribers attend to the clients but rely on younger colleagues or nurses to handle the data entries for

them since they lack computer manipulation skills [A health information officer in one of the facilities]

Discussion of Findings

The adoption and implementation of the Lightwave Health Information Management System (LHIMS) in healthcare facilities across Ghana highlight challenges associated with health information technology. In particular, the findings from the study illustrate that the technology's use is hindered by infrastructural, technical, and human resource challenges, which align with insights from the Technology Acceptance Model (TAM) and the ISO's standards of efficiency, effectiveness, and satisfaction. From the perspective of the TAM, which posits that the perceived ease of use and usefulness are key determinants of technology acceptance, several issues emerge in the context of the LHIMS. The inadequacy of computer infrastructure, as noted in the study, directly affects users' perceived ease of use.

Health professionals frequently encountered challenges, such as having access to only one desktop computer per unit, resulting in slow data entry processes and a reliance on paper records during system downtimes. These findings align with prior research by Howard et al. (2013), Anyango (2017), and Mensah et al. (2023), which similarly highlighted inadequate computer devices as a common issue in electronic health record (EHR) implementation. Furthermore, in line with ISO 9241-11, these challenges detract from the system's efficiency, effectiveness, and user satisfaction, underscoring the need for comprehensive support structures, including adequate training, timely maintenance, and ongoing software improvements, to enhance the user experience.

Likewise, Mawah et al. (2021) reported that many developing countries face a significant issue of unavailability of technological devices, such as computers, which need to be addressed before implementing electronic health systems (Mawah et al., 2021). This finding highlights the importance of ensuring adequate computer devices are procured and supplied to improve the effective usability of LHIMS across health facilities. Challenges in some facilities included insufficient devices, malfunctioning equipment, and delays in repairs. When devices are not promptly fixed, health professionals often revert to paper-based systems for recording patient information, which increases their workload. They may need to transfer paper records onto LHIMS once the devices are repaired. Therefore, it is crucial to ensure that malfunctioning devices are quickly repaired or replaced to maintain the smooth functioning of LHIMS.

From a usability perspective, inconsistencies in report generation pose substantial issues. These inconsistencies may result from a variety of errors, such as software bugs, incomplete or incorrect templates, and improper insertion of patient data into the wrong medical records. As Bowman (2013) suggests, such discrepancies may also be linked to inconsistent wording and outdated embedded objects. These errors directly hinder the system's effectiveness and efficiency, leading to delays in data processing and incorrect report outputs, which compromise the reliability of the system. Moreover, Hoffman and Podgurski (2009) argue that software bugs could be a contributing factor to the confusion and mismanagement of data, which ultimately affects both system usability and user satisfaction.

This aligns with the TAM framework, where perceived ease of use is directly related to how effectively users can navigate and trust the system. The presence of bugs and errors, in this context, acts as a significant threat to the user's perception of the system's usefulness.Phillips and Fleming (2009) also highlight that improper usage of the electronic system could exacerbate data capturing issues, which further points to the need for adequate user training and system design optimisation. From an ISO 9241-11 perspective, improper use of the system negatively impacts both effectiveness and user satisfaction. Therefore, aligning the design of such systems with the requirements of user-centric standards like ISO 9241-11 is crucial to minimise these discrepancies and enhance the overall technology acceptance among healthcare professionals.

The findings of this study reveal that the lack of standardisation in data capturing and Electronic Health Record (EHR) systems across healthcare facilities presents significant challenges, in line with prior research (Rathert et al., 2018; Dutta & Hwang, 2020; Li et al., 2021). From the perspective of the Technology Acceptance Model (TAM), this inconsistency impacts perceived ease of use, as healthcare staff encounter increased workloads and service duplication, while vital patient information may be overlooked (Roman et al., 2017). The study echoes the Council for Affordable Quality Healthcare (2016), which highlighted the difficulty of achieving interoperability due to the absence of uniformity in healthcare systems.

In this research, some facilities used the Basic Laboratory and Information System (BLIS) for lab processes while others relied on the LHIMS, illustrating a clear disparity in system usage. This lack of

standardisation hinders both the efficiency and effectiveness outlined in ISO 9241-11, as the primary goal of EHR systems—seamless data sharing—is compromised. Without interoperability, the full potential of these systems to improve efficiency, effectiveness, and user satisfaction cannot be realised. Establishing clear standards is therefore essential to overcoming these barriers and ensuring smooth interoperability across healthcare systems. Once again, multiple studies conducted in different regions, including the United States of America (Meigs & Solomon, 2016), high-income countries (Li, Clarke, Neves, Ashrafian, & Darzi, 2021), developing countries (Gambo et al., 2011), Botswana (Ndlovu et al., 2021), have reported similar findings that align with the results of this study. The common thread among these studies is the lack of standardisation in electronic health systems, leading to the inability to seamlessly transfer data effectively between healthcare facilities and hindered healthcare delivery.

For example, in Botswana, despite adopting well-known interoperability standards and data formats, multiple databases are still in use, with many of them lacking interoperability both within and between institutions or sectors (Ndlovu et al., 2021). Efficient referrals in healthcare require extensive coordination and direct engagement between healthcare facilities, subspecialists, and patients (Hysong et al., 2011). An essential goal of electronic health systems is to improve the overall quality of treatment by increasing transparency, reducing operational inefficiencies, and enhancing patient referral systems for both large and small healthcare institutions (Esquivel et al., 2012). However, the findings of the current study indicate that

the Lightwave Health Information Management System (LHIMS) had no feature to initiate referrals.

As a result, health professionals still rely on paper systems to refer clients to other healthcare facilities, leading to possible duplicates in client registration should health information officers avoid utilising a specific function called the global search on the LHIMS. This issue is not isolated, as a previous study in Southwest Nigeria also reported that 36.4 per cent of health workers faced the inability of the Electronic Medical Records (EMR) to refer patients to other health facilities (Ajayi et al., 2021). These collective findings emphasise the need to address and enhance the referral capabilities of electronic health systems for smoother healthcare processes and improved patient care.

Nevertheless, it's crucial to recognise that while interoperability within the same facility was feasible through LHIMS, achieving interoperability among various facilities became viable and practical through the utilisation of a global search feature integrated into LHIMS. Despite the capability to retrieve patient information from other health facilities, the process was not entirely seamless. For instance, within the same facility, there was successful interoperability between doctors and the pharmacy for drug prescriptions and generating X-ray film translations, as intended with the implementation of LHIMS. The LHIMS demonstrated interoperability among different units, enabling the electronic exchange of patient data across multiple healthcare providers. This streamlined the process for health professionals to offer care to their clients, and it facilitated the seamless movement of clients between different departments.

A report by Wheel Health (2022) further supports the significance of interoperability, as it ensures accurate communication of patient data among healthcare team members, leading to increased efficiency, reduced unnecessary medical tests, and improved communication between referring doctors and specialists. Another major challenge associated with the Lightwave Health Information Management System (LHIMS) is its limited system functions. The study findings revealed that certain essential functions were either unavailable or restricted in the system, affecting effectiveness and efficiency with the use of the LHIMS.

As reported by health professionals, the LHIMS did not have a comprehensive list of diagnoses, the ability to upload scans and X-rays, an autosave function, and previewing before saving entries. The limited list of diagnoses compelled doctors to choose approximate conditions rather than specific ones. The LHIMS used a drop-down menu for the list of diagnoses, and until one or multiple conditions were chosen, clients could not receive their prescriptions. This limitation may be attributed to inadequate knowledge of health professionals on ICD coding, leading to the challenge of identifying the appropriate diagnosis from the list of ICD codes embedded in the LHIMS as its standard list of diagnoses. Additionally, the LHIMS utilising outdated International Statistical Classification of Diseases and Related Health Problems (ICD) coding, like ICD-10 instead of the more current ICD-11 could be a possible reason why some prescribers struggle using the LHIMS.

Additionally, the LHIMS faced challenges in uploading scanned X-ray files, leading clients to carry paper results to physicians for examination and prescription. Furthermore, the system did not include health professionals such

as physiotherapists, resulting in them having to log in as doctors, despite their different roles. These findings align with previous studies conducted in Zimbabwe (Mukono & Tokosi, 2019) and Southwest Nigeria (Ajayi et al., 2021). It is worth noting that the study in Zimbabwe focused on Healthcare Information Technology (HIT), the Nigerian study on Electronic Medical Records (EMR), and the current study on the Lightwave Health Information Management System (LHIMS). Despite the specific platforms being different, the systemic challenges related to limited system functions are prevalent in all Electronic Health Records (EHR) systems. The LHIMS, EMR, and HIT are all classical examples of EHR, facing similar issues in their respective contexts.

With an electronic health record (EHR), patient records become inaccessible without electricity. Power outages can occur naturally or as a result of weather events or disasters. Such outages can have a substantial impact on physician office operations, and the usage of electrical medical devices, equipment, and EHRs, especially if they are prolonged or if emergency backup systems fail. Findings from the current study indicate that power interruptions greatly affect the usage of the Lightwave Health Information Management System (LHIMS) in health facilities. This observation is consistent with previous studies conducted in Hong Kong (Or et al., 2018) and Saudi Arabia (El Mahalli, 2015), which reported similar findings. These studies highlighted that power outages act as barriers to using electronic health data when compared to paper health records, which do not require any software.

In Ghana, a study on the knowledge and use of Electronic Health Records in healthcare delivery was conducted at Kwadaso S.D.A hospital in

Kumasi reported that frequent system unavailability due to power outages has resulted in a lack of enthusiasm for using EHRs, thus reducing their usefulness and efficiency (Addo & Agyepong, 2020). Addressing the issue of power outages on a national level would stabilise and improve the effectiveness and efficiency of LHIMS. Some notable implications of power outages on the use of LHIMS include an increase in workload, as system downtime leads to users' inability to capture all data, resulting in work overload (Addo & Agyepong, 2020). A stable internet connection is crucial for using electronic health records, and the Lightwave Health Information Management System (LHIMS) is no exception. To use LHIMS effectively and efficiently to the optimum satisfaction of its users, a smooth and stable local area network (LAN) is necessary.

According to Evans (2016), local area networks and the internet provide faster and easier access to medical information, leading to the adoption of web based EHRs to enhance healthcare delivery. While some facilities in the study area reported stable connections during the day, there were instances where some facilities faced slow internet connection during the day but faster connections at night. A possible explanation for this discrepancy could be related to rainfall and the pressure on local area network bandwidth. Similarly, LAN facilitates the sending and receipt of data, but bottlenecks may occur when there are too many connections, slowing down the broadband (Chetty et al., 2011). The findings of the current study align with those of Or et al. (2018), who reported that healthcare providers in Hong Kong were concerned about the instability of computer networks regarding electronic health records. To address instability in the local area network, increasing the

network's bandwidth to accommodate more users during the day could be a potential solution. Additionally, each unit could have its server closer to them, rather than a central server located far from most units, which could contribute to slow connections.

One of the most crucial components of EHR deployment and usability is training because the software is only useful if physicians and staff understand how to utilise it (Boyles, 2021). EHR training educates healthcare personnel on making fast and precise notes, ensuring comprehensive records, and spending more time with patients (Longhurst et al., 2019). Knowledge of an EHR's automatic coding capabilities helps assure accuracy. However, the results of the current study reveal that health workers did not receive sufficient training to operate the Lightwave Health Information Management System (LHIMS) properly.

Most of them received only a day of training on LHIMS, which they perceived as insufficient. Others learned how to use LHIMS from co-workers who had also received training. They considered this a challenge to the usability of LHIMS in delivering healthcare services to clients. Previous studies also reported similar findings (Addo & Agyepong, 2020; Longhurst et al., 2019). For instance, health professionals who do not receive proper EHR training are more likely to make documentation errors, decrease productivity, and jeopardise the health of their patients. According to Boyles (2021), inadequate training often leads to preventable errors, resulting in additional time spent redoing or completing EHR activities. In some cases, professionals enter erroneous data or leave the information blank, putting the patient at risk (Addo & Agyepong, 2020; Boyles, 2021; Longhurst et al., 2019).

A study by Robinson and Kersey (2018) reported that an EHR training program resulted in enhanced efficiency, reduced medical mistakes, and improved documentation accuracy and service quality. Some doctors even claimed to have a better work-life balance after training (Robinson and Kersey, 2018). Most research participants stated that they saved four to five minutes per hour on documentation duties after training, amounting to approximately an hour per day for some healthcare practitioners (Robinson and Kersey, 2018). Despite its relevance, EHR training is often not given the attention it needs by many institutions. According to Applied Clinical Informatics, 43% of clinicians thought their first EHR training was insufficient, and nearly 95% believed they could enhance their EHR abilities with adequate training (Pantaleoni et al., 2015). Therefore, users of LHIMS in health facilities in Ghana need to receive adequate training so that the country can reap the short- and long-term benefits associated with the software's use to improve the health of the Ghanaian populace.

Computer illiteracy among LHIMS users, especially older staff members, poses a challenge to the software's effective usability as indicated in the conceptual framework and the technology acceptance model. The findings reveal that due to a lack of computer literacy, some health professionals resort to using paper records and later ask their junior staff or subordinates to enter the information into the system. Similar findings were reported in other studies conducted in the Northeastern United States of America (Howard et al., 2012), Ghana (Addo & Agyepong, 2020), Kuwait (Kamel & Saadoun Faris, 2008), and Saudi Arabia (Alasmary, El Metwally & Househ, 2014; El Mahalli, 2015). These studies indicated that EHR usage is influenced by

technical/computer literacy and abilities such as typing. Similarly, in the current study, those who were not technologically inclined found the utilisation of LHIMS unsatisfactory. This implies that those with inadequate computer knowledge should sharpen their skills before LHIMS training, as computer literacy plays a significant role in its effective use. This finding aligns with a study by Van Der Meijden, Tange, Troost, and Hasman (2003).

CHAPTER TEN

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Introduction

The concluding chapter of this study presents a summary of the work. It outlines the research problem, the objectives of the research, the various relationships examined in the study, the theories, the methodologies used in achieving the research objectives, and the data processing and analysis methods. This chapter also summarises the significant results obtained in line with the study's hypotheses and makes conclusions on them. The chapter finally presents some recommendations for further research on the topic.

Summary of the Study

Health Information Systems are vital assets for any healthcare system, as they significantly enhance healthcare delivery. In Ghana, the use of health information systems has become increasingly important and has resulted in an overall improvement in healthcare provision throughout the nation over the years. The study sought to assess the Lightwave Hospital Information Management System (LHIMS) for health service delivery in Ghana, specifically the Central Region. The study specifically examined how health professionals use the LHIMS effectively and efficiently and how satisfied they are with the system.

The population of this study was made up of health professionals, namely, prescribers, nurses/ midwives, diagnostics, medical records personnel, and dispensers in the Central Region. This population was chosen because the implementation of the LHIMS began in the Central region. The target population for the study was health professionals in ten facilities using the

LHIMS for healthcare delivery. The chosen facilities had a minimum of two years of experience in using the system. Thus, it was assumed that the health professionals within these facilities had acquired sufficient familiarity with the system, making them valuable sources of data for the research.

The study explained the 3-usability domains of the LHIMS (efficiency, satisfaction, and effectiveness). The Technology Acceptance Model/Theory was the main theory employed for the study which is an extension of the theory of Planned Behaviour. Additionally, the Usability Evaluation Framework of ISO 92-41-11 was adapted to aid in understanding the use of health information systems in the Ghanaian context of healthcare delivery. Various literature on the 3-usability domains of health information systems, the independency among the 3-usability domains and the challenges associated with the use of electronic health records systems were reviewed. This was done to present empirical evidence to support the subject under study.

The pragmatism paradigm was the research philosophy underlying the study. This philosophy was used because the study sought both objective and subjective opinions on health professionals' use of the LHIMS for health service delivery. The study employed a quantitative and qualitative approach, which is in line with the pragmatist research philosophy, for a better understanding of the usability of the LHIMS among health professionals. The study sample for the quantitative aspect was estimated to be 1033 health professionals. However, an additional 10% was added to surmount attrition, making 1136 health professionals. The study employed the stratified

probability sampling method in selecting these respondents. The study used this method as a result of the nature of the analysis direction of the study.

The study analysed respondents' responses based on their characteristics (socio-demographic characteristics, professional characteristics, and Training /Computer proficiency) to ascertain whether there are differences in responses based on the differences in characteristics. For the qualitative component of the study, 30 Unit Heads from the 10 facilities were chosen. Unit heads were chosen as it is assumed that their position makes them privy to some information that may be unavailable to all other professionals. These 30 respondents were chosen using the purposive sampling technique as the researcher used his judgment to decide who could provide the information necessary for this research.

Primary data was collected from respondents in the form of a cross-sectional survey. A standardised and validated questionnaire was used for the collection of data from respondents in the quantitative space. The questionnaire was divided into four sections which contained questions on the demographic characteristics of the respondents, their efficient use of the LHIMS-EHR, satisfaction with the use of the LHIMS and the effective use of the LHIMS respectively. An interview guide was also employed for the collection of data from the health professionals in the qualitative space on health professionals' perceptions of the usage of the LHIMS and some of the challenges associated with its use. The pretesting was conducted to determine the validity and reliability of the study's instrument. Research assistants were engaged to aid in the collection of the quantitative data for one month. Within

this period, in-depth qualitative interviews were conducted with the unit heads at the various facilities.

The study used 1126 responses in data analysis which represents 99.11% of the study's sample. The study hypothesised that there is a statistically significant association between socio-demographic characteristics and the 3-usability domains of LHIMS (satisfaction, efficiency, and effectiveness). For this analysis, SPSS version 26 was used in processing the data by way of bivariate and multivariate analysis. The study hypothesised that there is an interdependency among the 3-usability domains of EHR use. For this analysis, Amos version 26 was used to perform structural equation modelling and test for interdependency among the 3-usability domains of LHIMS. The data analysis produced the results presented.

The table below presents a summary of the major findings from the study, which aimed to evaluate various aspects of health professionals' interaction with the Lightwave Health Information Management System for health service delivery. The table organises the results according to the specific research objectives, highlighting the key factors influencing the efficient use, satisfaction, and effectiveness of LHIMS, as well as the interdependencies among these factors and the challenges faced by health professionals. This structured overview provides a clear understanding of the determinants and implications of LHIMS usage in healthcare settings in the Central Region(see Table 26).

Table 26: Summary of the Major Findings of the Study

Research Objective	Major Results/Findings
Research Objective One (1) – assess health professionals' efficient use of the LHIMS for health service delivery.	It was revealed that sex, educational qualification, and training prior to the use of LHIMS were not statistically significant to health professionals' use of the LHIMS-EHR. However, years of work experience and computer proficiency have a statistically significant effect on the efficient use of the system.
Research Objective Two (2) - analyse the satisfaction of health professionals using the LHIMS.	The results obtained show that educational qualification, work experience, training status of respondents before the use of LHIMS, and duration of the training and computer proficiency have a statistically significant impact on the satisfaction of health professionals in the use of the LHIMS-EHR.
Research Objective Three (3) - measure the effectiveness of the use of LHIMS.	The results revealed that years of work experience, educational qualification, and training prior to the use of LHIMS were statistically significant predictors of health professionals' effective use of the LHIMS-EHR.
Research Objective Four (4) - establish the interdependency among effectiveness, satisfaction, and efficient use of the LHIMS by health professionals.	The results revealed a positive but weak relationship between satisfaction and efficient use of the LHIMS, satisfaction and effective use of the LHIMS and effectiveness and efficient use of the LHIMS by health professionals.
Research Objective Five (5) - explore the challenges associated with the use of the LHIMS for health service delivery.	The findings revealed technological challenges (Power interruption, unstable local area network (LAN) and distortion of information after updates), technical (software and hardware challenges) and human factors including inadequate training received on the use of the LHIMS and computer illiteracy.

Source: Agyemang (2021)

Conclusions of the Study

The study concludes that LHIMS has significantly improved service delivery, leading to reduced documentation time, faster task execution, and enhanced patient care, which aligns with the Ghana National e-Health objectives. As part of the efficient use of the LHIMS, years of work

experience are crucial determinants of the efficient use of the LHIMS. At the same time, other socio-demographic factors such as age, sex, and educational qualifications demonstrate limited influence. This emphasises the importance of work experience in technology adoption within the healthcare sector. The TAM's framework highlights external factors, including user characteristics, that shape a system's perceived usefulness and ease of use. While the study supports key aspects of the TAM, particularly regarding perceived efficiency and task performance as critical to system acceptance, it can be said that not all external factors, such as age and gender, consistently predict the efficient use of LHIMS.

Furthermore, there is a strong correlation between health professionals' computer proficiency and their years of work experience with efficient system usage. The study concludes that user competency, rather than solely demographic variables, is a primary driver of efficient LHIMS utilisation. The LHIMS facilitates the rapid retrieval of accurate information and is well-received by health professionals. The study underscores the pivotal role of the effective implementation of Electronic Health Records (EHR), particularly the Lightwave Health Information Management System (LHIMS), in enhancing operational efficiency and improving patient care outcomes. The findings demonstrated that health professionals benefitted from increased productivity and enhanced data collection through LHIMS, which minimises errors and fosters optimal patient care.

Also, it can be concluded that years of work experience and educational qualifications are significant determinants of effective LHIMS utilisation, whereas age and sex do not exhibit a similar influence

scientifically. This finding contrasts with the Technology Acceptance Model (TAM), which posits that external factors like age should affect technology use. Additionally, the study emphasises the critical importance of training; without adequate training, health professionals face challenges in fully utilising the LHIMS.

Moreover, the hypothesis of a positive and significant relationship among efficiency, effectiveness and satisfaction, demonstrates that improvements in satisfaction lead to more efficient and effective use of LHIMS. These findings align with the ISO framework, which emphasises the importance of usability metrics in technology assessment. Although the strength of the correlations in this study was weak, they indicate that enhancements in one area can have beneficial implications for others. This supports the argument that focusing on usability across multiple dimensions is crucial for optimising technology performance.

The study further concludes that the deployment of LHIMS, while beneficial, faces key challenges including technical limitations such as power interruptions, software shortcomings, and inadequate hardware, as well as human factors like insufficient training and low computer literacy. According to the Technology Acceptance Model (TAM), these external threats significantly influence the perceived ease of use and usefulness of the system, which in turn affects users' acceptance of the technology. Such barriers may hinder the effective use of LHIMS, reducing system efficiency and directly impacting user satisfaction with the use of the LHIMS. Despite these bottlenecks, the study concludes that LHIMS has positively enhanced healthcare delivery in Ghana, particularly in reducing patient wait times and

improving service efficiency which significantly contributes to progress towards attaining the Sustainable Development Goals (SDGs) and Universal Health Coverage (UHC).

Recommendation

The management of health facilities are recommended to sustain and utilise the Lightwave Health Information Management System (LHIMS) as professionals found it efficient, effective and satisfied using it for health service delivery. Management of Health facilities should implement training programs for all health professionals, especially those with less than one year of work experience. Health facilities through the Ministry of Health should design training modules tailored to the educational backgrounds of their staff, ensuring that certificate holders receive additional support to achieve the same proficiency levels as degree holders when using the LHIMS. Also, since certificate holders have been less efficient in using the LHIMS and these professionals are largely from public health training institutions, it is recommended that a demo application of the LHIMS be installed in the computer laboratories of these institutions nationwide. This will facilitate learning and help students better understand the LHIMS functionalities.

Regarding the interdependency of effectiveness, satisfaction, and efficient use of the LHIMS by health professionals, the study reveals a positive and significant relationship among these three domains. The positive relationship among the domains suggests that improvements in one domain can lead to positive effects on the other domains as well. Policymakers can strategically allocate resources to any of these domains to enhance the LHIMS's effectiveness, satisfaction, or efficiency, knowing that improvements

in any of these areas would likely enhance the overall usability and success of the system.

Management of Health facilities should establish reliable power backup systems to prevent power interruptions, ensuring the uninterrupted operation of the LHIMS and avoiding a fallback to paper records. Moreover, introducing a specialised module for managing patient referrals and a dedicated module for physiotherapists within LHIMS, along with an autosave feature, will address specific needs, enhance the user experience, and reduce the risk of data loss. These measures will significantly improve the system's usability and effectiveness in healthcare delivery. Emphasising the importance of computer proficiency among health professionals and providing comprehensive training will further enhance patient care and overall healthcare outcomes.

Contribution to Literature

This study contributes to the literature on the LHIMS in Ghana healthcare facilities. The findings derived from this study were disseminated to contribute to policy development during the National Health Research Dissemination Forum, organised by the Ghana Health Service on 5th May 2022 at the Ghana Institute of Management and Public Administration (GIMPA). The findings from this study were presented in a session chaired by the Deputy Director General of the Ghana Health Service. Two scholarly papers have also been published from this study and two other papers are undergoing journal review. The first paper, titled "Assessing the efficient use of the Lightwave health information management system for health service delivery in Ghana," was published by BMJ Health & Care Informatics

Journal. The second publication titled "Effective Use of Electronic Health Records System for Healthcare Delivery in Ghana" was published in Frontiers in Health Informatics journal. Together. These contribute to the literature on LHIMS and service delivery in Ghana.

Recommendations for Further Research

The study recommends that further research focus on the perspectives and experiences of patients regarding the efficiency, effectiveness and satisfaction of LHIMS in health service delivery.

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APPENDICES

APPENDIX A: QUESTIONNAIRE

University of Cape Coast

Department Of Population and Health

Survey on Lightwave Health Information Management System

Section One: Socio-Demographic Characteristics

No.	Question	Response	
1	Name of Facility	1. Cape Coast Teaching Hospital [ ] 2. Metro Cape Coast [ ] 3. Winneba Trauma Hospital [ ] 4. Saltpond Municipal Hospital [ ] 5. Ajumako Hospital [ ] 6. Abura-Dunkwa Hospital [ ] 7. Ankaful Leprosarium [ ] 8. Agona-Swedru Hospital [ ] 9. Kasoa Polyclinic [ ] 10. Adisadel Urban [ ]	
2	Sex	1. Male [ ] 2. Female [ ]	
3	Age (in complete years)	……	
4	Marital Status	1. Never married [ ] 2. Married [ ] 3. Cohabitation [ ]	4. Separated [ ] 5. Divorced [ ] 6. Widowed [ ]
5	Educational Qualification	1. Certificate Holder [ ] 2. Diploma / HND Holder [ ] 3. Degree Holder [ ]	4. Masters [ ] 5. PhD [ ]
6	Professional Category	1. Doctor [ ] 2. Physician Assistant [ ] 3. Nurse [ ] 4. Nurse Assistant Clinical [ ] 5. Midwife [ ] 6. Health Information Officer [ ] 7. Biostatistician [ ] 8. Laboratory Officer [ ] 9. Radiologist [ ] 10. X-ray Technician [ ] 11. Physiotherapist [ ] 12. Other (specify) ……	Specify Rank …….....

7	Which professional council regulates your practice?	1. Ghana Medical and Dental Council [ ] 2. Nursing and Midwifery Council [ ] 3. Allied Health Professional [ ] 4. Pharmacy Council [ ] 5. Psychology Council [ ] 6. Other (specify) ……
8	Where did you receive your training as a health professional?	1. Ghana [ ] 2. Within Africa [ ] 3. Outside Africa [ ]
9	If the training was obtained in Ghana, please indicate the institution.	1. Ministry of Health Training Institution (College of health, NTC etc.) [ ] 2. Private Health Training Institution [ ] 3. Public University [ ] 4. Private University [ ]
10	How long have you been working at this facility?	Years …… Months ……
11	Have you ever received training on the use of the LHIMS?	1. Yes [ ] 2. No [ ]
12	How long did the training of LHIMS take?	……
13	How would you rate yourself as a LHIMS user?	1. Novice [ ] 2. Average user [ ] 3. Expert [ ]
14	In general, how would you rate yourself as a computer user?	1. Novice [ ] 2. Average user [ ] 3. Expert [ ]

Section Two: Efficiency

Please, on a scale of 5; where:

1= "Strongly Disagree", 2= "Disagree", 3 = "Neutral", 4 = "Agree" and 5 = "Strongly Agree; Rate the following statements on the efficient use of the LHIMS at your facility for health service delivery

No.	Statement	Scale				
		1	2	3	4	5
15	I can use the LHIMS without written instructions or an assistance (e.g from IT officer or Colleague)					
16	Using the LHIMS helps me provide the appropriate services for the patient					
17	It is easy to get the LHIMS to do what I want it to do					
18	I can complete a task quickly using the LHIMS					
19	Interaction with the LHIMS requires less mental effort					
20	Learning to operate the LHIMS was easy for me					

21	LHIMS requires fewer steps possible to accomplish a task					
22	I am familiar with the items on the screen of the LHIMS					
23	An increased time required to enter patient information					
24	LHIMS is simple to use					
25	I can recover from mistakes quickly and easily when using the LHIMS					
26	Using the LHIMS gives me more control to handle patient treatment/service on time					
27	Using the LHIMS reduces the time spent by a client at the Unit					

Section Three: Satisfaction

Please, on a scale of 5; where:

1= "Very Dissatisfied", 2= "Dissatisfied", 3 = "Neutral", 4 = "Satisfied" and 5 = "Very Satisfied; Rate the following statements on your satisfaction with the use of LHIMS for health service delivery at your facility.

No.	**Statement**	**Scale**				
		1	**2**	**3**	**4**	**5**
28	I am satisfied with the rate LHIMS generate information in a timely manner					
29	I am satisfied with the reliability of the LHIMS					
30	It is easy to retrieve the information I need using LHIMS					
31	I am satisfied with how flexible the system is					
32	I am satisfied with the accuracy of the information generated by the LHIMS					
33	I am satisfied with the system quality/usefulness of the LHIMS					
34	I am satisfied with the consistency of the system interface					
35	I am satisfied with the quality interface of the LHIMS					
36	I am satisfied with the speed (minimal wait between screens, minimal boot-up time etc.) of the LHIMS during task execution					
37	I am satisfied with the arrangement and clarity of the screen items (font, tables, pop-up list etc.) on the interface of the LHIMS					

Section Four: Effectiveness

Please, on a scale of 5; where:

1= "Strongly Disagree", 2= "Disagree", 3 = "Neutral", 4 = "Agree" and 5 = "Strongly Agree; Rate the following statements on the effective use of LHIMS

	Statement	Scale				
		1	2	3	4	5
38	The use of the LHIMS has improved productivity					
39	LHIMS improves sharing of patient information amongst providers within the facility					
40	LHIMS improves patient information gathering/ collection					
41	LHIMS enhances continuity of Care					
42	LHIMS supports data sharing among other facilities					
43	LHIMS reduces the risk of making errors by alerting users of errors made					
44	The use of the LHIMS improves quality decision making					
45	LHIMS enhances ability to coordinate the continuity/organisation of care					
46	Using the LHIMS has improved my job performance					
47	LHIMS has all the functions I expect within my area of practice					
48	The functions in the LHIMS are well integrated					

APPENDIX B: IN-DEPTH INTERVIEW GUIDE

University Of Cape Coast

Department of Population and Health

Interview on Lightwave Health Information Management System

Name of Facility……
Bed Capacity ……
Date of Interview (DD/MM/YY) …../…../……
Time of Interview: Start……

A. Background issues

Please, tell me about yourself; your age, level of education, marital status, years of working at the facility, and the duties you (your unit) perform using the LHIMS.

B. Usability challenges associated with the use of the LHIMS for service delivery?

Sometimes, health professionals say the use of the Electronic Health Record System for health service delivery is challenging, others are of different opinions. I would like to hear your experiences with the use of LHIMS at this facility.

- Can you please tell me how satisfied you are with the use of the LHIMS for health service delivery? [**Probe: system quality / usefulness, speed, reliability, flexibility, information quality and Graphical user interface quality (font, colours, navigating through pages)]. Probe for examples and scenarios.**
- Please, can you also tell me your view about the effective use of the LHIMS by you? [**Probe: work domain saturation, data collection, advanced clinical practice, improved job performance, improved quality of care rendered to patients, risk of making errors, better coordination of care and improved overall productivity**]. **Probe for examples and scenarios**
- Can you please share your thoughts on whether your unit use the LHIMS efficiently for health service delivery? [**Probe: learnability, recovering from mistakes, performing 3 major system functions (inputting, retrieval and storage) without 3rd party assistance or colleague, Quick task execution, familiarity with screen items, ease of use, simplicity, recall and less mental effort**]. **Probe for examples and scenarios.**
- In your opinion, do you think socio demographic characteristics influence the use of the LHIMS? **[Probe: Age, gender, years of work experience, professional characteristics (Professional category, regulatory body, and place of training)]**

C. Technical challenges associated with the use of the LHIMS.

The goal of EHR integration is to be able to share patient data from one facility to the other through the use of internet and computer device and also to have patient records readily available for service delivery. Please, I want you to take your mind back to the time you started using this system.

- Can you please share your thoughts on how the LHIMS allows health professionals to share patient data? [**Probe: Data sharing within (Units), outside (facilities), and patient data handling during referrals**]
- Can you tell me if you have access to a reliable internet connection? (**Probe: source/ provider and fast/slow service**)
- Can you please share your thoughts on whether there is inadequate technical assistance from IT team [**Probe: Troubleshooting, fixing of the broken device, installing packages, and running updates**]
- Do you often receive training on the use of the LHIMS? **[Probe: Duration of training, Number of trainings received by far, training after every system update]**
- Does system update cause any challenge to existing information stored in the LHIMS?
- Do you rely on the services of a third party?
- How do you (your unit) operate the LHIMS during a power outage (lights out)? [**Probe: "Bring your own computer" (personal mobile phone, tablet or laptop computer) or facility owned. If BYOC, further probe; privacy, information security and confidentiality]**
- Is your unit equipped with enough computers and hardware, such as mouse and keyboards, to run the LHIMS? Were the computers and accessories procured by the Ministry of Health? **(Probe whether the facility had to pay for it/ or jointly paid with the MoH)**.
    - Ask whether the facility purchased additional ICT devices or replaced ICT devices to run the LHIMS after implementation. Can you please mention the devices if there are any?

D. Financial challenges associated with the use of the LHIMS.

Cost is frequently cited as the main obstacle to widespread adoption and use of the Electronic Health Record System. I want to know more about how the facility manages the financial obligations and costs associated with using the LHIMS to deliver services.

- Does the use of the LHIMS, in your opinion, impose any extra financial obligations on the unit/facility? [**Probe: cost to health professionals ("bring your own computer")**] Will the facility be able to afford the cost going forward?

- Do you think the facility will get a good return on the investment if you compare the resources put into sustaining and running the LHIMS as against the benefits to be derived?
- Are there any resources you will need to keep the LHIMS running smoothly that your unit/facility has not been able to procure due to financial constraints?

E. Social issues associated with the use of the LHIMS.

Please, let us discuss whether you receive support and encouragement to use the LHIMS for service delivery.

- When using the LHIMS and at the same time interacting with the patient, does it decrease the professionals' rapport with the patient? Can you share with me your experiences in that regard?
- Does management encourage health care providers to use the LHIMS and how? (Probe: financial incentives/ allowances, support)
- Do co-workers encourage each other to use the LHIMS and how?

Closing Courtesies:

Please, do you have concerns associated with the use of the LHIMS that are not mentioned in this survey? Also, should the need arise, I may have to contact you for further clarification.

Thank you very much for your time and consideration.

Time of Interview: End……

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
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My Ref. GHS/RDD/ERC/Admin/App | 21 | 352
Your Ref. No.

19th August, 2021

Edward Agyemang
C/O Department of Population and Health
University of Cape Coast
Central Region

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC: 011/07/21**
Study Title	Electronic Health Records (EHR) Systems and Health Service Delivery in the Central Region of Ghana
Approval Date	19th August, 2021
Expiry Date	18th August, 2022
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
Dr. Cynthia Bannerman
(GHS-ERC Chairperson)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

In case of reply the number and date of this letter should be quoted.

My Ref. :GHS/RDD/ADMIN/22/37

Your Ref. No.

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13th April, 2022

Mr. Edward Agyemang
Population and Health Department
University of Cape Coast
Central Region

Dear Sir,

INVITATION TO PRESENT AT THE GHANA HEALTH SERVICE NATIONAL HEALTH RESEARCH DISSEMINATION FORUM

The Research and Development Division (RDD) of the Ghana Health Service (GHS) as part of its mandate is organizing a two-day National Health Research Dissemination Forum with an overarching theme; "**Generating Research Evidence to Support Health Service Delivery".**

This forum brings together researchers, policy makers, health care providers and other stakeholders to deliberate on current research work conducted within the Ghana Health Service.

We are please to invite you to present on your study entitled ***"Electronic health records (EHR) system and health service delivery in the Central region of Ghana"*** at the forum on the **5th of May, 2022 at 9:00am. The forum will be held at GIMPA Executive Conference Room, Legon-Accra.**

Kindly find attached the meeting synopsis and draft programme.

For further administrative support and enquiries, kindly contact Ms. Mary Duffie Osei on 0500026291 or Mrs. Sybil Opoku-Asiedu on 0552480056

Thank you.

Yours sincerely,

Dr. Abraham Oduro
Director