UNIVERSITY OF GHANA
COLLEGE OF EDUCATION

PREDICTORS OF MOBILE APPS USE IN ACCESSING EMERGENCY RISK PUBLIC HEALTH INFORMATION: THE CASE OF THE COVID-19 PANDEMIC IN GHANA

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OCTOBER 2023

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN COMMUNICATION STUDIES

OCTOBER 2023

DECLARATION

I do hereby declare that this thesis is my own original work and has not been submitted either in whole or in part to any institution for any degree. Where references are made to works of other researchers, due acknowledgements are given.

..... 22/07/2024

DANIEL KWAME AMPOFO ADJEI **DATE**

We, the undersigned supervisors, certify that we supervised the candidate to produce this original work. We are convinced that the thesis meets all required standards set by the University of Ghana for an award of a Doctor of Philosophy Degree.

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ABSTRACT

The outbreak of the COVID-19 pandemic has renewed both epistemic interest in and technophilic attention to the relevance of mobile apps in public health communication. In an era of digital and information technologies, technophiles have expressed optimism about the role technology can play without considering the realities that may invite differentiated possibilities for the value of technology in enhancing communication during public health emergencies. There is limited research evidence, especially from the perspective of users, of the utility and use of mobile apps to access information on infectious diseases such as COVID-19. Moreover, a review of the literature on the use of mobile apps in public health communication shows that theoretical models that directly contribute conceptual understanding and predictive power to the appreciation and use of mobile applications in public health communication are limited. This study adapted the UTAUT model to explore the predictive power of three variables—trust, perceived susceptibility, and perceived self-efficacy—to respond to the research gap. Drawing from the positivist philosophy, a quantitative survey and structural equation modelling techniques were used to collect and analyse the data of the study. The findings showed that performance expectancy, social influence, facilitating conditions, perceived susceptibility, self-efficacy, and trust all influence behavioural intention towards the use of mobile apps in accessing information on infectious diseases. It is recommended that infectious disease management bodies and public health communicators take advantage of the popularity of verified mobile apps among the Ghanaian populace to share information on infectious diseases. These messages should offer pertinent information on the specific disease of public concern and should be designed to appeal to the youth.

DEDICATION

This thesis is dedicated to my late father, Rev. Anthony Fidelis Kwadwo Adjei. I also dedicate it to my wife, Ms. Evelyn Acquah, and my lovely children, Nana Yaa Gyanewah Ampofo-Adjei and Jesse Kwadwo Ampofo-Adjei.

ACKNOWLEDGEMENT

I thank the Almighty God for making this possible. My heartfelt gratitude and appreciation go to my principal supervisor, Dr. Gilbert K. M. Tietaah, and co-supervisor, Prof. Abena Animwaa Yeboah-Banin, for the advice and constructive criticism that helped shape the thesis's preparation. The exceptional tutelage provided throughout the thesis preparation facilitated the early completion of this work. I am grateful to the Building a New Generation of Academics in Africa (BANGA-Africa) Project at the University of Ghana, funded by the Carnegie Corporation of New York (CCNY), for supporting me with grants that facilitated the completion of this thesis. My gratitude also goes to my mother, Madam Martha Ama Gyanewah, and my siblings, Mrs. Theodora Boakye-Ansah, Mr. Michael Kwaku Agyin Adjei, and Mr. John Boakye Adjei, for their support and prayers. I am eternally grateful to my dear better half, Ms. Evelyn Acquah, for the unflinching support—emotionally and otherwise—throughout the thesis work.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
ANOVA	Analysis of Variance
AVE	Average Variance Extracted
BI	Behavioural intention
CFA	Confirmatory Factor Analysis
CFI	Comparative fit index
CMIN	Chi-square value
ConTS	Contact Tracing
COVID-19	Coronavirus disease
CR	Composite Reliability
CST	Critical Social Theory
DA	Disease Avoidance Theory
DF	Degree of freedom
DIT	Theory of Diffusion of Innovations
DTPB	Decomposed Theory of Planned Behaviour
EE	Effort Expectancy
EFA	Exploratory Factor analysis
EVD	Ebola Virus Disease
FC	Facilitating Conditions
Fram	Framing
GESI	Gender and Social Inclusion
GFI	Goodness of fit index

Abbreviation	Meaning
GOF	Goodness of Fit
GSMA	Global System for Mobile Communications
HBM	Health Belief Model
IMF	International Monetary Fund
ISD	Information System Development
MANOVA	Multivariate Analysis of Variance
NFI	Normed-fit index
PClose	Probability of close fit
PE	Performance Expectancy
Peng	Public Engagement
PMT	Protection Motivation Theory
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PS	Perceived Susceptibility
PSE	Privacy and Security
RMSEA	Root mean square error of approximation
SARS-Cov-2	Severe acute respiratory syndrome coronavirus 2
SE	Self-Efficacy
SEM	Structural Equation Modelling
SI	Social Influence
SRMR	Standardized Root Mean Square Residual
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour

Abbreviation	Meaning
TRA	Theory of Reasoned Action
UB	Use Behaviour
URT	Uncertainty Reduction Theory
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Chapter one of the study describes the basis and context of the thesis. The purpose of the study was to examine the factors affecting the use of mobile apps in accessing emergency-risk public health information within the context of the COVID-19 outbreak in Ghana. The chapter includes a background of the study; the research problem; the research purpose; and specific objectives. The research questions underpinning the study, the significance of the study, and the organisation of the study are also presented in this chapter.

1.2 Background

Several global public health emergencies (pandemics) have been recorded in human history. These include the smallpox disease outbreak and the Black Death, otherwise referred to as "The Plague" (DeLeo & Hinnebusch, 2005). In August 2014, the World Health Organisation (WHO) announced the Ebola Virus Disease (EVD) outbreak as an international public health emergency (Daral et al., 2015). COVID-19, also known as SARS-CoV-2, was declared a pandemic by the World Health Organisation (WHO) in March 2020. The possibilities and process of mitigating the effects of the virus on humanity depend on early detection and control of infection, as well as the cessation of community transmissions.

Prior to the introduction of COVID-19 vaccines, some of the key protocols recommended by the World Health Organisation and adopted by many countries, such as Ghana, included the isolation of affected individuals (GHS, 2020) and the restriction of population movements

(GHS, 2020). Other public health measures included surveillance and prompt case detection (GHS, 2020). At the centre of all these measures is effective public health communication and a robust monitoring system to enhance the successful implementation of these control measures.

Risk communication theories indicate that during public health emergencies, people are concerned and eager to learn about the nature and form of the disease, the mode of transmission, and preventive and control measures (World Health Organisation, 2017). Communication creates awareness, influences attitudes, and assures adherence. It also underlines and expedites the process of applying and ascertaining intervention antecedents. Amid public health crises, real time communication is crucial because public engagement efforts are necessary to gain the trust and support of the populace to mitigate, if not eliminate, the risk associated with disease outbreaks. Timely communication targeted at individuals becomes important, particularly in the era of fake news and disinformation. The extensive adoption and use of mobile phones present an opportunity for such strategic public health communication efforts.

According to the Global System for Mobile Communications' (GSMA) 2020 report, close to seventy percent (67%) of the world's population used mobile phones, of which the majority (65%) were smartphones. Sub-Saharan Africa was reported to have the fastest growth (GSMA, 2020). Thus, mobile apps could become a major tool for effective public health communication. Research has shown that mobile phone data can assist in predicting the dynamics of the geographical spread of epidemics (Wesolowski et al., 2012; Tizzoni et al.,

2014; Bengtsson et al., 2015; Wesolowski et al., 2015; Finger et al., 2015). Mobile apps are also reported to be useful in reducing the threats of disease outbreaks (Ekong et al., 2020; Asadzadeh et al., 2020), such as in the case of monitoring and detecting the Zika virus (Fujibayashi et al., 2018; Rodriguez-Valero, 2018; Wesolowski et al., 2014) and the tracing of contacts of infected individuals (Popkin, 2016) to facilitate a better appreciation of the dynamics of infections. Other studies have shown that the use of mobile devices and apps facilitates the work of healthcare professionals, particularly in terms of increased access to point-of-care tools that inform clinical decision-making and, for that matter, improve patient outcomes (Aungst, 2013; Divall et al., 2013; Mickan et al., 2013; Martinez-Millana et al., 2018).

The outbreak of the COVID-19 pandemic has renewed both epistemic interest and technophilic attention to the relevance of mobile phones and mobile applications in public health communication. Activities such as public health sensitization, monitoring of affected patients, and contact tracing of infected individuals require effective and real-time information sharing. Mobile applications are important tools that could be leveraged for real-time, two-way public health communication (Heron & Smyth, 2010; Runyan & Steinke, 2015). Knowledge of the predictors that influence the use of mobile apps in accessing emergency risk communication is important for public health communication research and practice.

1.3 Statement of the problem

Pandemics have had a long history with humans. Over the years, several pandemics have been recorded in history. These include the Athenian plague that occurred in 430–26 B.C. (Littman,

2009); the Antonine Plague of 165–180 AD (Sabbatani & Fiorino, 2009); Justinian plague 541-542 (Horgan, 2023); the Black Death which wiped off as many as 60% of European lives at the period (Horgan, 2023); Plague Doctor (Boeckl, 2000); Spanish Flu Pandemic 1918–1920 (Antonovics et al., 2006); Smallpox Outbreak in Former Yugoslavia in 1972 (Tarantola, 2016); HIV pandemic (Cohen et al., 2008); and the more recent ones such as the 2009 H1N1 pandemic (Trifonov et al., 2009); and the 2020 Coronavirus disease (COVID-19) pandemic.

Public health responses to disease outbreaks over the years have evolved from divination during the mediaeval times (Sampath et al., 2021) through isolation in leprosaria which was common in Europe (Tulchinsky et al., 2014). For example, in France alone, there were 2000 leprosaria in the fourteenth century (Tulchinsky et al., 2014). Other measures aside quarantine include the introduction of inoculations and vaccines, and in more recent times public education (Plotkin & Plotkin (2011). China and India were the first to experiment with active immunisation, injecting variola into healthy people to avoid scarring following a natural illness. This was followed by the creation of vaccinations by Edward Jenner, Louis Pasteur, Calmette, and Geurin (Plotkin & Plotkin (2011).

In the twenty-first century, the proliferation of mobile technology – mobile phones and mobile applications – has facilitated a vast amount of real-time data that characterises the evolution of pandemics, achieving goals such as pandemic detection and monitoring, impact assessment, analysis of the success of corrective actions, and developing appropriate control tactics. (Alamo et al., 2021). The WHO has become the lead agency in the development and communication of recommendations that are deployed. The deployment of these interventions

and recommendation do not necessarily consider the peculiarities of cultures irrespective of the utility and use of mobile apps in mitigating the spread of infectious diseases.

In an era of digital and information technologies, technophiles have expressed optimism about the role technology can play without considering the realities that may invite differentiated possibilities for the value of technology in enhancing communication during public health emergencies. Yet, previous research shows that the value of mobile applications for risk health information communication is tempered by barriers and enablers to their adoption (Zhou et al., 2019). Understanding the factors that enable the use of mobile apps to access such important public health information becomes imperative.

Previous studies have recommended constructs that could enable acceptance of technology such as mobile health applications (Davis, 1989; Venkatesh et al., 2003, 2012). A major contribution to this body of research is the Unified Theory of Acceptance and Use of Technology (UTAUT) developed and enhanced by Vanketash and others (Venkatesh & Davis, 2000; Venkatesh et al., 2003; Venkatesh and Bala, 2008). UTAUT is commonly regarded as a useful approach for analysing ICT adoption (Dwivedi et al., 2016). The UTAUT model assumes that four drivers influence behavioural intentions and use of technology: performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2000; Venkatesh et al., 2003, 2016).

Whereas the major predictors of the UTAUT model - performance expectancy, effort expectancy, social influence, and facilitating conditions – provide sound theoretical basis for

predicting the use of technology and have been employed by other researchers to explore technology acceptance in the context of health and wellbeing (Lie et al., 2022; Klaver et al., 2021), the model was not originally designed with health relevant constructs as predictors. Moreover, the nature of the COVID-19 pandemic – a global health crises, that is existential, and universal in its effects – demands further considerations as existing knowledge may not be enough to inform health communicators in the development of health promotion messages deployed via mobile apps. For example, the vast amounts of misinformation and disinformation (WHO, 2020) introduced dynamics such as mistrust to public health information consumption that previous conceptualisations of mobile health apps did not envisage.

Also, extant literature indicates that demographic variables such age, gender and education could influence use of technology such as mobile apps for public health information. For example, younger people show interest in health behaviour change apps (Dennison et al., 2013). There is also a higher usage of mobile health apps among younger, and better-educated individuals who trust the apps' security (Krebs & Duncan, 2015). This study sought to explore how these demographic variables will influence the predictive constructs of UTAUT within the context of a pandemic.

To this end, this study explored whether the predictor constructs in the UTAUT model, when integrated with the new constructs of trust, self-efficacy, and perceived susceptibility will enhance our understanding of use of mobile apps in accessing emergency risk public health information. Moreover, review of extant research on or related to COVID-19 and public health

communication shows that the majority (80%) of the publications did not utilise existing theories in the design of their research (See appendix D). This indicates a gap in conceptualization as far as mobile apps and public health communication research within the context of pandemics is concerned. Thus, theoretical models that should offer conceptual rigour and predictive power to the appreciation of use of mobile applications in public health communication within the context of pandemics is limited.

The review also showed that beyond the plethora of social media apps available for information sharing, several COVID-19 inclined mobile apps were developed and were globally accessible. However, there is limited research evidence, especially from the perspective of users, of the usefulness and utility of mobile apps in accessing information on infectious diseases such as COVID-19 within the Sub-Saharan Africa region.

This study therefore, sought to determine the best predictors of the use of mobile apps in accessing emergency risk public health information. The study is set within the context of the COVID-19 outbreak in Ghana and tests the predictive power of an expanded UTAUT model in determining uptake of public health information via mobile apps during the COVID-19 pandemic.

1.4 Research Purpose and objectives

The purpose of the study was to develop a model that predicts the use of mobile apps in accessing emergency-risk public health information within the context of the COVID-19 outbreak in Ghana. The specific objectives of the study were to:

1. Examine the drivers of mobile app use in accessing emergency-risk public health information within the unique context of pandemics by assessing the roles of performance expectancy, effort expectancy, social influence, and facilitating conditions in shaping use intentions.
2. Explore the value of perceived susceptibility, self-efficacy, and trust as extensions to UTAUT's predictors of behavioural intention to use mobile apps in accessing emergency-risk public health information.
3. Examine the moderating effect of gender, age, and education on performance expectancy, effort expectancy, social influence, and facilitating conditions on behavioural intention to use mobile apps in accessing emergency-risk public health information.

1.6 Research Questions

1. To what extent do performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention influence the use of mobile apps in accessing emergency-risk public health information?
2. How do perceived susceptibility, self-efficacy, and trust predict the use of mobile apps in accessing emergency-risk public health information?
3. To what extent do gender, age, and education moderate the effect of performance expectancy, effort expectancy, social influence, and facilitating conditions on behavioural intention to use mobile apps in accessing emergency-risk public health information?

1.7 Significance of the Study

This study investigated the potential of the predictor constructs in the UTAUT model to enhance our appreciation of the use of mobile apps in accessing emergency health risk information when augmented with trust and health-specific constructs of self-efficacy and perceived susceptibility within the context of a global pandemic in a developing country. The study has contributed to theory-building through the extension of the UTAUT model and has made substantial contributions to various aspects of implementing emergency risk communication campaigns. Firstly, it examined the applicability of the UTAUT model, which was originally developed and validated among users in North America, in explaining similar behaviours in the sub-Saharan African region.

The study confirmed the validity of the expected relationships among the key constructs in the UTAUT model as originally proposed by Venkatesh et al. (2003), albeit in a distinct geographical and user context. Furthermore, the research introduced a novel model tailored specifically to the utilisation of technologies for emergency risk communication purposes through the introduction of health-specific constructs such as perceived susceptibility and self-efficacy. In contrast to the UTAUT model's organisational focus, this study's contribution is particularly noteworthy for its application in an absolute voluntary usage behaviour scenario.

This has expanded research in public health communication, particularly within the context of pandemics. Moreover, the study has been useful in identifying the best predictors of the use of mobile apps in accessing emergency-risk public health information. This study has also provided empirical evidence that could inform the formulation of policies to enhance the use

of mobile apps in emergency public health communication and emergency risk communication in general.

1.8 Organisation of the study

This thesis is organised into seven chapters. The first chapter presents an introduction to the research. The chapter comprises: a background of the study; the research problem; the research purpose; and specific objectives of the study, as well as the research questions underpinning the study. This is useful in establishing the foundation of the study that informed the proposed research objectives and questions. Chapters two presents an overview of how mobile applications have been leveraged to address public health communication gaps, the theoretical and practical solutions suggested, and the methods used to reach those solutions. This was helpful in identifying research gaps in existing literature and informing the logic and direction of this study. Chapter three discusses the theoretical arguments underpinning the study based on existing literature. Further, the chapter explains the justification for the choice of the theoretical model adopted and the conceptual framework adapted for the study. The theoretical arguments leading to the development of research hypotheses for the study are also explained in this chapter.

The fourth chapter of the study presents the philosophical assumptions and methodologies that underpinned the study. The chapter also explains the selected philosophy behind the study and provides a justification for how it informed the design of this research, including the methodology employed. Thus, the research design, population of the study, data collection technique, instrumentation, and the statistical analysis used to analyse the data.

Chapter five accounts for the key outcomes derived from the analysis of the field data gathered. A description of the demographic background of respondents as well as a descriptive statistic of the scales of measurement employed to measure the major constructs of the study are presented in this chapter.

Chapter six provides a discussion of the results of the analyses with respect to the data collected. The discussions reveal the statistical relationships observed between and among variables of interest, as represented in the proposed research model. The influence of the research moderators on the exogenous variables in explaining behavioural intention to use mobile apps in accessing emergency-risk public health information is also discussed. Chapter seven, which is the last chapter, summarises the entire thesis write-up. This chapter highlights the key findings drawn out in the process. The study's contribution to research, policy, and practice is also provided in this chapter. Finally, the chapter presents a discussion of the study's limitations and potential areas for future research.

CHAPTER TWO

LITERATURE REVIEW

2. Introduction

In accordance with the study's aim to examine the predictive factors of behavioural intention to use mobile apps for accessing emergency risk public health information among Ghanaians, this chapter provides a literature review encompassing related research in the field of mobile app adoption within health communication and other relevant disciplines. This review aimed to enhance knowledge of the use of mobile apps for public health communication, identify new research areas, and justify the necessity of the study.

The first section offers an overview of health communication and information-seeking behaviours in the context of an information age. The second section focuses on reviewing the utilisation of mobile apps in public health communication, including the benefits or relevance of their usage as well as the barriers encountered in their adoption. Subsequently, the third section delves into a comprehensive examination of various theories of technology adoption.

These theories—the Theory of Diffusion of Innovations (DIT), the Theory of Reasoned Action, the Theory of Planned Behaviour, the Technology Acceptance Model (TAM), the Health Belief Model (HBM), and the Unified Theory of Acceptance and Use of Technology (UTAUT)—are reviewed to establish a conceptual framework for determining the factors influencing the use of mobile apps in accessing information on infectious diseases like COVID-19.

Finally, the fourth section of this chapter presents a discussion on the predominant themes and theories in research concerning mobile applications and public health communications. The section highlights the contextual, theoretical, methodological, and thematic gaps identified from the literature review, which subsequently informed the direction and focus of the current study.

2.1. Health Communication Overview

Health communication comprises two words: health and communication. Several authors have defined health communication in several ways. Nishiuchi et al. (2016) and Stacey et al. (2015) describe it as the process of communicating health values to the public through effective ways of communication. Alternatively, health communication is said to primarily initiate a positive dialogue between health professionals, health communicators, and media professionals with the goal of creating awareness for health rights, health beliefs, and health sensitization at the grassroots level (Kozel et al., 2006; Scheirer et al., 2017; Starmann et al., 2018).

According to the Centre for Disease Control and Prevention (CDC), health communication is defined as the utilisation of communication strategies to inform and influence the decisions made by individuals and communities to enhance their well-being (Schiavo, 2014). Essentially, the primary goal of health communication is to educate the public about health issues, challenges, and possibilities, with a special emphasis on mass media and interpersonal communication via health communicators employed as public servants or within philanthropic agencies (Glanz & Bishop, 2010).

One of the primary goals of health communication is to actively engage and empower individuals and communities while also influencing positive health outcomes. This objective is commendable as it seeks to enhance health by disseminating relevant health-related information. Nevertheless, the broader scope of health communication is intrinsically tied to its potential impact on marginalised and underserved populations. These populations may experience challenges related to physical, psychological, or social health due to inadequate conditions that hinder positive outcomes. Examples of such vulnerable groups include children, the elderly, individuals with disabilities, migrant populations, and other marginalised communities affected by stigma and social discrimination.

Underserved populations encompass geographical, ethnic, social, or community-specific groups that lack adequate access to healthcare, community services, infrastructure, and information. Health equity entails providing equal opportunities for every individual to maintain good health or effectively manage illness and crisis, irrespective of factors such as race, gender, age, economic conditions, social status, environment, and other socially determined factors.

Achieving health equity necessitates establishing an inclusive and supportive environment that enables the adequate sharing, comprehension, absorption, and discussion of information within diverse communities and sectors, particularly those representing vulnerable and underserved groups. This requires a comprehensive understanding of the unique needs, beliefs, taboos, attitudes, lifestyles, socioeconomics, environments, and social norms prevalent among key groups and sectors involved, or should be involved, in the

communication process. Furthermore, effective communication must be based on messages that are easily understood, as Pearson and Nelson (2000) define communication as the process of comprehending and exchanging meanings (p. 6).

The goal is to improve health literacy by disseminating health information and knowledge among the public. The major issues that could be deduced here are that health communication techniques require some level of framing of the health message or subject to be communicated, the medium through which the message would be published, and the characteristics of the target audience. The socio-cultural characteristics and geographical location of the targeted audience determine the medium of communication (du Gay et al., 1997). In this era of digital and information age, the role that modern means of communication such as mobile apps play cannot be overemphasised.

Mobile Health communication in this thesis is defined as the act of sharing carefully curated health messages via mobile apps among mobile app users to influence their attitudes and behaviours towards positive health outcomes. Communicating health messages during crises such as epidemics and, in the case of pandemics, where they affect all humanity across the globe, could require some more attention and strategies in communication. The next sub-section of this chapter throws more light on health information-seeking behaviours in an information age.

2.1.1. Health information seeking behaviours in an information age

Communication has been brought into the service of health interventions and outcomes, particularly public health solutions. This role has become even more prominent in the

eventuality of disease outbreaks, be it an epidemic at the regional level or diseases of global public health concern such as pandemics, especially within the age in which digital technologies and information systems are becoming instrumental in all kinds of fields. This section of the thesis sheds light on how people across the globe leveraged different media platforms and sources, including digital platforms, to remain informed about the COVID-19 pandemic.

After the World Health Organisation (WHO) declared COVID-19 a global pandemic, governments worldwide issued guidelines to their citizens to contain the spread of the virus. These guidelines included recommendations such as travel restrictions, the closure of schools, markets, and public spaces, as well as the promotion of social distancing measures (Fang, Nie, & Penny, 2020; Wilder-Smith & Freedman, 2020). Governments utilised various communication channels, including mass media, print media, and the internet, to disseminate information, educate the public about precautionary measures, and provide updates on available support.

Individuals, in turn, sought information from various sources, with a significant reliance on internet-based platforms, to stay informed about COVID-19. Driven by a concern for their health amidst the prevailing uncertainty, people quickly turned to online searches for information regarding symptoms and preventive measures related to the virus (Bento et al., 2020). According to Statista (2020), individuals utilised a range of sources to stay updated on COVID-19, including mass media (television and radio), print media (newspapers and magazines), social media platforms (such as Facebook and Twitter), search engines like

Google, input from family and friends, and scientific and official websites (Gadzekpo et al., 2023). Google Trends data further validates the global interest in seeking COVID-19 information online (Soroya et al., 2021). During public health emergencies like the COVID-19 pandemic or other disasters, information sources play a crucial role in helping individuals comprehend the situation, adopt preventive measures, and alleviate anxiety stemming from the uncertainties associated with such events (Chao et al., 2020).

2.2. Use of Mobile Apps in Public Health Communication

The discussion from the previous section of this chapter emphasises the fact that we live in an information and digital age, otherwise referred to as a digital and information age. The section also explained how digital information technologies are being brought about or deployed to enhance effective communication in health in general. This scenario therefore provides a reason for increasing scholarly interest in the use of digital technologies such as mobile apps to facilitate health communication, especially during disease outbreaks.

This section of the chapter and the subsequent sub-sections provide a review of the extent to which mobile apps have been leveraged in health communication. Specifically, the relevance of mobile apps in public health communications; barriers to mobile app usage in public health communications; and the determinants of adoption of public health communication mobile apps.

2.2.1. Relevance of Mobile Apps in Public Health Communications

The current era of communication and information, or the digital age, has invited scholarly interest and the application of all sorts of possibilities and affordances of technologies to

support health outcomes. Communication plays a vital role in addressing various public health issues, including disparities in maternal mortality and the recognition of child abuse as a population health concern (Mackert et al., 2021). An illustrative example is the national anti-smoking campaign called Tips From Former Smokers, led by the US Centres for Disease Control and Prevention. This campaign utilised mass media platforms and featured real individuals who had experienced severe long-term health consequences due to smoking (CDC, 2023). Notably, the campaign's television commercials presented powerful testimonials, combining graphic visuals with emotional narratives. This extensive initiative contributed to approximately 1 million successful smoking cessation outcomes (CDC, 2023).

Mobile apps in the present day have become a major tool for health communication. Considering the widespread usage of mobile devices among the general population (Boruff & Storie, 2014)), the utilisation of mobile apps for delivering health messages proves to be highly advantageous (Riley et al., 2011). Mobile apps offer an efficient means of delivering appropriate and timely health messages, effectively serving as in-the-moment health interventions (Riley al., 2011; Runyan & Steinke, 2015), which can be classified as just-in-time adaptive interventions (Runyan & Steinke, 2015). By delivering tailored health messages to individuals at specific and opportune moments within their daily lives, mobile apps effectively address the challenge of delivering appropriate message doses, often faced by health campaigns (Riley et al., 2011). Further, mobile apps have the capability to intervene effectively across multiple health issues within a specific group or population.

An instance of health communication leveraging mobile applications is the Text4Baby

smartphone application, specifically designed for expectant mothers and new mothers in the United States. This app offers a wide range of information covering topics such as baby milestones, nutrition, and childcare tips. It delivers over 250 text messages to the user's phone, providing essential and timely information crucial for pregnant women and mothers (Text4baby, 2020). Studies indicate that women who used the Text4Baby app reported feeling more prepared for motherhood (Evans et al. 2012), exhibited positive attitudes towards prenatal vitamins (Evans et al. 2012), and demonstrated a higher level of knowledge regarding pregnancy health (Evans et al. 2012).

This study paid further attention to the extent of use of mobile apps during emergency health crises, such as outbreaks of diseases of public health concern. A review of relevant literature shows that several benefits accrue from the use of mobile apps to combat COVID-19. Specifically, mobile apps were used to facilitate effective and efficient contact tracing of symptomatic, pre-symptomatic, and asymptomatic individuals (Lin & Hou, 2020; Ekong et al., 2020; Verhagen et al., 2020;) and managing health records (Yamamoto, 2020).

Other health communication apps include specific COVID-19 apps that were developed by health practitioners for medical consultation and the input of self-measured vitals for health observation, among other forms of primary healthcare (Bae et al., 2020; Krausz et al., 2020; Marin-Gomez et al., 2018; Yamamoto et al., 2020; Colubri et al., 2016). State agencies and public health officials are also purported to have leveraged social media to engage with the public on preventive behaviour during the peak of the COVID-19 pandemic (Kothari et al., 2021; Malik et al., 2021; Li et al., 2020).

Again, the WHO, working in collaboration with Meta, the owners of Facebook and WhatsApp, launched an app to provide pertinent information on the COVID-19 pandemic to a target audience of about 2 billion people across the globe (WHO, 2020). In responding to the use of mobile apps as a communication tool in communicating crisis information during disease outbreaks such as the COVID-19 pandemic, the scholarship has perhaps been less up-to-date in exploring the factors that might have contributed to or motivated the patronage of these apps and the extent to which the patronage of these mobile apps contributed to shaping the attitudes and behaviours of consumers of COVID-19 messages on mobile apps. The next sub-section of this chapter looks at some of the challenges associated with the deployment and use of mobile apps in facilitating public health communication.

2.2.2. Barriers to Mobile Apps Usage in Public Health Communications

In this information and communication age, people are seeking and consuming health information in different spaces and different media or technologies or devices. Part of that reality is that the multiplicity of opportunities for accessing and engaging knowledge and information to advise response to outbreaks and pandemics has come with several potential consequences or effects. In this section of the thesis, a few studies that sought to identify users' attitudes toward and perceptions of using mobile apps for health communication are discussed.

To begin with, a major challenge to the adoption and use of mobile apps for public health communication is the issue of privacy and security concerns. For example, in 2015, Krebs and Duncan conducted a cross-sectional survey across the United States to investigate the adoption of mobile health (mHealth) apps among mobile phone users and the factors influencing their

decision to use or not use such apps (Krebs & Duncan, 2015).

Krebs and Duncan's (2015) included 1,604 participants, and more than 40% of mobile phone users reported choosing not to download mHealth apps. Privacy and security concerns were cited as one of the main reasons for this decision. Conversely, those who did download mHealth apps expressed a higher level of trust in the security measures implemented by the apps. The study also revealed that individuals who were more likely to use health apps tended to be younger, have higher incomes, higher education levels, identify as Latino/Hispanic, and have a body mass index indicating obesity.

Atienza et al employed a mixed-methods approach, combining surveys and focus group studies, to examine consumer attitudes and perceptions towards the privacy and security of mHealth apps (Atienza et al., 2015). The study concluded that user attitudes regarding privacy and security were highly influenced by contextual factors such as the type of health information, location, time, purpose, and the individuals accessing the data. The researchers found that people within similar demographic groups could hold diverse opinions on privacy concerns. Dennison et al conducted four focus group studies with university students and staff in the United Kingdom to assess the opportunities and challenges associated with encouraging young adults to use smartphone apps for promoting health behaviour change (Dennison et al., 2013).

The study revealed that young and healthy adults displayed some interest in behaviour change apps. However, participants expressed apprehension regarding the security of their data within

the apps, fearing that it could be accessed by third parties. They also perceived a sense of intrusiveness when apps employed context-sensing techniques to generate reminders or suggestions, particularly when it involved tracking their locations through the Global Positioning System.

Beyond the issues of privacy and security concerns that have been elaborated above, other factors that hinder use of mobile apps for health communication include limited network availability, especially in rural areas (Saylors, 2016; Leon et al., 2012). Issues related to electricity supply and stability have also been cited (O'Connor et al., 2014). Additionally, challenges such as a lack of awareness about mHealth services (Akter & Ray, 2010), insufficient evidence linking use of mobile apps in health to improved health outcomes (Bradway et al., 2017), staff turnover and attrition (Medhanyie et al., 2015), perceived difficulties in using mHealth technologies (Davies, 1989), and resistance from medical staff towards adopting new technologies (Poon et al., 2006), among others, have been recognized.

In the context of Ghana, some specific challenges that hinder the effective use of mobile apps in health communication projects have been identified. These challenges encompass financing, infrastructure limitations, gaps between healthcare practitioners and telecommunication companies, donor-driven projects, parallel mobile health-based programs, and issues related to electricity access (Vroom, 2017). The next section of this chapter, provides a review of the determinants of adoption of public health communication mobile apps. The study also reviewed the conceptual methods used to reach these conclusions, as well as the theories and models applied in research on mobile app adoption.

2.2.3. Factors affecting Mobile Apps Usage in Public Health Communications in Africa and the Ghanaian Context

This section of the thesis presents a synthesis of review of factors influencing attitudes and behaviours toward the use of mobile apps for public health communication in African. These factors involve a variety of social, technological, and contextual elements. Research identifies several key factors including technological accessibility and infrastructure, health literacy and education, perceived usefulness and ease of use, trust and credibility, cultural and social influences, and psychological factors.

Access to reliable internet and mobile networks is crucial for the adoption of mobile health (mHealth) applications. In many parts of Africa, including Ghana, inconsistent network coverage and limited internet access can significantly hinder the widespread use of these apps (Aikins et al., 2014; Yaya et al., 2017; Haruna et al., 2019). Improving technological infrastructure is essential to enhance the feasibility and reliability of using mobile apps for health communication. Also, health literacy significantly affects the adoption and effective use of mHealth apps. Individuals with higher levels of health literacy are more capable of finding, understanding, and acting on health-related information than those with lower literacy levels. This higher health literacy correlates with greater trust and use of mobile health apps. For instance, Bo et al. (2014) noted that individuals with better health literacy are more likely to engage with health technologies.

Mensah (2022) found that perceived usefulness and ease of use are significant predictors of the intention to use and recommend mHealth services in Africa. Conversely, perceived risk negatively impacts these intentions, while mobile self-efficacy positively influences them

(Mensah, 2022). The perceived usefulness and ease of use of mHealth apps are critical determinants of their adoption, as noted by the Unified Theory of Acceptance and Use of Technology (UTAUT). Apps that are user-friendly and provide clear health benefits are more likely to be adopted. In the context of Ghana, Mensah (2022) emphasized that these factors significantly predict behavioural intentions towards mHealth services.

Social norms and cultural factors also play a substantial role in shaping health behaviours. In many African societies, including Ghana. Recommendations from family, friends, and community leaders heavily influence individual behaviours. Social influence is particularly potent among older adults, who might rely more on social networks for decision-making regarding new technologies (Addotey-Delove et al., 2023). Trust in the information provided by mHealth apps has also been reported to be crucial within the African context. Users must believe that the health information is reliable and that their data privacy is protected (Bene et al., 2024). Factors such as fear of disease (perceived susceptibility), and anxiety can also drive the adoption of mHealth apps within the Ghanaian context (Ntsiful et al., 2022).

2.3. Theoretical Approaches to Mobile App Adoption Research

Mobile apps could be categorised based on their nature, dividing them into two main groups: utilitarian apps and hedonic apps. Utilitarian apps are primarily used by consumers for information-seeking purposes, focusing on tasks and work-related activities. On the other hand, hedonic apps are designed to provide entertainment and facilitate activities such as shopping, emphasising fun and playfulness rather than task-oriented behaviour (Racherla et al., 2012). The adoption of utilitarian apps is influenced by factors like user interface, perceived ease of use, perceived usefulness, and aesthetic appeal. In contrast, the acceptance

of hedonic apps is driven by emotions, achievement, enjoyment, and social norms (Tang, 2016; Kim & Han, 2014). This study focussed on theoretical approaches that focussed on utilitarian apps because the study sought to access the predictors of mobile apps use to access information on COVID-19 among Ghanaian residents.

Researchers have explored technology acceptance extensively to gauge attitudes towards technology and the intention to adopt it (Abu-Dalbouh, 2013; Deb & Lomo-David, 2014). This has led to the development of several models and theories. These theories and models include: The Theory of Diffusion of Innovations (DIT) (Rogers, 1995); the Theory of Task-technology Fit (TTF) (Goodhue & Thompson, 1995); the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); the Theory of Planned Behaviour (TPB) (Ajzen, 1985, 1991); the Decomposed Theory of Planned Behaviour (Taylor & Todd, 1995); and the Technology Acceptance Model (TAM) (Davis et al., 1989).

Among the lot, perhaps the TAM has proven most prolific, having become the subject of many attempts to extend its universality and applicability. Such research has yielded the birth of Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis, 2000); Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003); and Technology Acceptance Model 3 (TAM3) (Venkatesh & Bala, 2008). This section of the chapter provides a review of how relevant technology acceptance models and theories have been leveraged to explain the factors affecting the utility and use of mobile apps in health and other sectors. In the process, it draws out the constructs of common interests, notes their areas of synergy and inter-complementarity, acknowledges their points of divergence and differencing perspective,

and identifies the epistemological gaps in relation to public health emergency communication research.

2.3.1. Theory of Diffusion of Innovations (DIT)

The theory of diffusion of innovation (DIT) was developed by Rogers (1995) as the basis for research that seeks to determine the antecedents of innovation acceptance and adoption. The theory was formulated from a review of more than 500 related diffusion studies. The DIT theory details "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1995, p. 5).

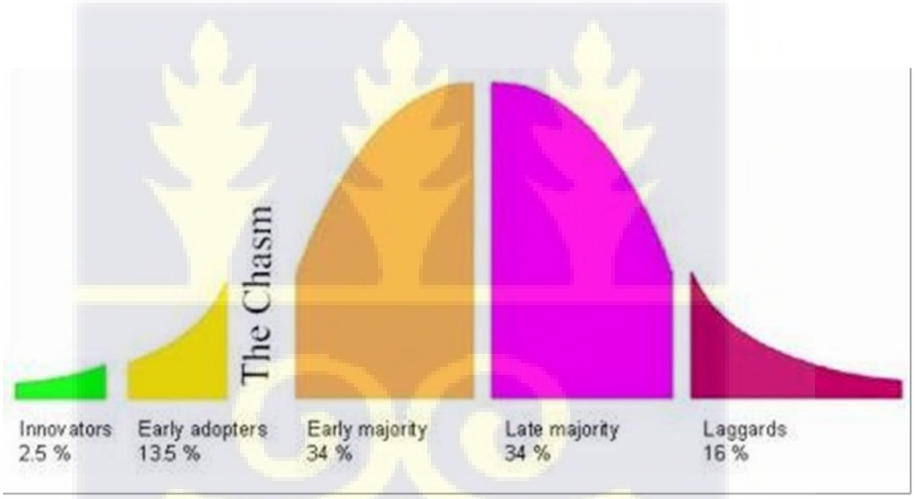

Figure 1: Innovation Adoption Curve (Roger, 1995)

The theory provides pathways to innovation and adoption through several phases. These include understanding, persuasion, decision, implementation, and confirmation. The process is graphically presented in an S-shaped adoption curve (Figure 1), indicating innovators, early adopters, early majority, late majority, and laggards. According to Rogers (1962), an emerging innovation needs to surpass five critical criteria in order to be implemented by a larger audience: the innovation needs to have a relative advantage over the existing technology that

it might replace; it needs to be compatible in order to fit into existing societal and/or technological mechanisms; it needs to be simple and intuitive enough in order to be used by a larger group of consumers; it needs to be easy to experiment with; and, finally, it has to be physically seen in action or use (Swasy, 2016).

Scholars have extensively employed the theoretical framework of diffusion of innovation as a valuable perspective for the advancement of supplementary and intricate concepts aimed at elucidating the ever-evolving technological landscape and the process of diffusion (Atkin et al., 2015; Danowski et al., 2011). The most popular discipline of application, however, seems to be in the education sector. Other disciplines include banking and marketing, sociology, and ICT management (Sahin, 2006). For example, Isleem (2003) conducted a study that employed Rogers' diffusion theory alongside qualitative research methodology to assess the level of computer utilisation among technology educators for instructional purposes. Similarly, Less (2003) utilised Rogers' diffusion theory to evaluate the adoption of computer technology for teaching within a community college in North Carolina. Moreover, Surendra (2001) applied Rogers' diffusion of innovation framework to investigate the acceptance of Web technology among professors and administrators at a college.

Furthermore, Al-Jabri and Sohail (2012) conducted a study focusing on mobile banking in Saudi Arabia, utilising the diffusion of innovation framework as the theoretical foundation. Brown and Molla (2005) conducted an exploratory study in South Africa on cell phone banking, investigating the predictors of cell phone banking adoption through the lens of diffusion theory. Additionally, Tunmibi et al. (2015) adopted the diffusion of innovation

framework to explore the factors influencing the adoption of smartphones among university students, incorporating a cross-border perspective into their research.

The original metrics introduced by Rogers have not only facilitated scholars but also communication professionals in comprehending the adoption of innovations, thus contributing to the comprehension of the fundamental processes involved in the decision-making process. Nonetheless, some limitations arise, which makes the use of DIT less suitable for this study. A key concern that has been raised by scholars has to do with the limited predictive power of the diffusion of innovation theory, criticising its exclusive focus on mass communication while neglecting environmental, technological, and interpersonal factors (Atkin et al., 2015). Recognising the need for updates to enhance the predictive capabilities of his theory, Rogers himself encouraged scholars to further develop a comprehensive understanding of the diffusion of innovation (Rogers, 2003).

In response to these limitations, several studies have proposed additions or modifications to the original theory. Danowski et al. (2011) have expanded the model by incorporating the variable of interpersonal channels, which results in a convex curve when interpersonal channels influence the diffusion process. This addition provides a more nuanced understanding of why certain trends fail to gain acceptance among the wider public. Another contribution suggests the inclusion of active adopters in the model, particularly when examining media adoption in domains such as social media and digital interaction (Atkin et al., 2011). Atkin et al. (2015) propose a transformation of the theory into a more integrated technology adoption model that incorporates audience motivation to adapt to diffusion,

thereby aiding the decision-making process within the realm of new media.

In summary, despite its ability to outline the essential steps through which adopters must progress for an innovation to gain traction (Atkin et al., 2015), the diffusion of innovation theory faces challenges when applied to complex technologies (Lyytinen & Damsgaard, 2001). The increasingly fragmented media landscape and the resulting lack of internal consistency (DeFleur, 1998) present difficulties in predicting outcomes within the dynamic and ever-changing media environment (Danowski et al., 2011; Atkin et al., 2015).

2.3.2. Theory of Reasoned Action

The Theory of Reasoned Action (Fishbein & Ajzen, 1975) is a popular theory that predicts the behavioural intention of an individual by examining their attitude towards a behaviour (Figure 2). “Attitude” is defined as an individual’s assessment of an object (Fishbein & Ajzen, 1975), whereas “belief” is defined as a relationship between an object and some attribute (Fishbein & Ajzen, 1975). "Behaviour,” on the other hand, is defined as an outcome of intention.

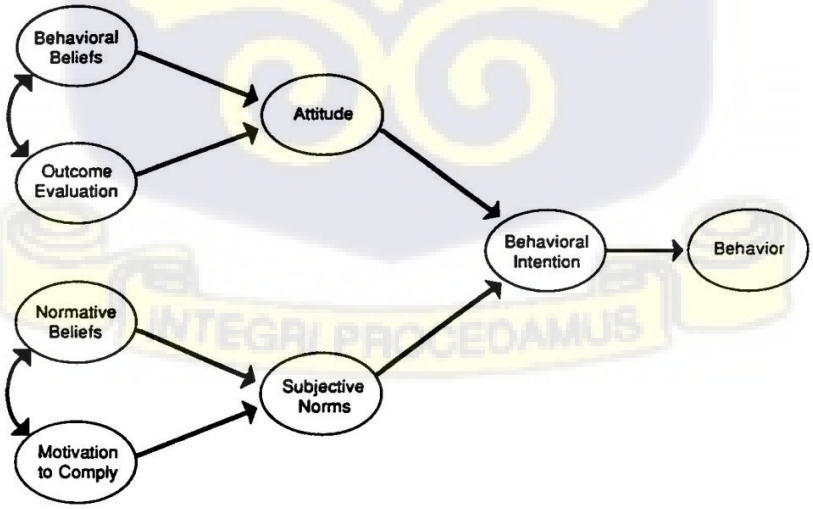

Figure 2: The Theory of Reasoned Action (Fishbein & Ajzen, 1975)

The Theory of Reasoned Action (TRA), introduced in 1980, has gained substantial recognition and application in the domain of technology adoption as well as in various other research fields. This theory has served as a fundamental framework for numerous studies, demonstrating its versatility and influence. Considered a seminal theory in understanding volitional human behaviour, TRA has been widely employed to investigate a diverse range of contexts and phenomena (Terry et al., 1993).

The Theory of Reasoned Action has garnered significant application across diverse research settings, exemplified by its utilisation in predicting knowledge sharing intentions (Bock et al., 2005) and contraceptive usage among low-income Indian women (Kulkarni, 2007). Furthermore, TRA has been extensively employed within the information system field, as demonstrated by studies conducted by Loiacono et al. (2007) and Rensel et al. (2006). That notwithstanding, TRA has several limitations that render the theory less significant for this study. A few of the limitations are elucidated in the paragraphs below.

According to Terry et al. (1993), a major drawback of the Theory of Reasoned Action (TRA) is its failure to consider the interconnectedness between individuals, encompassing both their interpersonal and social relationships, as well as the larger social structures that govern social practices. While TRA acknowledges the significance of social norms, its strategies are limited to examining individual perceptions of these social phenomena. The omission of external factors in TRA has garnered criticism for its individualistic bias and theoretical inadequacies (Kippax & Crawford, 1993). TRA research consistently emphasises the individual perspective when investigating the adoption of usage.

However, taking a broader view reveals that consumers' usage is often influenced by a system where they interact with other individuals and market participants. Scholars such as Kippax, Crawford (1993), and Werner (2004) argue that TRA neglects the broader social structures operating in society. This suggests that a more comprehensive understanding of the specific behaviour under investigation can be attained by exploring additional variables alongside TRA, thereby underscoring the need to further investigate external factors. The TRA was subsequently enhanced by Ajzen (1985, 1991) into the Theory of Planned Behaviour, which is discussed in the next section of this thesis.

2.3.3. Theory of Planned Behaviour

The theory of planned behaviour (TPB) (Figure 3) was developed by Ajzen (1991) to enhance the explanatory strength of the TRA. The theory proposes a direct relationship between belief and behaviour. The theory proposes that the three main constructs of attitude, subjective norms, and perceived behavioural control collectively influence an individual's behavioural intentions. Thus, behavioural intention is the most important proximate measure of human social behaviour (Ajzen, 1991). The Theory of Reasoned Action (TRA) has made significant contributions by challenging the notion that behaviour is solely determined by attitudes, as proposed by previous theories. TRA introduced novel explanatory factors, including intention and subjective norm, and facilitated the advancement of research designs, thereby enriching our understanding of human behaviour.

However, despite its merits, the Theory of Planned Behaviour (TPB) has faced substantial criticism. One notable critique pertains to the TPB's exclusive emphasis on rational decision-making processes, thereby neglecting unconscious influences on behaviour (Sheeran et al.,

2013) and the role of emotions beyond anticipated affective outcomes (Conner & Armitage, 1998).

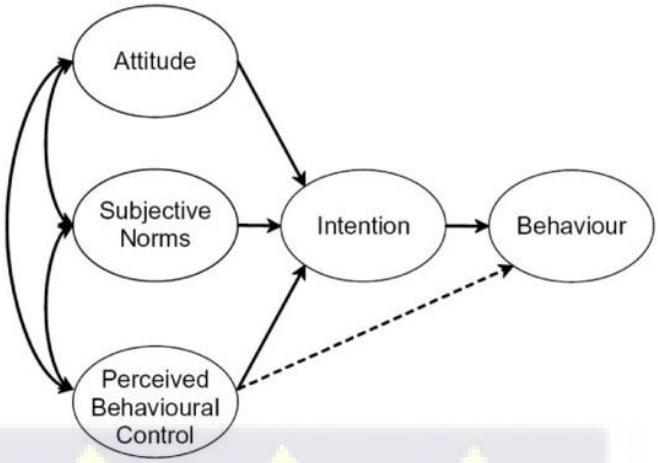

Figure 3: The Theory of Planned Behaviour (Ajzen, 1991)

Further, the static nature of TPB's explanatory framework presents limitations in comprehending the reciprocal relationship between behaviour and cognitive processes, as well as their influence on future behaviour (McEachan et al., 2011). Critics argue that relying solely on observed correlations between measures over time does not provide a sufficiently rigorous test of the theory, especially when more robust research designs are available (Weinstein, 2007).

In addition, TPB fails to consider other pertinent variables that influence behavioural intentions, such as past experiences, fear, and threat (LaMorte 2022). Moreover, the theory overlooks factors like environmental and economic considerations, which can significantly impact a consumer's intention to engage in a particular behaviour. To this end, the theory of planned behaviour was not taken into consideration. The next theory to be considered was the

technology acceptance model, which is discussed in the immediate section below.

2.3.4. Technology Acceptance Model (TAM)

One significant contribution to the body of knowledge that seeks to understand the reasons or factors that influence an individual's decision to obtain and subsequently utilise technology has been the introduction and adaptation of the Technology Acceptance Model (TAM) (Figure 4), which was proposed by Fred Davis in 1989. Fred Davis leveraged Fishbein and Ajzen's (1975) theory of reasoned action (TRA).

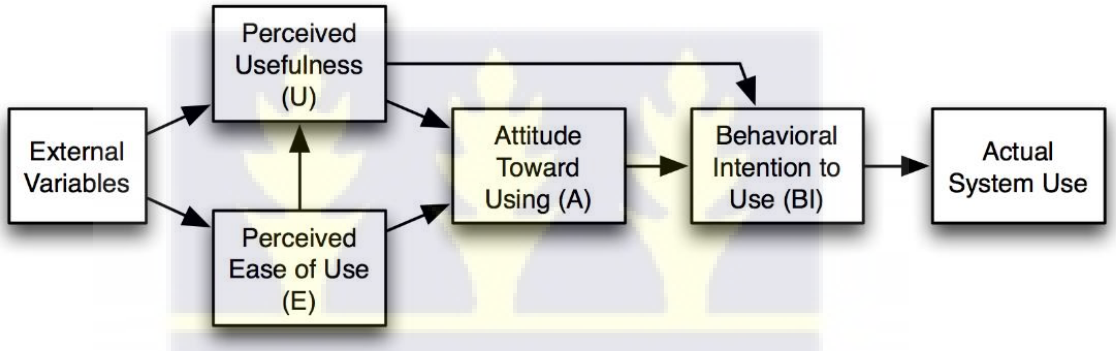

Figure 4: Technology Acceptance Model (Davies, 1989)

Fishbein and Ajzen (1975) propounded the TRA in the field of psychology. The TRA advances the argument that the behavioural attitude of a person is determined by a premeditated intention. They explained that this premeditated intention is significantly influenced by the subject's frame of mind concerning the behaviour and what other significant others in the life of the individual think of the act. Therefore, behaviour is a consequence of attitudes as well as beliefs.

TAM employed more specific attitude constructs: perceived usefulness and perceived ease of use as the predictors of an individual's intention to use and the subsequent actual utilisation

of a new technology (Davis, 1989). Perceived usefulness was defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). Perceived ease of use refers to "the degree to which an individual believes that using a particular system would be free of physical and mental efforts" (Davis, 1989, p. 320). The heuristic nature of TAM has led to several studies that have either adopted TAM wholly or adapted it to examine user acceptance of technology (Yamin & Alyoubi, 2020; Sumak et al., 2017; Chauhan & Jaiswal, 2016; Cimperman et al., 2016; Sumak and Sorgo, 2016).

Some scholars, however, have outlined the limitations and challenges of the TAM. According to Chuttur (2009), TAM as a theory has been criticised in respect of its questionable heuristic value, its predictive power, triviality, limited explanatory power, and lack of practical value. Moreover, Benbasat and Barki (2007) are of the view that the singular efforts by many researchers to adapt the TAM to the rapidly changing information technology age have resulted in a state of theoretical chaos and confusion. Lunceford (2009) also criticised the TAM by indicating that perceived usefulness and ease of use alone, without the addition of other important factors such as cost, limit the TAM in explaining technology adoption.

The limitations of the TAM dictate the need for a more rigorous technology acceptance theory or model that will incorporate other potential constructs that have eluded earlier scholars to build a more resilient model to predict the use of mobile apps in accessing information on infectious diseases. The UTAUT model presented an opportunity to aggregate the strengths of all the previous theories reviewed while addressing the weaknesses of the same. Section

2.3.6 provides a discussion of the UTAUT and a justification for its selection for this study.

2.3.5. Health Belief Model (HBM)

Notwithstanding the fact that the constructs discussed above, including those that were considered in the development of the UTAUT model, have not eluded scholarly interest and attention, a sense of curiosity arises as to how these constructs, when combined with constructs that are specific to health behaviours, will predict the use of mobile apps in accessing information on infectious diseases. In this light, the Health Belief Model (Figure 5) was reviewed to get a fair sense of how relevant constructs of the model could predict the use of mobile apps in accessing information on infectious diseases.

According to the Health Belief Model (HBM), an individual's perception of their personal risk of illness or disease, along with their belief in the efficacy of the suggested health behavior or action, determines the likelihood that they will adopt that behavior (Rosenstock in 1974). The Health Beliefs Model is a widely recognised framework that encompasses various beliefs related to health. It was originally proposed by Rosenstock in 1974, with subsequent additions and refinements. The model consists of four primary types of beliefs: perceived susceptibility, perceived severity, perceived benefits of preventive actions, and perceived barriers (Rosenstock, 1974).

One significant criticism of the Health Beliefs Model is the contention that there are other factors beyond those included in the model that can predict health behaviour. For example, scholars have suggested that outcome expectancy, which pertains to an individual's perception of the health benefits they will gain from engaging in a specific behaviour (Schwarzer, 2001),

and self-efficacy, which refers to an individual's confidence in their ability to successfully carry out preventive behaviours (Seydel & Wiegman, 1990), may play crucial roles in shaping health behaviours. Later, the concept of self-efficacy, which refers to an individual's belief in their ability to successfully adopt a behaviour, was incorporated into the model by Rosenstock et al. in 1988 (Champion & Skinner, 2008). This addition has been found to enhance the applicability and effectiveness of the model.

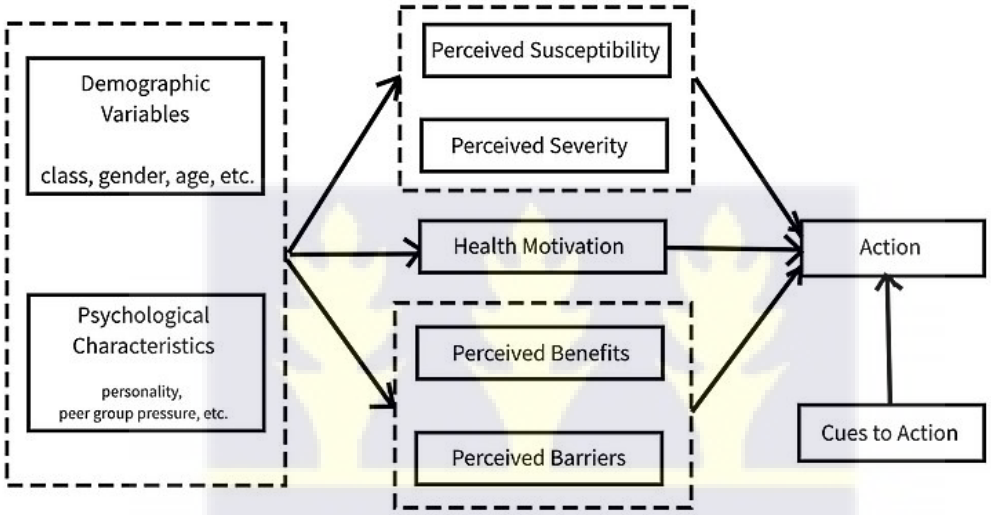

Figure 5: Health Belief Model
Source: Rosenstock (1974).

The HBM has been widely applied and shown to be relevant in various health contexts. For instance, it has been used to examine behaviours such as influenza vaccinations, breast self-examination, diet, exercise, smoking cessation, and seat-belt use (Prentice-Dunn & Rogers, 1986). The model has also been applied in studies related to HIV prevention (Steers et al., 1996), Type 2 diabetes mellitus management (Tan, 2004; Chao et al., 2005), dental health (Chen & Land, 1986), adherence to disease-modifying therapy in multiple sclerosis (Turner et al., 2007; Yoshitake et al., 2019), skin cancer prevention (Jeihooni & Rakhshani, 2019), oral cancer prevention (Jeihooni et al., 2019), nutritional behaviours (Vahedian-Shahroodi et

al., 2019), and the development of preventive behaviours in young adults (Luquis & Kensinger, 2019). This study incorporates the constructs of perceived susceptibility and perceived self-efficacy into the UTAUT model to test the extent to which these health-specific constructs will influence the use of mobile apps in accessing information on infectious diseases such as COVID-19.

2.3.6. Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. (2003), in their quest to respond to the limitations of TAM, developed a more complete technology acceptance model. They proposed the Unified Theory of Acceptance and Use of Technology (UTAUT). Venkatesh et al. (2003) integrated the major constructs of eight tried and tested models and theories: theory of reasoned action (TRA) (Davis et al., 1989); innovation diffusion theory (IDT) (Rogers, 2003); the theory of planned behaviour (TPB) (Ajzen, 1991; Taylor and Todd, 1995); the TAM (Davis, 1989; Davis et al., 1989; Venkatesh and Davis, 2000); the combined TAM-TPB (Taylor and Todd, 1995); the motivational model (MM) (Vallerand, 1997); the model of PC utilisation (MPCU) (Thompson et al., 1991); and the social cognitive theory (SCT) (Bandura, 1986; Compeau and Higgins, 1995) to predict individuals' acceptance and use of technology.

UTAUT elucidates the factors influencing user intentions and subsequent usage behaviour towards information systems (IS). According to this theory, there are four fundamental constructs, namely performance expectancy, effort expectancy, social influence, and facilitating conditions, that directly determine the intention to use and actual usage behaviour of IS (Venkatesh et al., 2003). Moreover, the theory proposes that gender, age, experience, and voluntariness of use act as moderators, influencing the impact of the four key constructs

on usage intention and behaviour (Venkatesh et al., 2003).

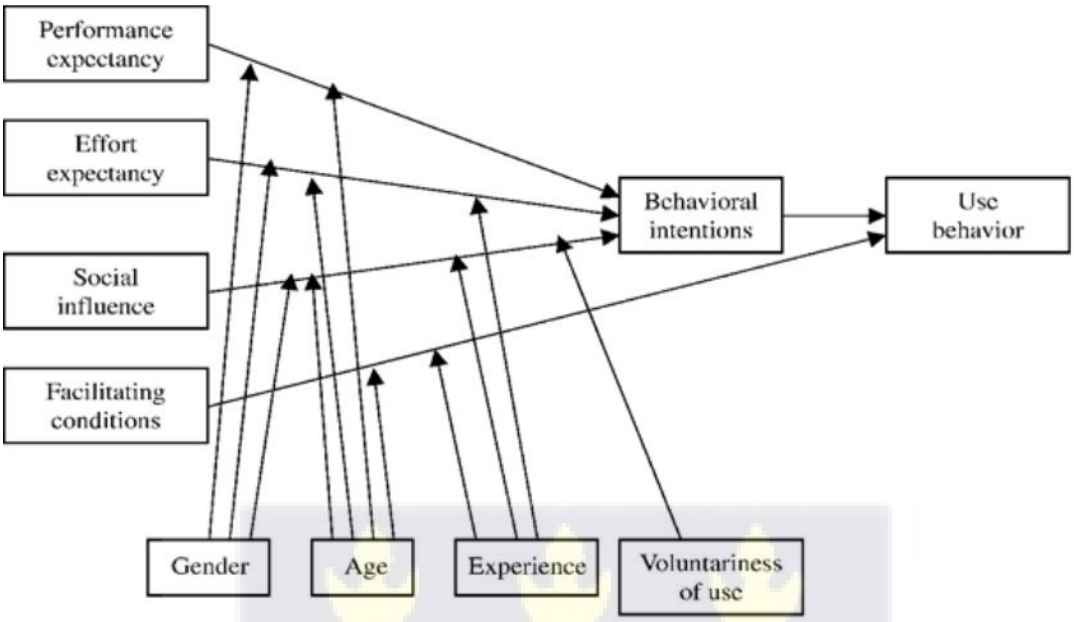

Figure 6: The unified theory of acceptance and use of technology (UTAUT) model (Venkatesh et al., 2003).

The UTAUT model (Figure 6) has been adopted or adapted in several studies to predict the use of technology in diverse disciplines, such as mobile health (Hoque & Sorwar, 2017); mobile banking (Baptista & Oliveira, 2015); healthcare services (Wiegard & Breitner, 2017); e-learning platforms (Dečman, 2015); online banking (Thusi & Maduku, 2020); tourism (Tao et al., 2018); and home telehealth services (Cimperman et al., 2016). The UTAUT model, in addition to its ability to explain user acceptance of technology, also explains the actual use of the technology in question. This study adopted the UTAUT model to predict use of mobile apps for public health communication. The next section of the review explains the constructs of the UTAUT model, as well as the newly introduced constructs of trust, perceived susceptibility, and perceived self-efficacy.

2.4 Extension of the UTAUT Model

Venkatesh et al. (2003) define effort expectancy (EE) as "the degree of ease associated with the use of the system" (p. 450). EE, in the context of this study, is defined as the ease with which users navigate mobile apps on their phones to access information on COVID-19. Behavioural intention (BI) is "the degree to which a person has formulated conscious plans regarding whether to perform a specified future behaviour." (Venkatesh et al., 2003, p. 450). BI in the context of this study represents the willingness or behavioural intention of users to use mobile apps for public health communication. PE portrays users' beliefs in respect of mobile apps facilitating access to relevant information on COVID-19 or otherwise.

According to Venkatesh et al. (2003), PE is the best predictor of a user's willingness to accept a technology. Other studies have also shown that PE and EE directly influence BI (Venkatesh et al., 2003; Sumak and Sorgo, 2016; Hoque and Sorwar, 2017; Khalilzadeh et al., 2017; Sumak et al., 2017). This study hypothesises that PE and EE could significantly predict users' BI towards the use of mobile apps for health communication. Social influence (SI) is defined as "the degree to which an individual perceives his or her significant others to influence their intention to use technology" (Venkatesh et al., 2003, p. 450). Several studies have found a positive relationship between behavioural intention to use technology and SI (Guo et al., 2012; Lu et al., 2005). This study hypothesised that users' behavioural intention to use mobile apps for public health communication is influenced by what their family, friends, and peers, among others, believe in respect of the use of mobile apps for public health communication.

Facilitating conditions (FC) are defined as "the degree to which an individual believes that an

organisational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p. 450). Several studies have found FC to be a predictor of behavioural intention and actual use of technology (Boontarig et al., 2016; Yi et al., 2006; Hikmet et al., 2007). Boontarig et al. (2016) found FC to have a direct positive influence on the behavioural intention and actual use of smartphones for health services. This study defines FC to include access to smart phones, availability, access, and affordability of internet service. The study hypothesised a positive relationship between FC and the actual use of mobile apps for public health communication.

Venkatesh et al. (2003) indicate that the four main constructs (EE, PE, BI, and FC) of the UTAUT model are moderated by gender, age, experience, and willingness on the part of the prospective user to use the technology (Figure 6). Venkatesh et al. (2016), however, in a review of literature on the UTAUT to set the pace for future research, posit that most of the UTAUT applications they reviewed examined only the main constructs of the UTAUT. "Few studies tested the moderation effects of individual differences specified in the original UTAUT." (Venkatesh et al., 2016, p. 332).

Nonetheless, the few include Gupta et al. (2008), who tested the moderating influence of gender. Al-Shafi et al. (2009) explored the moderating influence of age, gender, and experience. This study hypothesised a positive moderating effect of age, gender, experience, and voluntariness on the intention to use mobile apps for public health communication. Due to the integrated nature of the several dominant relevant models and theories, the UTAUT tends to be a preferred model for predicting technology acceptance and usage (Venkatesh et

al., 2003). That notwithstanding, to enhance UTAUT's capability to explain individuals' technology acceptance, several scholars (Martins et al., 2014; Cimperman et al., 2016; Kabra et al., 2017; Khalilzadeh et al., 2017) recommend an increase in the external variables during its application.

Many variables have been scientifically proven to complement the constructs of the UTAUT model. These include self-efficacy, trust, and perceived risk. Kabra et al. (2017) introduced personal innovation relative to information technology as well as trust into the UTAUT model to examine the best predictors of users' behavioural intention to use technology. Similarly, Khalilzadeh et al. (2017) integrated self-efficacy, risk, trust, security, and attitude into the UTAUT model to determine the predictors of users' intention to patronise mobile payment platforms.

Recent studies on the utility of mobile applications (Alalwan et al., 2017; Khalilzadeh et al., 2017) indicate trust as a function of users' behavioural intentions to use technology. This study adapted the UTAUT model to include trust and presents the hypothesis that trust is a predictor of intention to use mobile apps for public health communication. The construct of trust becomes more relevant in this study due to concerns raised by the WHO considering the COVID-19 outbreak. The WHO bemoaned the fact that the negative consequences of the pandemic were exacerbated by the spread of misinformation and disinformation in the search for information. This situation invites curiosity with respect to the extent to which scholarship has paid attention to the deployment of mobile apps as a credible means of accessing information and the role of trust therein.

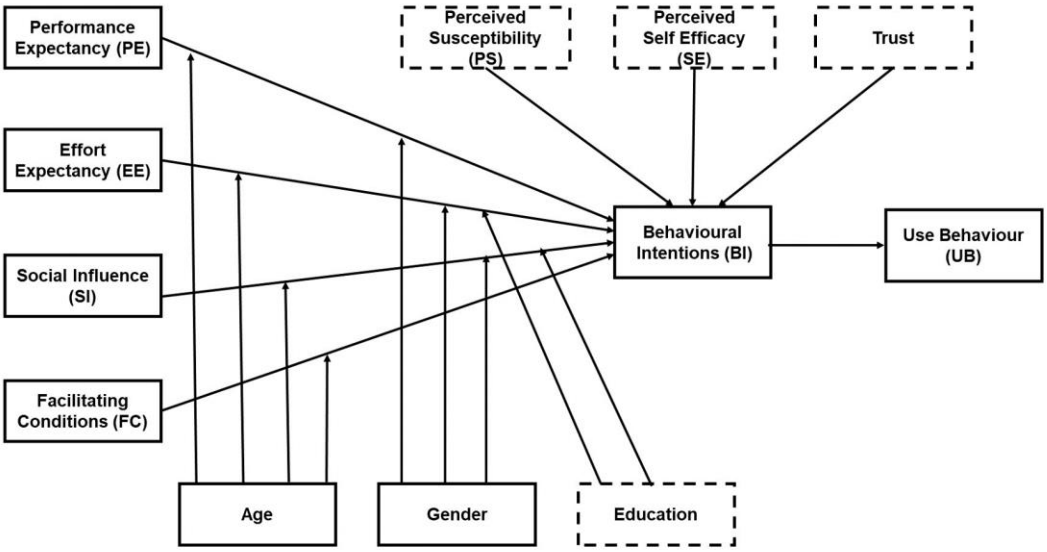

Figure 7: Conceptual Framework for the study
Source: Adapted from (Venkatesh et al, 2003)

Moreover, perceived susceptibility becomes an important construct amid varied information and several conspiracy theories, many of which were fuelled by religious and cultural reasons. More so, it is also important to note that the control of the spread of the virus was accompanied by prescribed protocols disseminated by the WHO through various health institutions. The ability of the target audience to observe these protocols also justifies the inclusion of self-efficacy as a construct of interest in this study. Whereas the identified constructs have not eluded scholarly interest and attention in previous studies, their application have been in other than in a global public health outbreak context. Again, other than in the context of their divergent and independent capacity to predict mobile app use, this study brings them together to the logic of the predictability of the collective constructs in informing technology acceptance and use, specifically use of mobile apps in accessing information during a global health crisis.

Based on the above theoretical analysis, this study adapted the UTAUT model to develop the theoretical and conceptual basis to predict the use of mobile apps in accessing information within the context of public health emergencies such as during pandemics. Variables including trust, perceived susceptibility, and perceived efficacy were combined with the substantive predictors of the UTAUT model to develop the conceptual framework for the study as seen in Figure 7. The newly introduced constructs are in broken lines.

2.5. Synthesising Research Gaps

The purpose of the study was to explore the predictors of use of mobile apps in accessing information on infectious diseases using the incidence of the COVID-19 pandemic in Ghana as a case. To produce a comprehensive and complete inventory of the gaps identified in the review of literature discussed earlier in this chapter, and the subsequent chapter (three), a systematic, second layer of review was conducted. The gaps thus identified are discussed under four key themes: the issue of interest that was investigated; the theoretical gaps; contextual gaps; as well as the methodological gaps.

Specifically, a systematic search was conducted for articles published in English language with publication dates from January 1, 2014 to December 31, 2021. The process was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2018) format and considerations and recommendations by Watson and Webster (2020) for conducting systematic literature reviews. Original papers (50) that addressed the use of mobile phones in relation to the Ebola Virus Disease (EVD) outbreak, the recent COVID-19 pandemic, and other public health emergencies were noted and considered for inclusion in the review. Appendix D presents the list of papers or articles included in the review.

2.5.1. Issue Gap

In the contemporary era dominated by digital and information technologies, there exists a prevailing optimism among technophiles regarding the potential role of technology. However, it is crucial to acknowledge the existence of various realities that may give rise to divergent possibilities associated with the utilisation of technology. Specifically, the advent of mobile applications aimed at providing user-friendly experiences necessitates an examination of the factors that influence their adoption and use, as their efficacy depends on a multitude of barriers and enablers.

In view of the considerations above, it becomes imperative to comprehend the elements that facilitate the utilisation of mobile applications as a means of accessing critical public health information. Consequently, the systematic literature review highlights the presence of numerous mobile applications with a focus on infectious diseases such as Ebola virus disease (EVD) and COVID-19, which have been developed and made globally accessible, in addition to the abundance of social media apps available for information dissemination.

Nevertheless, it is important to note that there was a scarcity of research evidence, particularly from the users' perspective, concerning the motivating factors that influence the adoption and use of mobile applications in accessing information pertaining to infectious diseases such as COVID-19 in the Sub-Saharan Africa region. Therefore, there is a need to address this research gap and gain a comprehensive understanding of the predictors of mobile app use in accessing information on infectious diseases in the specified region.

2.5.2. Theoretical Gap

The UTAUT model, encompassing predictors such as performance expectancy, effort expectancy, social influence, and facilitating conditions, provides a robust theoretical foundation for predicting technology adoption. However, the unprecedented and all-encompassing nature of the COVID-19 pandemic as a global health crisis necessitates further considerations beyond the existing knowledge. This is particularly relevant for health communicators who strive to develop effective health promotion messages through mobile apps. The complexities associated with the pandemic introduce various dimensions and factors that may influence the extent to which Ghanaians can benefit from the integration of technology in accessing COVID-19 information.

Furthermore, the systematic review reveals that a majority (80%) of the publications failed to incorporate established theories in their research design. This signifies a gap in conceptualization concerning the relationship between mobile apps and public health communication research, particularly within the context of pandemics. Consequently, the availability of theoretical models that offer conceptual rigour and predictive capabilities to understand and utilise mobile applications in public health communication during pandemics remains limited.

2.5.3. Contextual Gap

Following the declaration of COVID-19 as a global pandemic by the World Health Organisation (WHO), the WHO assumed the leading role in providing safety protocol information. Given the global target audience for WHO messages, the information conveyed was of a generic nature, lacking customization to specific socio-cultural and technological

contexts. In response, governments worldwide implemented guidelines based on WHO recommendations to contain the spread of the virus. Governments utilised various communication channels, including mobile apps, to disseminate information, educate the public about precautionary measures, and provide updates on available support. As an example, the Government of Ghana launched the GH COVID-19 tracker app to communicate COVID-19-related information based on WHO recommendations.

Within the Ghanaian setting, the level of literacy is relatively low, and there exist various religious groups that perceive the disease as non-existent and attribute diverse religious interpretations to it. Furthermore, personal beliefs regarding the ability to control one's own motivation, behaviour, and social environment play a significant role in embracing the use of mobile apps to access such information.

In the context of this study, the underlying assumption is that regardless of the relevance of health information or suggestions for health behaviour, a certain degree of personal conviction and the ability of the intended recipients to observe and comply with the recommended protocols are required. This situation may vary based on individual characteristics and environmental factors, such as education, religion, culture, and other facilitating conditions such as access to the internet. Although previous studies have explored the predictors of mobile app usage in health communication scenarios, the existing scholarship lacks updated responses to a pandemic situation within the unique context of Ghana.

2.5.4. Methodological Gap

The UTAUT model was developed and validated among users in North America. Venkatesh

and Zhang's (2010) call for further studies to investigate the generalizability and validity of the UTAUT model under different technological contexts and demands. This study identified the opportunity to test the model in explaining similar behaviour within the sub-Saharan Africa region, specifically the Ghanaian context. Moreover, the UTAUT model was created within an organisational context. Employing the UTAUT model within a purely voluntary kind of usage behaviour, based on survey feedback from over 450 respondents at the national lever across all sixteen regions of Ghana, also responds to a methodological gap for this study.

2.6. Summary

In accordance with the study's objective, which aims to investigate the factors influencing the behavioural intention to use mobile apps for accessing emergency risk public health information among Ghanaians, this chapter provided an empirical literature review encompassing relevant research in the domain of mobile app adoption within health communication and related fields. This was useful in expanding knowledge on the identified phenomenon, identifying new research areas, and establishing the rationale for conducting this study.

The chapter provides an overview of health communication and information-seeking behaviours in the context of the information age and the utilisation of mobile apps in public health communication, examining the benefits, relevance, and barriers associated with their adoption. Also, the chapter provides a discussion and synthesis of various theories of technology adoption, such as the Theory of Diffusion of Innovations (DIT), the Theory of Reasoned Action, the Theory of Planned Behavior, the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT). These

theories, in addition to the Health Belief Model (HBM), were reviewed to establish a conceptual framework for understanding the factors influencing the use of mobile apps in accessing information on infectious diseases like COVID-19.

The discussion on the prevailing themes and theories in research concerning mobile applications and public health communications synthesised the contextual, theoretical, methodological, and thematic gaps identified from the literature review, which subsequently informed the direction and focus of the current study. The research gaps identified were: a lack of understanding of motivating factors; limited utilisation of theoretical models; contextual challenges specific to Ghana; and the necessity of testing existing models in the Ghanaian context. Additionally, the study revealed a methodological gap in applying the UTAUT model in a voluntary usage behaviour setting in Ghana.

CHAPTER THREE

RESEARCH HYPOTHESES DEVELOPMENT

3.1. Introduction

This segment presents the conceptual model guiding the study. Chapter two of the thesis elucidate theoretical limitations in public health communication research, particularly in the use of mobile apps for public health communication. The literature review indicates a gap in conceptualization as far as mobile apps and public health communication research within the context of pandemics are concerned. In response to the above, this study sought to contribute to theory-building by developing a model that predicts the use of mobile apps to access emergency-risk public health information within the context of pandemics. This has strengthened the conceptualization of the use of mobile applications in public health communication, particularly within the context of infectious diseases.

The UTAUT model was selected because the major constructs of performance expectation (PE), effort expectation (EE), social influence (SI), and facilitating conditions (FC) were best placed to answer the research questions. At the same time, the heuristic nature of the UTAUT model also presented an opportunity to adapt the model to the unique and exigent circumstances of pandemics, which is the context within which the study is set. In this regard, three extensions were made to the constructs of UTAUT, drawing from extant public health communication literature. The three extensions are self-efficacy, perceived susceptibility borrowed from the health belief model, and trust. Also, the chapter presents a discussion of literature pertinent to the theory as grounds for articulating the research hypotheses.

3.2. Hypotheses Development

This section of the chapter provides details of the constructs of the study and the relationships that are hypothesised to exist among them. The arguments supporting both the direct and indirect hypothesised paths are also provided in this section.

3.2.1. Performance Expectancy (PE)

Performance Expectancy (PE) is a pivotal construct in the context of individuals' beliefs concerning the potential gains in job performance that can be achieved through using a specific system. Vanketash et al. (2023) formally defined PE as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (p. 447). In their earlier work (Vanketash et al., 2003), the authors developed PE by integrating five constructs drawn from other established models that are closely related to performance expectancy.

These include perceived usefulness, derived from the Technology Acceptance Model (TAM) and its enhanced version, TAM2, as well as the combined TAM and the Theory of Planned Behaviour (C-TAM-TPB). Additionally, extrinsic motivation, originating from the Motivational Model (MM); job fit, based on the Model of Personal Computer Utilisation (MPCU); relative advantage, grounded in the Innovation Diffusion Theory (IDT); and outcome expectations, appropriated from the Social Cognitive Theory (SCT), are integrated into the concept of PE.

The incorporation and combination of these constructs in the PE model have been

corroborated by findings from prior research studies, which have reported similarities between them. For instance, previous studies have highlighted the association between perceived usefulness and extrinsic motivation (Davis et al., 1989, 1992); perceived usefulness and job-fit (Thompson et al., 1991); perceived usefulness and relative advantage (Davis et al., 1989; Moore and Benbasat, 1991; Plouffe et al., 2001); perceived usefulness and outcome expectations (Compeau & Higgins, 1995; Davis et al., 1989); and job-fit and outcome expectations (Compeau and Higgins, 1995).

In the context of the present study, performance expectancy is specifically defined as an individual's belief in the ability of mobile apps to provide pertinent information on COVID-19. During epidemics, the availability of timely, accurate, and authentic information is of utmost importance in shaping public opinion and promoting safety. The COVID-19 pandemic witnessed a surge in the demand for information, leading to a corresponding increase in searches for coronavirus-related content (Mangono, 2021). Interestingly, the surge in COVID-19-related searches coincided with a decline in searches related to other health behaviours, such as doctor's appointments and health insurance (Mangono, 2021). This underscores the significance of seeking information to stay informed about the best practices for remaining safe during such health crises.

Further, the perceived usefulness of mobile apps as channels for disseminating relevant and pertinent COVID-19 information leads individuals to expect positive outcomes from their use. Conversely, irrelevant information may lead to indifference and reduced attention to infectious disease information, potentially diverting users' focus to other behaviours than

using apps to access health information. The concept of performance expectancy has been widely applied across various theories and models. Notably, the TAM and the combined TAM-TPB predict a positive relationship between PE and behavioural intention (BI). Additionally, within the context of the Theory of Diffusion of Innovation (DOI), relative advantage is deemed analogous to PE. Again, other studies have employed the Unified Theory of Acceptance and Use of Technology (UTAUT2) and its antecedent model, UTAUT, to demonstrate that PE significantly influences the behavioural intention and actual use of technology (Thakur & Srivastava, 2013; Slade et al., 2014; Venkatesh et al., 2011).

Based on the theoretical underpinnings and prior empirical evidence, the present study postulates a direct relationship between performance expectancy and the behavioural intention to utilise mobile apps for accessing COVID-19 information:

H1: Performance expectancy (PE) will have an influence on the behavioural intention to use mobile apps to access information on COVID-19.

3.2.2. Effort Expectancy (EE)

Venkatesh et al. (2023) have provided a definition for effort expectancy (EE), which pertains to the "degree of ease associated with the use of the system" (p. 450). To establish this construct, the authors integrated elements from existing models. Specifically, they incorporated perceived ease of use from both the Technology Acceptance Model (TAM) and TAM2, as well as complexity derived from the Model of Personal Computer Use (MPCU) and ease of use adapted from the Innovation Diffusion Theory (IDT).

It is worth noting that prior research (Davis et al., 1989; Moore and Benbasat, 1991; Plouffe

et al., 2001; Thompson et al., 1991) has observed substantial similarities among the definitions and measurement scales of these constructs. It must be said that in the early stages of adopting a new behaviour, effort-oriented constructs tend to hold greater prominence as individuals encounter challenges that need to be overcome (Venkatesh et al., 2023). However, as familiarity with the technology increases, these concerns become less significant, and instrumentality-related considerations become more salient (Davis et al., 1989; Szajna, 1996; Venkatesh, 1999).

In the context of this study, effort expectancy (EE) specifically relates to the ease with which users navigate mobile applications on their phones to access information on infectious diseases like COVID-19. The hypothesis posits that when users consider themselves to be required to invest less effort in using mobile apps, it will boost their readiness. Consequently, individuals who perceive that they will require less effort to use and interact with a technology are more inclined to adopt it as a valuable source of information on infectious diseases (Giovanis et al., 2019).

This notion aligns with previous studies indicating that effort expectancy (EE) can directly impact behavioural intention (BI) (Venkatesh et al., 2003; Sumak and Sorgo, 2016; Hoque and Sorwar, 2017; Khalilzadeh et al., 2017; Sumak et al., 2017), leading to the expectation that:

> *H2: Effort expectance (EE) will have a direct influence on the behavioural intention to use mobile apps to access information on COVID-19.*

3.2.3. Social influence (SI)

Venkatesh et al. (2023) propounded an in-depth definition of social influence (SI) as the "degree to which an individual perceives that important others believe he or she should use the new system" (p. 451). In their study, they have developed this construct as a direct determinant of behavioural intention, drawing on representations from various constructs established in previous research.

These include subjective norms from the Theory of Reasoned Action (TRA), TAM2, Theory of Planned Behaviour (TPB)/Decomposed TPB (DTPB), social factors from MPCU, and images from the Innovation Diffusion Theory (IDT). Notably, Thompson et al. (1991) also referred to a similar construct as social norms, which was recognised as akin to subjective norms within TRA by Venkatesh et al. (2023). Each of these constructs encompasses the explicit or implicit notion that individuals' behaviours are influenced by their perceptions of how others view them based on their technology usage.

According to Venkatesh et al. (2003), the role of social influence in technology acceptance decisions is intricate and subject to various contingent factors. Social influence impacts individual behaviour through three mechanisms: compliance, internalisation, and identification (Venkatesh & Davis, 2000; Warshaw, 1980). While the latter two mechanisms involve altering an individual's belief structure and/or prompting responses due to potential social status gains, the compliance mechanism leads an individual to simply modify their intention in response to social pressure, meaning that the individual intends to comply with the social influence (Venkatesh et al., 2003).

In this study, social influence (SI) is defined as "the degree to which an individual perceives his or her significant others to influence their intention to use technology" (Venkatesh et al., 2003). The underlying mechanism posits that social interactions serve as an active means to gather information. Users of mobile apps actively engage with their social environment to seek information, considering the potential consequences of using or not using a specific technology. The presumed reactions of the social environment can significantly influence an individual's attitude and behaviour regarding the adoption of technology, specifically in the context of using mobile apps to access information on infectious diseases like COVID-19.

Several studies have found a positive relationship between behavioural intention to use technology and SI (Guo et al., 2012; Lu et al., 2005). This study hypothesises that users' behavioural intention to use mobile apps for public health communication is influenced by the beliefs of their significant others, such as family, friends, peers, etc., regarding the use of mobile apps.

H3: Social influence (SI) will have direct influence on the behavioural intention to use mobile apps to access information on COVID-19.

3.2.4. Self-Efficacy (SE)

Perceived Self-efficacy is a defined construct referring to an individual's belief in their capability to effectively perform a specific behaviour (Glanz et al., 2008). In psychology, self-efficacy pertains to an individual's confidence in their ability to undertake actions necessary to achieve goals (APA, 2009). This concept was originally introduced by the psychologist Albert Bandura (1977, 1986, 1997). Self-efficacy significantly influences various aspects of

human endeavours. By shaping an individual's beliefs about their capacity to influence situations, self-efficacy strongly impacts both the actual ability to confront challenges effectively and the choices individuals are likely to make (APA, 2009). This influence is particularly evident and compelling in investment behaviours, such as those related to health (Schwarzer, 2011).

A robust sense of self-efficacy fosters human accomplishments and personal well-being. Individuals with high self-efficacy perceive challenges as opportunities for mastery rather than threats to be avoided (APA, 2009). Such individuals are more resilient in the face of failure and are inclined to attribute any setbacks to a lack of effort rather than a lack of capability. Moreover, they approach threatening situations with the belief that they can exert control over them (Bandura, 1997). Conversely, individuals with low self-efficacy view difficult tasks as personal threats and tend to avoid them (Bandura, 1997).

In the context of this study, self-efficacy is defined as the mobile app user's ability to perform COVID-19 protocols, such as wearing masks, practicing social distancing, and regularly washing hands as recommended by health communicators via mobile apps. The underlying mechanism of this construct posits that users with a high sense of self-efficacy are more likely to seek information on infectious diseases via mobile apps to gain knowledge about appropriate actions to take and stay safe. Conversely, users with low self-efficacy are less inclined to access information on infectious diseases through mobile apps because their perceived inability to adhere to the prescribed protocols demotivates them from using such apps.

Previous research in technology adoption has indicated that perceived self-efficacy predicts an individual's intention to use technology (Bandura et al., 2003). Building on these findings, this study hypothesises a direct relationship between an individual's perception of their ability to perform COVID-19 response behaviours and their intention to use mobile apps to access information on infectious diseases such as COVID-19.

H4: Perceived self-efficacy will have a direct influence on an individual's behavioural intention to use mobile apps to access information on COVID-19.

3.2.5. Perceived Susceptibility (PS)

The Health Belief Model (HBM) originated in the 1950s, developed by a group of social psychologists within the U.S. Public Health Service. Their aim was to elucidate the prevalent lack of participation among individuals in disease prevention and detection programmes (Hochbaum, 1958; Rosenstock, 1960, 1966, 1974). Subsequently, the model's scope was expanded to encompass people's responses to symptoms (Kirscht, 1974) and their behaviour in reaction to diagnosed illnesses, particularly compliance with medical regimens (Becker, 1974).

In line with the HBM, threat perception drives behaviour, and the specific action taken is influenced by beliefs concerning available behavioural options to counter the threat (Hochbaum, 1958). The adoption of a particular behaviour is contingent on the perceived benefits it offers (e.g., potential to reduce disease threat) outweighing perceived barriers (e.g., cost, inconvenience, embarrassment, discomfort). Additionally, cues to action, such as the presence of symptoms, are considered crucial to "setting the process in motion" (Rosenstock,

1974).

Within the context of this study, perceived susceptibility (PS) describes the subjective assessment of mobile app users in relation to the risk of contracting an infectious disease, specifically COVID-19. According to the logic of the HBM, users who perceive themselves as susceptible to COVID-19 are more likely to seek information on their apps to inform behaviours aimed at mitigating the risk of contracting the disease.

The extent of perceived susceptibility directly influences users' behavioural intentions regarding accessing information through mobile apps. Those who feel more susceptible are more likely to pursue information on the disease of public concern, while those who perceive themselves as less susceptible are less inclined to do so. Therefore, this study hypothesises that perceived susceptibility will have a direct impact on the behavioural intention to use mobile apps to access information on infectious diseases.

H5: *Perceived susceptibility will directly influence the behavioural intention to use mobile apps to access information on COVID-19.*

3.2.6. Trust

Trust can be defined as the psychological belief in the presence of a reliable and dependable partner who demonstrates a lack of opportunism, as posited by Bunduchi (2005). This concept assumes significance in mitigating uncertainties, fears, and concerns associated with the utilisation of services, as observed in the study by Lu et al. (2011). However, its place in the UTAUT model has yet to be fully established, given that the model did not originally

conceptualise it to be included in the factors that predict use intention. Trust in the use of mobile apps is very important in the provision of healthcare. Especially when mobile apps are used for patients' interaction, engagement, and disclosure of their sensitive health and personal information. Lack of trust in the deployment of healthcare technology can result in negative or undesired health outcomes. This study attempts to address this gap by introducing trust as a construct in its conceptual framework.

Within the scope of this investigation, trust pertains to the degree to which users of mobile applications perceive infectious disease information disseminated through these platforms as authentic and genuine. The significance of this construct is underscored by its influence on motivating or demotivating users, especially with regards to the credibility of infectious disease information. This has been prominently evident during the COVID-19 pandemic, which witnessed an infodemic characterised by an overwhelming influx of information, including false or misleading content, across both digital and physical environments (WHO, 2020). The role of trust as a critical catalyst for adoption in the online context has been acknowledged by scholars like Gefen et al. (2003), primarily due to its capacity to address the inherent uncertainties and vulnerabilities associated with digital means. Noteworthy examples of research by Doney and Cannon (1997) and Gambetta (2000) further emphasise the significance of trust in influencing adoption behaviour.

Supporting evidence from Switzerland reveals that higher levels of trust in government and health authorities could lead to greater uptake of health-related initiatives (von Wyl, 2021). Similarly, findings from Germany suggest that general trust in official app providers plays a

pivotal role in fostering adoption (Kaspar, 2020). Furthermore, a study conducted across five countries—France, Germany, Italy, the United Kingdom, and the United States—highlighted the substantial influence of trust as a major barrier hindering the adoption of a contact tracing app (O'Callaghan, 2020). These empirical observations collectively emphasise the paramount importance of trust in shaping users' attitudes and behaviours towards digital health applications, particularly during infectious disease outbreaks, leading to the hypothesis that:

H6: *Trust will have a direct influence on the behavioural intention to use mobile apps to access information on COVID-19.*

3.2.7. Facilitating Conditions (FC)

Facilitating conditions, as defined by Venkatesh et al. (2003), pertain to "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (p. 453). This definition encompasses concepts represented by three distinct constructs: perceived behavioural control (TPBI DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT). Each of these constructs incorporates elements of the technological and/or organisational environment aimed at removing barriers to technology use (Venkatesh et al., 2003).

In the context of this study, Facilitating Conditions (FC) is defined as the extent to which mobile app users have access to technical and infrastructural support, such as smartphones, internet connectivity, call credit, or data, among others, that facilitate the use of mobile apps for accessing information on infectious diseases. It is essential to have access to a mobile phone to express interest in sourcing information shared through mobile apps. However, such

access necessitates certain accessories, including stable and affordable internet connectivity. The underlying assumption of this construct is that the availability and accessibility of these facilitating conditions could either motivate or demotivate users.

Numerous studies have demonstrated FC as a predictor of behavioural intention and actual technology use (Boontarig et al., 2016; Yi et al., 2006; Hikmet et al., 2007). Boontarig et al. (2016) found that FC directly and positively influenced the behavioural intention and actual use of smartphones for health services. Building on these findings, this study hypothesises a direct relationship between facilitating conditions (FC) and behavioural intention (BI) to use mobile apps for accessing information on infectious diseases like COVID-19.

H7: *Facilitating Conditions (FC) will have a direct influence on the behavioural intention to use mobile apps to access information on COVID-19.*

3.2.8. Behavioural Intention (BI)

Behavioural intention (BI) is "the degree to which a person has formulated conscious plans regarding whether to perform a specified future behaviour." (Venkatesh et al., 2003, p. 450). BI in the context of this study represents the willingness or behavioural intention to use mobile apps to access information on COVID-19. In line with various psychological theories that suggest individual behaviour is guided by personal intentions, the UTAUT model has argued and demonstrated that behavioural intention plays a crucial role in determining technology usage (Venkatesh et al., 2003; Venkatesh & Zhang, 2010).

Therefore, to maintain consistency with the core theory behind intention models, it is anticipated that behavioural intention will significantly influence the use of mobile apps in

accessing information on infectious diseases (Venkatesh et al., 2003). In other words, before an individual uses an app to access information on COVID-19, that individual must have a positive attitude towards the app as influenced by the predictive constructs of behavioural intention, which eventually influence the target individual's decision to use the app.

H8: Behavioural intention will have direct influence on the actual use of mobile apps to access information on COVID-19.

3.3. Moderation effects

The role of moderating factors in enhancing the power of established predictors in the UTAUT model has well been documented (Williams et al., 2015). Venkatesh et al. (2003) introduced moderating demographic variables of age, gender, experience, and voluntariness to enhance the explanatory power of the UTAUT. This study examined the contribution or otherwise of some of the demographic moderators, relative to the UTAUT constructs, thus: *Age* and *Gender* with the introduction of *Education*.

Several studies in communication and information systems research have tested the influence of the moderating factors in the UTAUT in the context of technology adoption. For example, Gefen and Straub (1997) observed that women rated perceived usefulness higher than men. Mikkelsen (2002) reported a similar trend, indicating that women tend to exhibit more computer anxiety compared to men. Moreover, Tsao et al. (2009) investigated the moderating effects of gender on the relationship between performance expectancy and behavioural intention, and their findings suggested that gender indeed played a role in this association. Venkatesh et al. (2003), in their research, also noted that the influence of performance

expectancy on behavioural intention was moderated by age, with a more pronounced effect observed among younger men. In concurrence with this, Tsao et al. (2009) found that gender also exerted a moderating effect on the relationship between performance expectancy and behavioural intention. These collective findings underscore the significance of gender and age as potential moderators in shaping individuals' perceptions and behavioural intentions towards technology usage. This study tested the moderating effect of gender, age, and education in the context of intention to use mobile apps to access information on COVID-19.

3.3.1. Age

Performance expectancy is defined in this study as an individual's belief in the capability of mobile applications to provide relevant information about COVID-19. During epidemics, timely, accurate, and reliable information is essential for shaping public opinion and promoting safety. The COVID-19 pandemic saw a substantial increase in the demand for information, leading to a surge in searches for content related to the coronavirus (Mangono, 2021).

Older adults generally exhibit less information-seeking behaviour compared to younger adults. Research has indicated that older adults are less intellectually curious (Zimprich et al., 2009) and less motivated to seek variety (Novak & Mather, 2007). However, despite this trend, the COVID-19 pandemic has demonstrated that older adults are particularly vulnerable, with higher mortality rates observed in this demographic compared to younger individuals, as evidenced by a study conducted by Yanez et al. (2020) across 16 countries. Given this increased vulnerability, it is expected that older adults would be more inclined to seek

pertinent information about the pandemic through mobile applications. Therefore, it is proposed that the influence of performance expectancy on the behavioural intention to use mobile apps for accessing COVID-19 information is stronger among older users.

Effort Expectancy (EE) is defined as the degree of ease associated with the use of the technology. Venkatesh, et al. (2003). Venkatesh et al. (2003) found that the relationship between Effort Expectancy and Behavioural Intention to use technology is stronger for older individuals than for younger ones. This is because older users are generally less familiar with new technologies and thus place greater importance on the ease of use. As individuals age, they may experience a decline in cognitive abilities and may therefore find new technologies more challenging to learn and use. Consequently, for older users, the perception that a technology is easy to use significantly enhances their intention to adopt it. This study therefore proposes that the influence of effort expectancy on behavioural intention to use mobile apps for accessing information on COVID-19 is stronger for older users.

Social Influence (SI) refers to the degree to which an individual perceives that important others believe they should use mobile apps to access information on COVID-19. According to Venkatesh et al. (2003), the effect of Social Influence on the Behavioral Intention to use technology is more pronounced for older adults compared to younger individuals. Older individuals are more likely to be influenced by the opinions of others due to factors such as less experience with technology, a higher reliance on social networks for decision-making, and a greater tendency to conform to social norms. Consequently, older users might be more inclined to adopt and use mobile apps for accessing COVID-19 information if they perceive

that significant others, such as family members, friends, or colleagues, think they should use it. On the other hand, younger individuals may rely less on such social cues when deciding to use these apps (Venkatesh et al., 2003). The study hypothesised that the effect of social influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.

Facilitating conditions (FC) pertain to an individual's perception of the extent to which adequate infrastructure is accessible to facilitate the utilization of a given technology, as established by Venkatesh et al. (2003, p. 456). Venkatesh (2000) further substantiated the notion of full mediation concerning the impact of facilitating conditions on behavioural intention. Within the realm of technology adoption, this construct holds significant importance in various contexts, such as mobile banking, where internet access serves as a fundamental prerequisite for usage (Joshua & Koshy, 2011), educational systems (Nistor et al., 2013), wearable technologies (Guest et al., 2018), and service chatbots (Kuberkar & Singhal, 2020).

In the specific context of this study, facilitating conditions encompass the availability of essential resources, including access to smartphones, complemented by stable, affordable, and easily accessible internet connectivity. Consequently, these requirements have implications for cost considerations. An underlying assumption posits that older individuals, who are more likely to be employed and, therefore, possess greater economic resources to finance such technological accessories, are anticipated to exhibit more frequent usage of mobile apps—in accessing information on infectious diseases like COVID-19—compared to their younger counterparts. As a result, the influence of facilitating conditions on the intention to use mobile

apps is expected to be more pronounced when moderated by age.

This study therefore hypothesised that:

H9: Age will significantly moderate the relationship between performance expectancy, effort expectancy, social influence, and behavioural intention to use mobile apps to access information on COVID-19.

H9.1: The influence of performance expectancy on behavioural intention to use mobile apps for accessing information on COVID-19 is stronger for older users.

H9.2: The influence of effort expectancy on behavioural intention to use mobile apps for accessing information on COVID-19 is stronger for older users.

H9.3: The effect of social influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.

H9.4 The effect of facilitating conditions on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.

3.3.2. Gender

From a theoretical perspective, the relationship between performance expectancy and intention is posited to be influenced by gender and age, as proposed by Venkatesh et al. (2003). Research exploring gender differences indicates that men often display a strong task-oriented orientation (Minton & Schneider, 1980), consequently rendering performance expectations, which centre around task accomplishment, particularly significant for men. Gender schema theory further suggests that such dissimilarities arise from gender roles and socialisation processes that are reinforced in the early stages of life rather than being strictly attributed to

biological gender itself (Kirchmeyer, 1997; Lynott et al., 2000).

For instance, due to traditional societal gender roles, the significance of job-related elements may undergo substantial changes (e.g., being overshadowed by family-oriented responsibilities) for working women as they transition from entering the labour force to reaching childbearing years (e.g., Barnett and Marshall, 1991). Consequently, it is anticipated that the impact of performance expectancy will be moderated by gender. In the context of this study, the task of using mobile apps to search for information on infectious diseases could moderate performance expectancy in that the influence of PE will be greater on intention to use mobile apps for men compared to women.

Again, Venkatesh and Morris (2000), building upon existing research (e.g., Bem and Allen 1974; Bozionelos 1996), proposed that the perceived ease of use, referred to as effort expectancy, holds greater significance for women compared to men. These gender disparities could be a result of knowledge of gender roles (Lynott & McCandless 2000; Wong et al. 1985). Previous studies lend support to the idea that constructs linked to effort expectancy exert stronger influences on women's intentions (Venkatesh et al., 2003; Venkatesh & Morris, 2000; Venkatesh et al., 2000). The assumption in this study is that the influence of effort expectancy on behavioural intention will be moderated by gender, such that the effect will be stronger for women.

Theoretical frameworks propose that women tend to be more attuned to the opinions of others, leading them to perceive social influence as more pertinent when forming intentions to adopt

new technology (Miller 1976; Venkatesh et al. 2000). As with performance and effort expectations, gender-related effects might be driven by psychological phenomena inherent in socially constructed gender roles (Lubinski et al., 1983). The mechanism behind this moderating effect is that the impact of social influence on behavioural intention to use mobile apps to access information on infectious diseases like COVID-19 is likely to be greater based on gender, particularly among women.

This study therefore proposed the following hypothesis:

H10: Gender will significantly moderate the relationship between performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile apps to access information on COVID-19.

H10.1: The influence of performance expectancy on intention to use mobile apps to access COVID-19 information is stronger for males compared to females.

H10.2: The influence of effort expectancy on intention to use mobile apps for accessing COVID-19 information is stronger for females compared to males.

H10.3: The effect of social influence on intention to use mobile apps to access COVID-19 information is stronger for females compared to males.

3.3.3. Education

The existing literature suggests a positive and significant correlation between educational status and the behavioural intention to use mobile technology (Yusuf & Xiaoyun, 2016; Abu-Shanab, 2011; Sharma & Kumar, 2012). It is posited that individuals with basic or no formal education may perceive higher barriers to technology adoption compared to those with higher formal education (Weijters et al., 2007; Liebermann & Stashevsky, 2002). This observation

is also supported by Rhee and Kim (2004), who reported that individuals with relatively higher levels of education were more inclined to use the Internet. Additionally, Porter and Donthu (2006) have indicated that early adopters of new technologies are often individuals with substantial formal education.

With the widespread availability of information and communication technology, seeking health information online has become a prevalent behaviour (Bundorf et al., 2006; Renahy et al., 2010; Lee et al., 2014; Maon et al., 2017). This trend is primarily attributed to the accessibility and comprehensive coverage of information, ease of searching, affordability of access, interactivity, and anonymity associated with online health information seeking (Asibey et al., 2017; Chu et al., 2017; Powel et al., 2011; Lagoe & Atkin, 2015).

A systematic review conducted by Jia et al. (2021) identified general behavioural patterns and various factors influencing online health information seeking. Among these factors, literacy (level of education) is recognised as an important influence. Drawing from the existing literature, it was hypothesised in this study that the educational status of mobile app users might moderate their effort exerted in using mobile apps to access information on infectious diseases. Also, previous studies have shown that education enlightens users and, for that matter, reduces the moderating effect of social influence on behavioural intention (Burton-Jones & Hubona, 2006). The underlying mechanism proposed is that individuals with higher literacy levels are more proficient in navigating mobile apps to seek information, particularly during a global health crisis like COVID-19, thus enabling them to make informed decisions to safeguard their health.

In the context of this study, the moderating effect of education was postulated to influence the relationship between effort expectancy and social influence on the behavioural intention to use mobile apps for accessing information on infectious diseases like COVID-19. The study hypothesised that:

H11: Education will moderate the influence of effort expectancy and social influence on intention to use mobile apps to access information on COVID-19.

H11.1: The influence of effort expectancy on intention to use mobile apps for accessing information on COVID-19 is stronger for users with lower education.

H11.2: The effect of social influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for users with lower education.

Figure 8 shows a graphical summary of the conceptual model that informed the collection and analysis, indicating all the hypothesised paths. Table 1 shows all the hypotheses formulated and their respective descriptions.

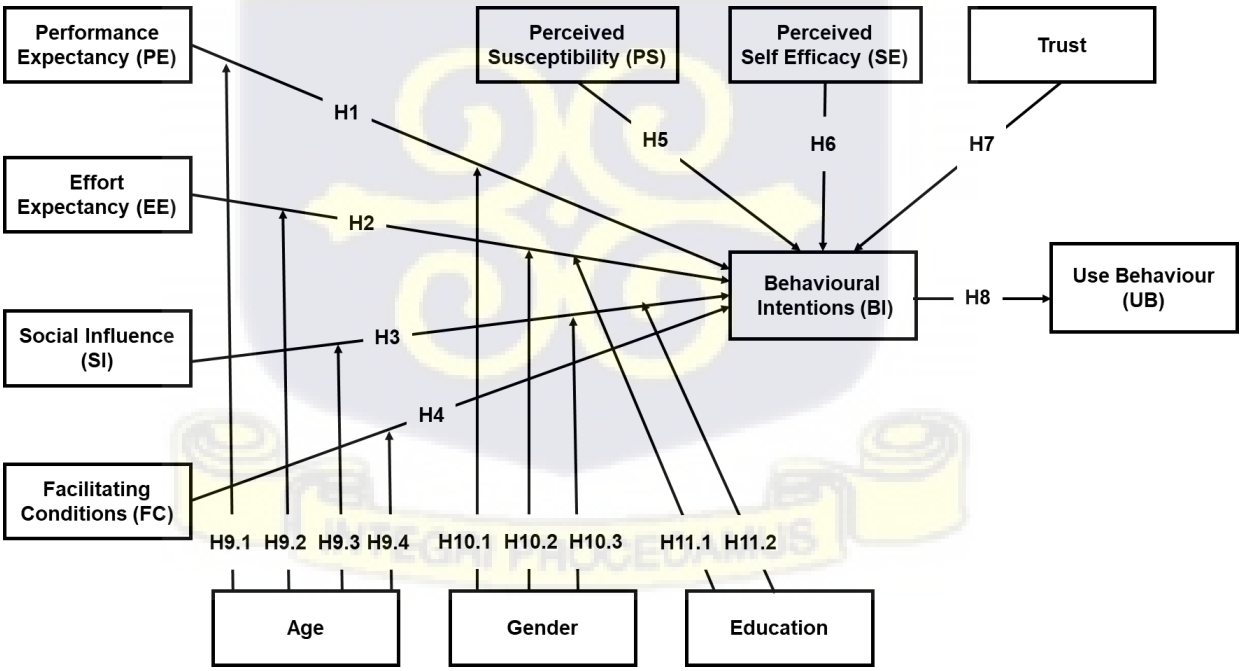

Figure 8: Conceptual model for the study
Source: Adapted from (Venkatesh et al, 2003)

Table 1: Table of Hypotheses

No.	Hypotheses
H1	PE will have a direct effect on the behavioural intention to use mobile apps to access information on COVID-19
H2	EE will have a direct influence on the behavioural intention to use mobile apps to access information on COVID-19
H3	SI will have a direct influence on the behavioural intention to use mobile apps to access information on COVID-19
H4	SE will have a direct influence on an individual's intention to use mobile apps to access information on COVID-19
H5	PS will directly influence behavioural intention to use mobile apps to access information on COVID-19
H6	Trust will have a direct influence on behavioural intention to use mobile apps to access information on COVID-19
H7	FC will have a direct influence on actual use of mobile apps to access information on COVID-19
H8	BI will have a direct influence on actual use of mobile apps to access information on COVID-19.
H9	The relationship between performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile apps to access COVID-19 information will be significantly moderated by age.
H9.1	Performance expectancy influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for younger users.
H9.2	Effort expectancy influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.
H9.3	Social influence on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.
H9.4	Facilitating conditions effect on behavioural intention to use mobile apps to access information on COVID-19 is stronger for older users.
H10	Gender will significantly moderate the relationship between performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile apps for public health communication.

No.	Hypotheses
H10.1	H10.1: Influence of Performance expectancy on intention to use mobile apps to access emergency risk public health information is stronger for males compared to females.
H10.2	H10.2: Influence of effort expectancy on intention to use mobile apps to access emergency risk public health information is stronger among females compared to males.
H10.3	H10.3: Effect of social influence on intention to use mobile apps to access emergency risk public health information is stronger for females compared to males.
H11	Education will have a direct influence on intention to use mobile apps for public health communication.
H11.1	H11.1: Effort expectancy effect on intention to use mobile apps to access emergency risk public health information is stronger for users with higher education
H11.2	H11.2: Social Influence effect on behavioural intention to use mobile apps to access emergency risk public health information is stronger for users with lower education

3.4. Summary

This chapter discussed the theories used in the development of the study's conceptual framework. The chapter provided a suggested response to the theoretical and conceptual gaps in public health communication research, specifically on the use of mobile apps for public health communication as identified in the second chapter of this study. This chapter also provides a description of the major constructs of the study. A justification for the choices of the UTAUT model and the specific constructs of performance expectation (PE), effort expectation (EE), social influence (SI), and facilitating conditions (FC) are provided in this chapter.

The chapter also presents reasons for the adaptation of the UTAUT model to include other constructs specific to the implementation of this current study but originally not part of the UTAUT model. These are perceived susceptibility (PS), self-efficacy (SE), and trust. The chapter also discussed literature relevant to the theoretical framework that enabled the development of the study's hypotheses. Subsequently, the chapter proposed the hypotheses of the study with respect to the identified constructs within the research framework to answer research question five (5) of the study. The next chapter presents the research methodology of the study.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This section offers an exposition on the philosophical foundations that underlie the design of the present study, along with the methodological choices made in the conduct of the research. It provides a comprehensive overview of the principal research approaches accessible within the epistemic bouquet, namely quantitative and qualitative paradigms. Subsequently, the rationale supporting the adoption of a quantitative approach is articulated. Furthermore, the way data were collected is explained, including explanations of the study's target, sampling techniques, instrument development, and administration processes. Finally, the chapter explains how the data collected was analysed.

4.2 Philosophical Underpinning

According to Kuhn (1970), a research paradigm refers to a "set of beliefs, values, and techniques that are shared by members of a scientific community and which act as a guide or map, dictating the kinds of problems scientists should address and the types of explanations that are acceptable to them" (p. 175). Therefore, the relevance of research paradigms is to situate research within a well-defined scope of acceptable philosophical thinking (Johnson & Clark, 2006). Myers and Avison (2002) contend that beyond the traditional definition of research, paradigms serve as important, applicable methods of conducting research.

Three different approaches have guided communication research for several years. These are the positivist, the interpretivist, and the critical paradigms (Mingers, 2004). These approaches

offer separate views of how social phenomena could be studied. Patton (2002) indicates that "when researchers operate from different frameworks, their results will not be readily interpretable by or meaningful to each other" (p. 134). Knowledge of a researcher's ontological and epistemological position facilitates a better appreciation of the significance of a study. A brief overview of the three identified paradigms is presented below, along with a justification for the choice of research paradigm adopted for this study.

4.2.1. Positivism

Positivism is a conceptual view that describes the researchers' approach to studying a social phenomenon (Cohen et al., 2007). Historically, positivism as a term was first used by the nineteenth-century French philosopher, Auguste Comte, to present a philosophical stance (Richards, 2003). Positivism is a "scientific method" where researchers tend to study social sciences in a similar way to the natural sciences. It holds that knowledge is acquired through close observation and measurement of the objective reality that exists "out there". It claims the label 'scientific' because phenomena can be studied as hard facts and the relationships between these facts are established as scientific laws, and scientific laws have the status of truth. Positivism professes that social objects can be studied in much the same way as natural objects.

From an epistemological perspective, a positivist views the claimed knowledge as hard, objective, and tangible, which requires the researcher to take on the role of an observer of social phenomena. The objective posture of the researcher makes it possible for the adoption of a quantitative methodology. Typically, research on the adoption of ICTs that is driven by

the positivist paradigm employs measurable, quantifiable variables. Gall et al. (2003) summarise this assertion:

> The use of quantification to represent and analyse features of social reality is consistent with positivist epistemology. Because this epistemology assumes that features of social reality have constancy across time and settings, a particular feature can be isolated and conceptualised as a variable, that is, as an entity that can take on different values. These values can be expressed as numerical scales (pp. 19–20).

The application of variables makes it possible for the development and testing of hypotheses informed by existing literature and the phenomena under investigation within a specified population. Empirical data is then collected and analysed to assess the predictive power of independent variables on the dependent variable.

4.2.2. Interpretivism

Proponents of interpretivism believe that reality is a subjective matter that should be researched. This is opposite to the views of advocates of positivism and realism, who believe in the objective nature of reality. Interpretive ontology thus fails "to adopt any permanent, unvarying standards by which truth can be universally known" (Guba & Lincoln, 2005, p. 204). Rather, interpretive ontology probes the contextual meaning humans appropriate to societal phenomena (Myers, 1997; Walsham, 2006).

Thus, truth and reality are formed, not discovered. Reality cannot be known, but reality is determined by what we feel through our senses as events emerge (Kaplan & Maxwell, 2005).

Epistemologically, interpretivists believe that knowledge cannot be detached from the researcher because the experiences of the researcher could influence the direction of the study. Moreover, the thoughts of the researcher and that of the subject under study could change due to the engagement between the two at any point of the study (Myers, 1997).

Methodologically, whereas positivists' approach tends to mimic the natural sciences, interpretivism leans towards a more social means of observing phenomena (Walsham, 1995a). Interpretivists hold the assertion that research should confer meanings on a phenomenon from the perspective of the study group and within the social context of the same (Walsham, 1995b). Interpretive researchers in communication research adopt research methods that collect data about a phenomenon as well as the context of the study to facilitate a better appreciation of how both the phenomenon and its context mutually affect each other (Walsham, 1995a). Therefore, interpretivism makes it possible for communication researchers to understand, for example, why an individual will use technology within a specific context (Myers, 2013). Critics of the interpretive paradigm are largely positivists, who present interpretivism as too subjective to be scientific. It appears “everything goes” and therefore renders it impotent in the development of theories that could be inferred to the larger population (Grix, 2004).

4.2.3. Critical Paradigm

Critical realism (CR) is, comparatively, a modern philosophy that arose from the proponents of realism and the Marxist tradition in social science (Bhaskar, 1978; Bhaskar, 1986; Bhaskar, 1993; Bhaskar, 1998). Critical realism holds that:

> We will only be able to understand and change the social world if we identify the

> structures at work that generate those events or discourses. These structures are not spontaneously apparent in the observable pattern of events; they can only be identified through the practical and theoretical work of the social sciences. (Bhaskar, 1989, p. 2)

The central premise of critical realism is that individuals could intentionally behave to adapt their respective socioeconomic circumstances (Klein & Myers, 1999). This research approach, for that matter, focuses on changing the existing situation with the objective of liberating marginalised or minority groups from distinctive situations because critical realists are of the opinion that societal verity could be inequitable (McAulay et al., 2002; Orlikowski & Baroudi, 1991).

Despite critical researchers' appreciation of the fact that people could influence their social and economic situations, they assert that several sociocultural barriers, legislation, political dominance, and disparities in resource allocation could hinder this potential (Klein & Myers, 1999; Orlikowski & Baroudi, 1991). For that matter, critical researchers portray these barriers as positively impacting the lives of marginalised individuals and liberating them from discrimination (Hirschheim & Klein, 1994). This paradigm is common in communication research, particularly in the fields of gender disparity in information systems, information systems failure, and power relations (Kvwasny et al., 2005; Wilson & Howcroft, 2002).

The ontology of critical realism is that there exists an independent, causally efficacious world that is different from what we know (Mingers et al., 2013). Critical realists, just as interpretivists, believe that reality is also socially constructed (Hirschheim & Klein, 1994).

However, researchers who adopt the critical realist approach to research hold the assumption that social reality could be constituted historically; therefore, it presents, to some level, cultural, political, economic, and social powers that enable the powerful in society to dominate the marginalised (Hirschheim & Klein, 1994).

Epistemologically, critical realists assert that all views must be equal, though critical realists hold the assumption that knowledge is local and historic (Mingers et al., 2013). Bhaskar (1986) argues that several scientific methodologies could be adopted as long as they offer solutions to the research question(s). In other words, critical realism is tolerant of different research methods and epistemological assumptions, but it also believes "that particular choices should be made based on the nature of the object of the study and what one wants to learn about it" (Sayer, 2000, p. 19).

4.2.4 Justification for choice of Positivist Paradigm

Knowledge of research paradigms is an essential condition in any research journey, especially where the research seeks to generate new knowledge in the sciences—natural, social, and human sciences (McGregor & Murnane, 2010). Previous sections of this chapter shed light on some of the popular paradigms used in communication research. This section presents a justification for the choice of the positivist paradigm for conducting the study.

A major assumption of positivism is the ability of the researcher to adopt a scientific view of observing social behaviour, which permits objective analysis (Travers, 2001). Moreover, research that is conducted in line with the positivist philosophy mostly uses deductive

theorising, which permits the development and testing of hypotheses that could be empirically verified (Babbie, 2005). This study sought to apply an adaptation of the UTUAT model to determine the best predictors of the use of mobile apps for public health communication in that regard. It must be noted, however, that some instances of positivist research could adapt an inductive strategy with "knowledge arrived at through the gathering of facts that provide the basis of laws" (Bryman & Bell, 2007, p. 16). Also, because positivist research is usually quantitative in nature, substantial data are usually needed, as in the case of this study, to analyse complex phenomena (Travers, 2001).

Nonetheless, the positivist paradigm has informed communication research within the context of the use of information systems such as mobile phones for several years. According to Orlikowski and Baroudi (1991), the positivist paradigm dominates the available literature with respect to communication research. More directly, research has also shown that at least four out of five (81%) research papers in information systems research are positivist-inclined (Guba, 1990; Chen & Hirschheim, 2004).

This research expands the existing body of literature by investigating the determinants that impact the utilisation of mobile applications for accessing information on infectious diseases, particularly within the context of the COVID-19 pandemic. Embracing a positivist philosophical stance allows for the systematic exploration of causal connections between the various constructs or variables under investigation, akin to the approach followed in the natural sciences. Specifically, the study had two (2) dependent variables: behavioural intention (BI) and use behaviour (UB). Use behaviour (UB) is defined as the actual use of

mobile apps to access emergency-risk public health information. In the interest of developing the model, seven (7) predictor constructs were identified: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), perceived susceptibility (PS), self-efficacy (SE), and trust. Three (3) moderating factors were: gender, age, and education. This study hypothesised that the four main constructs (PE, EF, SI, and FC) of the UTAUT model, when moderated by gender, age, and education, will have a direct influence on BI. The borrowed constructs of trust, PS, and SE were also predicted to directly influence BI. The other unobserved construct, UB in this study, was hypothesised to be directly influenced by FC and BI.

4.3. Research Methodology

The debate over the best approach to conducting social science research—qualitative or quantitative—is ongoing. Sharp disagreements exist between positivist and constructivist schools of thought (Robson, 2002). The two approaches remain independent and cannot be compatible. That notwithstanding, both methods are approaches to achieving the same objective, though this is done through different techniques and procedures, irrespective of the fact that each research approach possesses different strengths and logic (Maxwell, 2004; Maxwell & Loomis, 2002). It is therefore not surprising that both research approaches employ the phrase "explaining phenomena" in defining their respective research perspectives (Muijs, 2004).

This is an indication that both approaches seek to achieve the same objective. Therefore, the choice of methodology is informed by the research purpose rather than the research paradigm (Cavaye, 1996). Though several research methodology classifications exist, the quantitative

and qualitative approaches remain dominant (Johnson & Onwuegbuzie, 2004; Myers, 1997). The next section of this chapter provides an overview of these methods.

4.3.1. Qualitative Methodology

Qualitative research is the examination of the nature of phenomena, encompassing their qualities, various manifestations, contexts of occurrence, and the perspectives from which they are perceived, while excluding their range, frequency, and place within an objectively determined chain of cause and effect (Philipsen & Vernooij-Dassen, 2007). Qualitative research generally involves data presented as words rather than numbers (Punch, 2013).

Qualitative research is commonly employed in the humanities and social sciences, particularly in fields such as anthropology, sociology, education, health sciences, and history (Fossey et al., 2002). The primary objective of qualitative research is to achieve a comprehensive understanding of social phenomena within their natural settings. This approach relies on the direct experiences of individuals as meaning-makers in their everyday lives, focusing on the reasons behind social phenomena rather than merely describing them (Fossey et al., 2002).

To study human phenomena, qualitative researchers utilize a variety of inquiry systems, including biography, case study, historical analysis, discourse analysis, ethnography, grounded theory, and phenomenology. These methods contrast with the logical and statistical approaches typically used in quantitative research. These methods present detailed descriptions of the data collected among the subjects or participants of the study and therefore presents voluminous real-life data with respect to the people and situations under study (de Vaus, 2014; Leedy & Ormrod, 2014).

4.3.2. Quantitative Methodology

Quantitative methodology refers to the use of numbers to understand various aspects of human behaviour and society. Researchers gather heaps of data, often through surveys or observations, and then analyse them to uncover patterns or relationships (Coghlan & Brydon-Miller, 2014). This method allows for a better understanding of societal dynamics. Tools like questionnaires or experiments are commonly employed to collect this data (Allen, 2017). Quantitative research serves as a fundamental avenue for scholars to delve into the intricacies of social phenomena, including communication patterns. Quantitative researchers are influenced by objectivity and positivist paradigms in their approach to research (Creswell, 2009). The study design makes use of quantitative data. This assumption is affirmed by Straub and Gefen, (2004), who opined that important tools required for quantitative research pertain to statistical tools and software packages because quantitative research emphasises the use of numbers in the collection and analysis of data. This approach is associated with the positivist paradigm (Mingers et al., 2013).

4.3.3. Justification for Quantitative Methodology

Previous sections of this chapter have laid the premise for the choice of a quantitative research methodology as the approach to conducting this research. This is in line with suggestions by Creswell (2009) for the selection of a research approach that is driven by objectivity and positivist paradigms. Moreover, the positivist paradigm has informed much of the research on the use of technology.

The literature shows that at least four out of five (81%) research publications on technology adoption are positivist-inclined (Guba, 1990; Chen & Hirschheim, 2004). According to

Orlikowski and Baroudi (1991), the positivist paradigm dominates the available literature in respect of information systems research, including the adoption and use of information, communication, and technology devices such as mobile phones. This study sought to develop a model that predicts the use of mobile apps in accessing emergency-risk public health information within the context of the COVID-19 outbreak in Ghana. This goal could only be achieved by statistical analysis, therefore situating the study within the quantitative paradigm.

Moreover, the intent to generalise the findings of this study to a greater population beyond the respondents of the study, in line with the positivist paradigm, gives credence to the use of a quantitative approach (Bryman, 2001). Also, the quantitative approach makes it possible to replicate the study. This is made possible using hypothesis testing. This quantitative approach eliminates bias because it is informed by objectively verified scientific guidelines and guarantees anonymity for respondents (Muijs, 2004; Litchman, 2006; Bryman, 2012; Creswell, 2009). It therefore becomes possible to achieve similar results among the same or a similar population (Lichtman, 2013; Shank & Brown, 2007).

Again, the quantitative approach permitted the collection of data from a large sample. According to Tull and Hawkins (1990), data comprising responses from 50 respondents or more is deemed large. One of the most effective and efficient ways of collecting such large amounts of data is through structured questionnaires, which may include closed-ended questions. This approach is possible with quantitative methods. A sample size of 465 respondents was determined for this study.

4.4 Research Purpose

Research is conducted based on a purpose. This could be descriptive, explanatory, or exploratory. This section presents an overview of the three purposes of research.

4.4.1. Exploratory research

Exploratory research is "a form of research that generates initial insights into the nature of an issue and develops questions to be investigated by more extensive studies" (Marlow, 2005, p. 334). Exploratory research often precedes another study that is more detailed. Nonetheless, exploratory research could also be independent, full-scale research (Alston & Bowles, 2003). In exploratory research, large amounts of data are usually gathered to explore new or emerging areas of research, in response to novel research problems, or to explore topics that have little or no literature to gain a high-level appreciation of a phenomenon (Mitchell & Jolley, 2010; Royse, 2011). It must be noted, however, that explorative research is not limited to new concerns only, thus researching a topic to gain an initial understanding (Babbie, 2013; Pierson & Thomas, 2010). Again, explorative purpose is useful for generating more focused hypotheses for additional investigations (Babbie, 2013; Babbie & Mouton, 2010; Royse, 2011).

Qualitative methods are usually employed in collecting data for exploratory studies (Adler & Clark, 2008). Major forms of data collection include focus group discussions, in-depth interviews, and the analysis of secondary data (Babbie, 2010; Struwig & Stead, 2001). Quantitative data in an exploratory approach is usually collected on a need's assessment basis, which focuses on large-scale surveys (Lewis-Beck et al., 2004).

4.4.2. Descriptive research

Descriptive research is conducted to gather information or data through carefully designed procedures to accurately portray the incidence, distribution, and characteristics of a group or situation to, as accurately as possible, portray the distribution or incidence of the characteristics of a group, situation, event, or phenomenon (Babbie, 2010). Descriptive research helps the researcher describe and understand an existing situation, a status, or a relationship. It also helps the researcher better appreciate the general principles between and among phenomena. (Polit et al., 2001).

One common method of descriptive research is a survey where a careful sample is obtained and studied (Marlow, 2005; Rubin & Babbie, 2010). The data in quantitative research are usually presented in graphs, tables, frequency distributions, and scattergrams, among others (Gomm, 2009). Conversely, other researchers (Barker, 2003; Grinnell & Unrau, 2008; Wolcott, 2001) consider descriptive data to be qualitative in the form of narrative interviews, focus groups, and participant observation, which are employed to achieve a deeper appreciation of a phenomenon by describing the setting. It is worthy of note, however, that descriptive studies use either quantitative or qualitative data, or both. However, quantitative data is used when large numbers of participants are under study.

4.4.3. Explanatory research

Explanatory research seeks to understand the underlying causal relationships between and among variables to achieve an understanding of a phenomenon. Unlike exploratory research, which aims to uncover new insights or ideas, explanatory research delves deeper into the reasons behind occurrences, aiming to discern why and how specific situations unfold. This

approach is particularly useful when the problem is well-defined, but the underlying reasons are unclear, thus demanding a thorough explanation (Babbie, 2010). Explanatory research thus makes it possible to predict changes in one phenomenon because of a variation in another variable (Marlow, 2005; Pierson & Thomas, 2010). This explains why events occur, as well as testing or revising theory (Babbie & Mouton, 2010).

Whereas descriptive research focuses on how things are, explanatory research seeks to explain why things are the way they are (Adler & Clark, 2008; Babbie, 2013). Explanatory research could be useful in the evaluation of programmes to determine the impact of the programme on its beneficiaries. Thus, explanatory research places emphasis on the causal relationships between the predictor variable(s) and the dependent variable(s) to determine any possible influence among the dependent variables. Adler and Clark (2008) conclude that explanatory research is deductively inclined and therefore quantitative in nature.

This study sought to model the best predictors of use of mobile apps in accessing emergency public health information among residents of Ghana. The explanatory research paradigm came in handy as the appropriate research purpose for the study because the study proposed several hypotheses based on existing theory that guided the data collection and analysis.

4.5. Research Method

This study adopted survey as the research method. Check and Schutt (2012) define survey research as "the collection of information from a sample of individuals through their responses to questions" (p. 160). In the opinion of Nesbary (1999), survey research is “the process of

collecting representative sample data from a larger population and using the sample to infer attributes of the population" (p. 10). Survey research presents several options to select respondents, gather data, and use many methods of instrumentation. According to McIntyre (1999), "surveys are useful in obtaining information from large samples of the population and well suited for gathering demographic data that describe the composition of the sample" (p. 74).

Moreover, surveys "are inclusive in the types and number of variables that can be studied, (arguably) require minimal investment to develop and administer and are relatively easy for making generalisations" (Bell, 1996, p. 68). Again, "surveys are useful in eliciting information about attitudes that are otherwise difficult to measure using observational techniques" (McIntyre, 1999, p. 75). Also, survey research permits the use of numeric descriptions of the opinions of the population by using a representative sample (Creswell & Clark, 2007). These values, put together, made it preferable to use the survey research strategy to gather the opinion of Ghanaians on their behaviour and attitudes towards using mobile apps to access information on infectious diseases such as COVID-19. Additionally, the survey research approach falls in line with the positivist paradigm (Neuman, 2011), which is the philosophical foundation of this study.

Despite the advantages associated with surveys, they present some limitations, such as sources of error and bias, including sampling error and non-response error, as well as the impact of question wording and format. Survey results could be affected by factors like respondent motivation, availability, and willingness to participate. Additionally, the potential for

stakeholders to misinterpret or misuse survey outcomes can undermine the data's validity and usefulness. To optimize the benefits and mitigate the limitations inherent in the survey method, several practices were implemented. Firstly, the survey instrument underwent pre-deployment testing to ensure face and content validity - relevance, clarity, and conciseness. Secondly, the research instrument was administered ethically, with respondents being informed about the study's benefits and receiving necessary feedback. Most importantly, a thorough and objective data analysis was conducted using structural equation modelling techniques to address errors and biases effectively.

4.6. Study Area

The Republic of Ghana is bordered to the south by the Gulf of Guinea and the Atlantic Ocean. The nation shares borders with the Ivory Coast to the west, Burkina Faso to the north, and Togo to the east (Jackson et al., 2001). Ghana covers an area of 238,535 km2 and has 31 million people (Berry & Library of Congress, 1995). The nation is governed by 16 administrative regions that are subdivided into 275 districts. According to the Ghana Statistical Service (GSS, 2021), Ghana’s population has grown fivefold since its independence in 1957 (GSS, 2021).

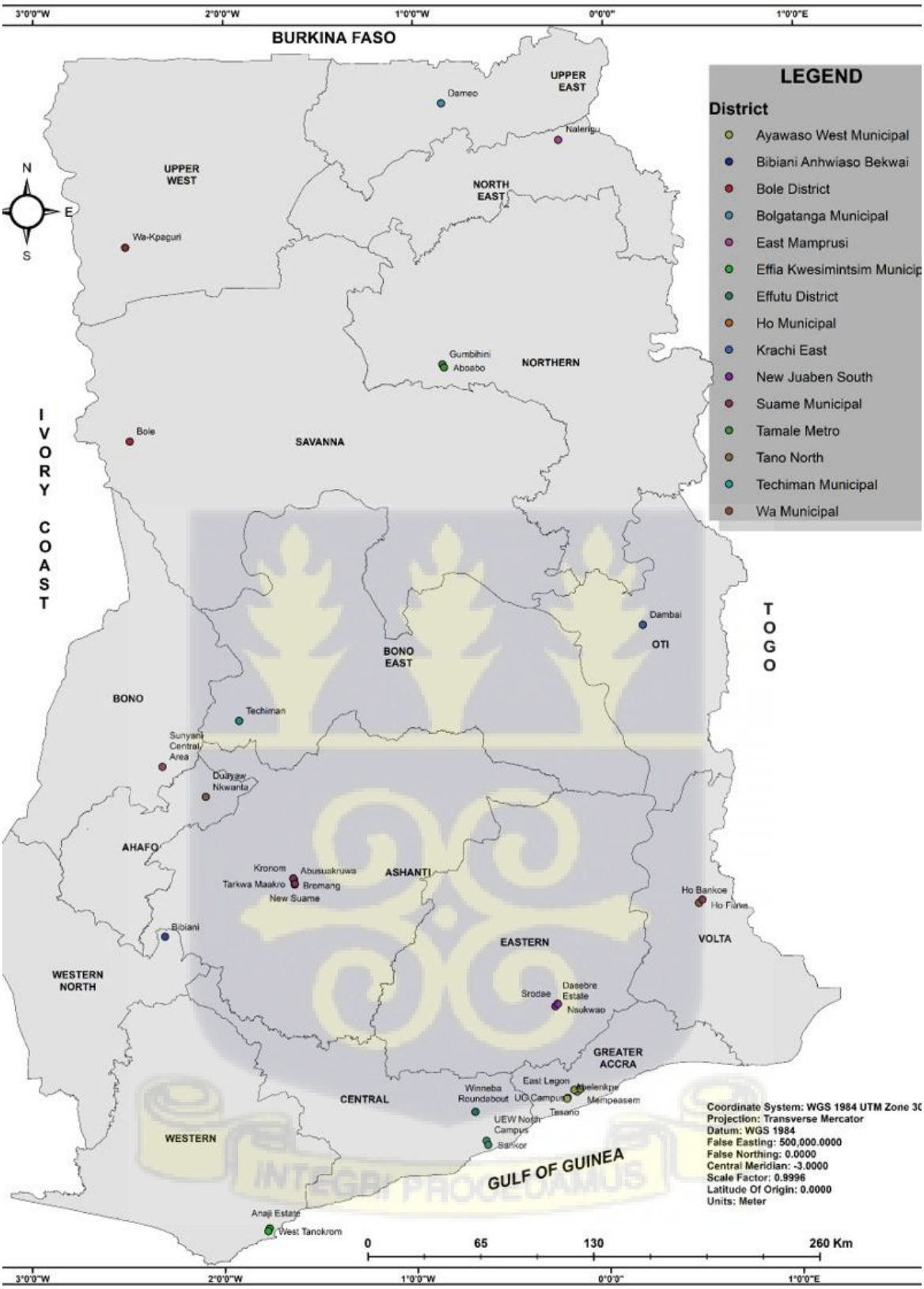

Figure 9: Representative Map of points of data collection across Ghana
Source: Field data (2022)

According to the Ghana Statistical Service, as of September 2021, Ghana's population stood at 30,792,608, a marginal majority of whom are females (50.7%) compared to males (49.3%) (GSS, 2021). More than one-third of people in Ghana live in the capital region of Ghana, the Greater Accra Region, or the second capital of the nation, the Ashanti Region, both with a population of 5.4 million (GSS, 2021). Close to 40 percent (38.2) of Ghana's population are young people, aged 15 to 35, the majority of whom live in urban areas (60.5%) compared to those living in rural areas, with females outnumbering males in urban communities by 5% (GSS, 2021).

Ghana was the first country in South-Saharan Africa to launch a cellular mobile network in 1992. In terms of internet connectivity, Ghana was one of the first countries in Africa to access the internet and introduce Asymmetric Digital Subscriber Line (ADSL) broadband services (Ghanaweb, 2015). Ghana placed 112nd in the Global Innovation Index in 2021 (British Broadcasting Cooperation News, 2012). The nation had previously been ranked 106th in 2019 (British Broadcasting Cooperation News, 2012). From January to December 2021, Ghana's voice subscription was 40,454,073, while mobile data subscriptions recorded 23,414,527 (National Communications Authority, 2022).

According to the Ghana Statistical Service, close to a third (30.2%) of residents aged 6 and older cannot read or write in any language. This is higher among females (34.4%) compared to males (25.9%) (GSS, 2021). Two in every five (40.7%) residents of Ghana aged 18 and older who are in school are at the tertiary level. More than 10 percent (13.0%) of residents who have completed formal education have attained a tertiary-level education (GSS, 2021).

The majority (82.0%) of Ghanaian residents aged 20 and older own a functional mobile phone (GSS, 2021). Close to half of the handsets are either a basic phone (47.9%) or a smartphone (46.1%), with a few (12.8%) feature phones. Close to two in every five (39.7%) residents of Ghana aged five years and older have knowledge of the internet (GSS, 2021).

4.7. Sample Size and Sampling

This section presents the sampling techniques adopted in selecting the sample for the study. The exclusion and inclusion criteria used are also described in the section. This study sought to develop a model that predicts the use of mobile apps for emergency risk communication within the context of the emergence of the COVID-19 outbreak in Ghana. The population of the study was residents of Ghana who use functional mobile device(s) (phones or tablets) that support the use of mobile apps.

The study adopted a probability sampling approach to identify respondents for the study. Specifically, a proportionate stratified sampling approach was used. In stratified random sampling, the study population is first divided into homogeneous groups (strata) based on some characteristic or variable. Thereafter, a representative sample is obtained by randomly sampling a desired number from each group and bulking the selected units. Equal numbers may be taken from each stratum, or numbers may be selected to reflect the proportion in which they appear in the population. The latter procedure is known as proportionate stratified sampling. The major advantage of stratified sampling is that it guarantees the representation of defined groups in the population (Taherdoost, 2016).

The Ghana 2021 Population and Housing Census (Ghana Statistical Service, 2022) indicates that 26,210,872 residents of Ghana owned mobile phones as of 2021. This figure was approximated as the population of mobile phone users in Ghana. The sample size of this study was determined using considerations for the determination of sample size suggested by Krejcie and Morgan (1970). Krejcie and Morgan (1970) posit that for a population of 1,000,000 or higher, a minimum sample size of 384 is deemed appropriate. Krejcie and Morgan's (1970) mathematical formula for the determination of an appropriate sample size is given as:

$S = X2\ NP(1-P) \div d2(N-1)+X2P(1-P)$

Where:

S = required sample size

X2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N is the population size.

P = the population proportion assumed to be 0.50 since this would provide the maximum sample

d is the degree of accuracy expressed as a proportion of 0.5.

This leads to a minimum sample size of 384; however, a total of 465 respondents were sampled for the study based on the criteria for selecting respondents (see Section 6.11). Respondents to the survey included individual residents of Ghana aged 18 years or older as of January 1, 2020, and who used a functional mobile phone that supports the use of mobile apps during the period from January 1, 2020, to December 31, 2022. While there is no direct

legislative provision for online activity by children in Ghana, the Children's Act, 1998, of Ghana prescribes that the processing of data relating to a child (under 18 years) is prohibited unless under special circumstances such as health and education. Therefore, respondents aged below the age of 18 were not qualified to respond to the study.

4.8. Selection of participants for the study

The study adopted a two-stage stratified sampling approach. Table 2 presents a summary of the distribution of the proportionate sampling approach used. Using the enumeration areas (EAs) designed by the Ghana Statistical Service for the nation's 2021 population and housing census, data were stratified into the 16 administrative regions of Ghana. A national representative sample comprising 31 EAs was randomly chosen from the entire nation to constitute the primary sampling units (PSUs). This was done in a proportionate manner using the regional distribution of mobile device (mobile phone and tablet) users in Ghana, as shown in Table 2. Thus, the percentage contribution of each region with respect to mobile device users (phones and tablets) was used in determining the number of EAs to be selected per region in relation to the sample size of 465.

Specifically, regions with a percentage contribution of less than 5% were assigned one enumeration area. Those with a percentage contribution of 5% to 7% were assigned two (2) enumeration areas, while regions with a percentage contribution of 8% to 10% were assigned three (3) enumeration areas. Regions contributing more than 10% of mobile users were assigned five (5) enumeration areas.

Subsequently, secondary data from all the listed households within the selected PSUs constituted the secondary level sampling units (SSUs). Each enumeration area had a sampling frame consisting of listed structures in the area.

Table 2: Summary distribution of respondents from each region

No.	Region	Population of smart phone users (N)	Percent %	No. of EAs Selected	Sample (n)
1	Greater Accra	4,766,249	18%	5	85
2	Ashanti	4,657,976	18%	5	83
3	Eastern	2,526,584	10%	3	45
4	Central	2,452,182	9%	3	44
5	Northern	1,828,512	7%	2	33
6	Western	1,764,583	7%	2	31
7	Volta	1,433,518	5%	2	25
8	Upper East	1,097,541	4%	1	19
9	Bono	1,036,053	4%	1	18
10	Bono East	1,002,548	4%	1	18
11	Upper West	754,267	3%	1	13
12	Western North	749,168	3%	1	13
13	Oti	616,851	2%	1	11
14	North East	522,717	2%	1	9
15	Savannah	521,415	2%	1	9
16	Ahafo	480,708	2%	1	9
		26,210,872	**100%**	**31**	**465**

Source: Ghana Statistical Service (2022)

Based on the GSS data, a minimum of 20 structures were randomly sampled using Microsoft Excel as potential respondents. The first fifteen structures in each of the sampled enumeration area constituted the sample for data collection. One qualified respondent was selected from a household within the sampled structures using the replacement method. Where there was more than one interested qualified respondent within a selected structure, the lottery method was

used to select one respondent in that structure. Where a structure could not avail any qualified respondent, that structure was replaced with the next in line until 15 qualified respondents had been interviewed in each enumeration area, constituting a total sample of 465 households nationwide.

4.9. Data Types and Sources

The substantive data analysed to reach the conclusion of the study were gathered from primary sources. The findings observed and post-analyses of the primary data were compared with secondary sources in related studies. The primary data was gathered by means of a questionnaire.

4.10. Ethical Approval and Data Collection

Prior to data collection, a request for ethical clearance was submitted to the Ethics Committee for Humanities, Institute of Statistical, Social, and Economic Research (ISSER), University of Ghana. Approval for the study was granted on August 1, 2022, with reference number ECH 345/21-22 (see Appendix A). All respondents consented to participate in the study by physically signing the informed consent form (see Appendix B) after it had been read to them in a language they could understand.

The data for this research was obtained from residents of Ghana within the timeframe spanning January 2020 to December 2022. Eligible participants were required to be 18 years of age or older as of January 1, 2020, possess prior experience with mobile applications, and consent to participate in the study. Data was collected by means of Kobo Toolbox, an open-

source Android app for collecting survey data. The data collection was cross-sectional, in that it was collected at one point in time—within eight consecutive days. This was useful in producing a snapshot of the population with respect to the factors affecting the use of mobile apps to access information on COVID-19 among residents of Ghana. Above all, to facilitate the collection of relevant data that will provide evidence to respond to the objectives of the study (Creswell & Clark, 2007), three main distinct stages of research design and data collection were used. These were: instrument design; selection of an appropriate sample size; and selection of only qualified participants as defined in the inclusion criteria as respondents.

4.11. Research Instrument

In line with the positivist paradigm and quantitative research approach adopted by this study, questionnaire was considered the best suitable tool for collecting data for the study. The use of a questionnaire enabled the researcher to gather the opinions of 455 respondents. The questionnaire was divided into five sections. These are: introduction and privacy statement; demographic information of respondents; experience of use of mobile apps; extent of use of mobile apps; measurement constructs of predictors of use of mobile apps for public health communication. The scales of measurement for the constructs of predictors of mobile app usage were adapted from Venkatesh et al. (2003). The items on the questionnaire were predominantly closed-ended questions. The variables of research interest and how they were measured in the study are explained below.

4.12.1. Performance Expectancy (PE):

Performance expectancy in the context of this study is defined as an individual's belief that

mobile apps provide pertinent information on COVID-19. Statements 16.1 to 16.5 of the research instrument estimated the PE construct on a five-point Likert-type scale where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.2. Effort Expectancy (EE):

Effort expectancy in the context of this study is defined as the ease with which users navigate mobile apps to access information on COVID-19 on their phones. Statements 17.1 to 17.5 of the research instrument estimated the EE construct on a five-point Likert-type scale where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.3. Social Influence (SI):

Social influence is defined as the extent to which an individual perceives family, friends, peers, and significant others who influence his/her use of mobile apps to access information on COVID-19. Statements 18.1 to 18.5 of the research instrument estimated the SI construct on a five-point Likert-type scale where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.4. Facilitating Conditions (FC):

Facilitating conditions are defined in this study as the extent to which an individual believes he or she has access to a smart phone, mobile network, and other relevant resources to support the use of mobile apps. Statements 19.1 to 19.4 of the research instrument estimated the FC construct on a five-point Likert-type scale where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.6. Behavioural Intention (BI):

BI in the context of this study represents the willingness or behavioural intention of users to use mobile apps purposefully designed to share information on COVID-19. Statements 20.1 to 20.4 of the research instrument estimated BI construct on a five-point Likert-type scale where one (1) signifies "strongly disagree" and five (5) implies "strongly agree."

4.12.7. Trust:

Trust is defined in this study as the belief that mobile apps developed purposely for sharing information on COVID-19 are genuine and offer reliable information on the virus. Statements 21.1 to 21.3 of the research estimated the trust construct on a five-point Likert-type scale where one (1) signifies "strongly disagree" and five (5) implies "strongly agree."

4.12.8. Self-Efficacy (SE):

Self-efficacy is defined in this study as an individual's perception of his or her ability to perform COVID-19 response behaviours such as wearing nose masks and observing social distancing. Statements 22.1 to 22.5 of the research instrument estimated the SE construct on a five-point Likert-type scale where one (1) signifies "strongly disagree" and five (5) implies "strongly agree."

4.12.9. Perceived Susceptibility (PS):

Perceived susceptibility in the context of this study is defined as the subjective assessment of an individual in relation to the risk of contracting the COVID-19 virus. Statements 23.1 to 23.5 of the research instrument estimated the PS construct on a five-point Likert-type scale

where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.10. Behavioural Use (BU):

Behavioural use is defined in this study as the actual use of the mobile app to access information about COVID-19. Statements 24.1 to 24.4 of the research instrument estimated the BU construct on a five-point Likert-type scale where one (1) signifies “strongly disagree” and five (5) implies “strongly agree.”

4.12.11. Demographics

This refers to gender, age of respondents as of their last birthday, and highest educational status attained by respondents. These variables are reported in the literature to influence technology adoption. Also, data on other variables such as ethnicity, religion, region of residence, disability status of respondents, employment status, and marital status were collected for analysis. Questions 1–10 collected information on these variables. Table 3 provides a summary of the measurement constructs and their corresponding items used in the study.

Table 3: Constructs and their respective measuring items

Construct	Definition	Measurement Items
Performance Expectancy (PE)	An individual’s belief that mobile apps provide pertinent information on COVID-19.	PE1. I find mobile apps useful in my daily life PE2. Using mobile apps helps me get information on COVID-19 more quickly PE3. Using mobile apps to access information on COVID-19 helps me to stay safe PE4. I get factual information on COVID-19 on my mobile apps
Effort Expectancy	The ease with which users navigate mobile apps to	EE1. Learning how to use mobile apps is easy for me

Construct	Definition	Measurement Items
(EE)	access information on COVID-19 on their phones.	EE2. My interaction with mobile apps is clear and understandable. EE3. I find it easy using mobile apps to access information on COVID-19
Social Influence (SI)	The extent to which an individual perceives family, friends, peers, and significant others who influence his/her use of mobile apps to access information on COVID-19.	SI1. People who are important to me think that I should use mobile apps to access information on COVID-19 SI2. People who influence my behaviour think that I should use mobile apps to access information on COVID-19 SI3. People whose opinion I value, prefer that I use mobile apps to access information on COVID-19.
Facilitating Conditions (FC)	The extent to which an individual believes s/he has access to a smart phone, mobile network, and other relevant resources to support the use mobile apps.	FC1. I have a smart phone that supports the use mobile apps. FC2. The network in my community supports the use mobile apps. FC3. I have the knowledge necessary to use mobile apps.
Behavioural Intention (BI)	The willingness or behavioural intention of users to use mobile apps purposefully designed to share information on COVID-19.	BI1. I intend to use mobile apps in the future to access information on COVID-19 and other future disease outbreaks. BI2. I will always try to use mobile apps in my daily life to access information on COVID-19 and other future disease outbreaks. BI3. I plan to use mobile apps frequently to access information on COVID-19 and other future disease outbreaks.
Trust	The belief that mobile apps developed purposely for sharing information on COVID-19 are genuine and offer or reliable information on the virus.	T1. I belief that mobile apps facilitate genuine information on COVID-19 T2. Mobile apps are designed to ensure that information on COVID-19 are genuine
Self-Efficacy (SE)	An individual's perception of his or ability to perform COVID-19 response behaviours such as	SE1. I understand the COVID-19 information I receive from the mobile apps I use SE2. I am able to perform the prescribed behaviours the mobile apps ask me to do to

Construct	Definition	Measurement Items
	wearing of nose masks and observing social distancing.	avoid COVID-19 SE3. I am able to use the help functions of mobile apps whenever I need them for COVID-19 information
Perceived Susceptibility (PS)	The subjective assessment of an individual in relation to the risk of contracting the COVID-19 virus.	PS1. I believe that the COVID-19 virus can spread from one person to another PS2. I believe that I can easily be infected by the COVID-19 virus PS3. I believe that the COVID-19 is a killer disease
Use Behaviour (UB)	Actual use of mobile apps to access information of COVID-19.	UB1: I use mobile apps to share information on COVID-19 UB2: Using mobile apps to share information on COVID-19 is a pleasant experience UB3: I currently use mobile apps to access information on COVID-19 UB4: I spend a lot of time using mobile apps to access information on COVID-19.

4.14. Measure assessment

This section presents information on measures taken to ensure that the research instrument was not only reliable but also valid. The test procedures and results are provided and discussed in Chapter 6 as part of the results and discussion of this thesis.

4.14.1 Reliability

The extent to which a research instrument repeatedly produces the same results for different measurements of a variable under similar or the same circumstances is known as reliability in research (Hair et al., 2006). Thus, reliability measures the steadfastness of the intended measurement (Ghauri & Gronhaug, 2005). Several tests exist for the assessment of the reliability of research instruments. These include: the test-retest, which involves repeating the

same test over time; the interrater test, where the same test is performed by different people; the parallel forms test, which involves the use of independent versions of a test designed to be similar; and the internal consistency test, which places emphasis on the individual items of the variable to be tested (Malhotra & Birks, 2007).

Nonetheless, the popular means by which the reliability of an instrument is assessed is by testing the instrument's internal consistency (Hair et al., 2006). One method of measuring internal consistency is the split-half reliability test, commonly assessed using the coefficient alpha value and the Cronbach alpha values (Malhotra & Birks, 2007). The Cronbach alpha reliability test as well as the composite reliability test were employed to test for the consistency of the domains measured on the Likert scale.

4.14.2 Validity

Validity measures how well a dataset represents the relevant field of study. In essence, it is the ability of the research instrument to measure what it intends to measure (Hair et al., 2006). This study employed face validity, content validity, and construct validity (Malhotra & Birks, 2007). Face validity was employed to ascertain the relevance, clarity, and reasonableness of the question items on the instrument through a pre-test and a focus group discussion with the research assistants of the study.

The content validity of the primary research instrument (the questionnaire) was ensured by means of a review by research supervisors, who judged the adequacy and relevance of the items as well as the appropriateness of the data on the instruments in achieving the objectives

of the study. Construct validity was also conducted to determine the extent to which the measurements on the questionnaire accurately represented the constructs. The UTAUT model constructs have been studied for a long time and have presented a rigorous first step in assessing construct validity. Above all, a confirmatory factor analysis (CFA) was conducted to assess the relationships between indicators and constructs. The statistical processes and outputs of the CFA are provided in the analysis and findings chapter (Six).

4.15. Training and Administration of Research Instrument

Sixteen (16) field staff, all of whom had a minimum qualification of Higher National Diploma (HND) and previous experience in collecting field data, including participation in the 2021 population and housing census in Ghana, were recruited and trained as research assistants for the study. A two-day virtual training was organised for the research assistants in December 2022, prior to the field data collection.

The research assistants were trained in interviewing techniques and the constructs and definitions of the survey instrument. The approaches employed for the training included: PowerPoint presentations; mock interviews, and role plays; as well as field practice with the research questionnaire. The use of the kobocollect platform for data collection facilitated an efficient and effective process enabling the collection of data across the country within a relative shorter time. The actual field data collection was conducted over eight consecutive days, from the 14th to the 21st of December 2022. The electronic questionnaire was administered by the research assistants after they had read the content of the consent form to respondents and later thumb-printed or appended their signature to the consent form.

The use of the Kobocollect platform also provided a virtual real time monitoring of the field data collection by the researcher, irrespective of his physical location at any point in time. The monitoring exercises included virtual tracking of geo points from which data were collected via the dashboard of the Kobo Collect toolbox. The researcher also embarked on physical visits to some field enumerators to observe and participate in the field data collection. Prior to the field data collection, the questionnaire was pre-tested on December 5 and 6, 2022. The pre-test was useful in the revision of some double-barrelled questions as well as the logistical arrangements required for the main survey. The use of the replacement method ensured that there was a relatively high response rate. Out of the total 465 administered, a total of 455 valid responses were retrieved from the field data collection, constituting a response rate of 97.8%. Figure 10 presents a heat map depicting the distribution and relative amount of data collected across the study site (Ghana).

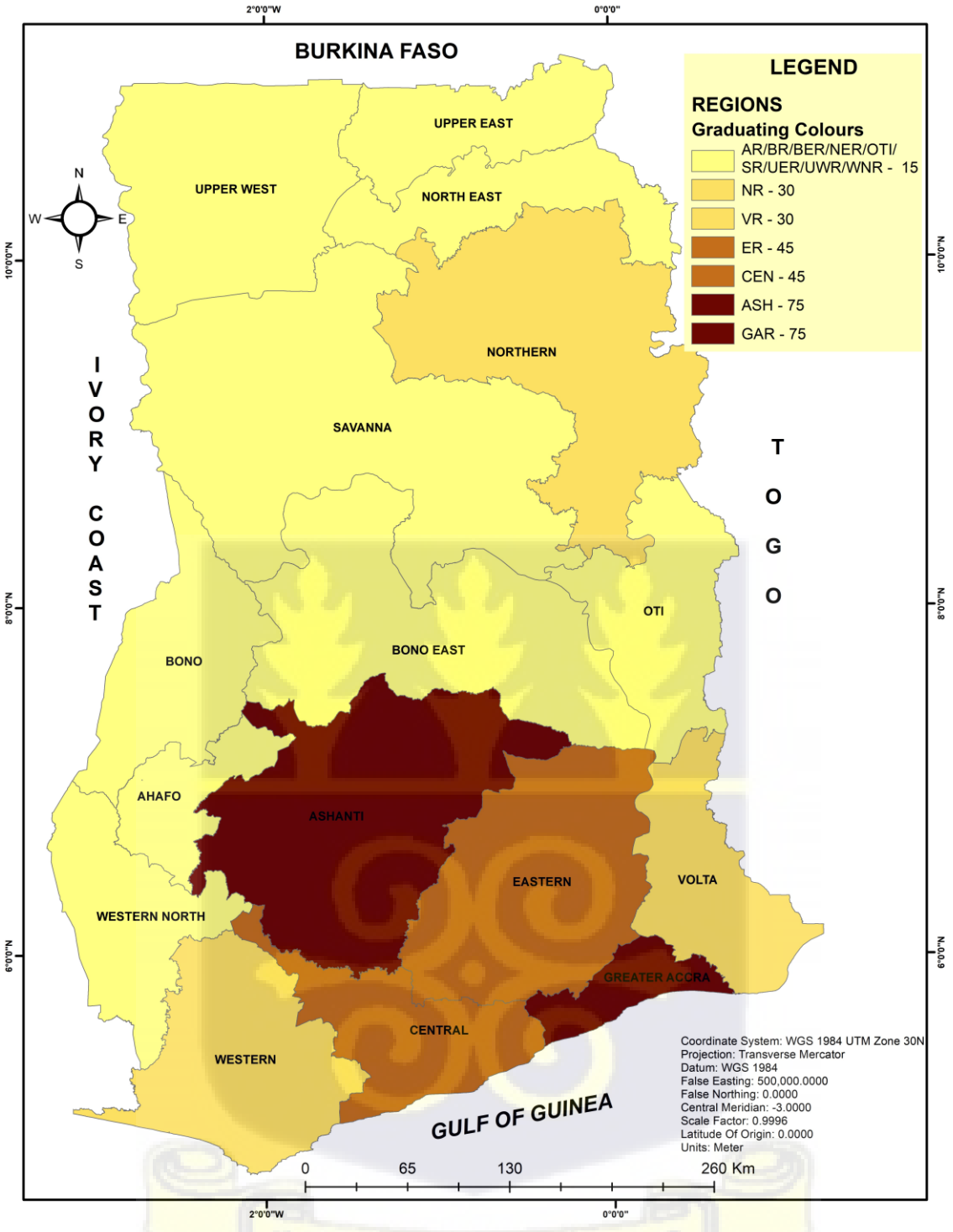

Figure 10: Heat map depicting the distribution and depth of data collection

4.16. Data Analyses

Data analysis involves cleansing, modifying, and modelling data with the aim of generating relevant information to arrive at conclusions and inform decision-making (Kudyba, 2014). In the case of quantitative studies, the process usually involves a systematic application of statistical techniques to represent the meaning of data. The essence is to present an opportunity to draw inferences from the data and differentiate the subject under study from the statistical fluctuations inherent in the data (Shamoo & Resnik, 2003). Irwin and Stafford (2016) recommend an analytical plan for any survey. The analytical plan serves as the basic unit for statistical scrutiny of the sampled responses received, maps the research constructs to the topics of interest, proposes the type of analysis to be used as well as its presentation of results, and ensures that the results of the study answer the research questions (Irwin & Stafford, 2016).

This study collated the data into variables presented on the research instrument as informed by existing literature and in line with the research questions. The data was probed, cleaned, and modelled into telling feedback that provided appropriate responses to the research questions, as suggested by Clark and Creswell (2011). The primary data was gathered by means of the Kobocollect platform, transferred, and computed into the IBM SPSS Amos software version 23 for Windows 11 for analysis. The data was coded, recoded where necessary, and analysed using the same software. Frequency distribution tables were used to detect any possible coding errors prior to analyses, as recommended by Berkowitz (1997).

Structural Equation Modelling (SEM) was used to explore relationships among the study

variables (Hair et al., 2006). Shah and Goldstein (2005) define SEM as a technique to "specify, estimate, and evaluate models of linear relationships among a set of observed variables in terms of a generally smaller number of unobserved variables" (p. 149). The SEM technique was adopted to examine and measure the proposed or hypothesised relationships among the constructs of the study for the following reasons:

SEM comprises several multiplex regression models where individual constructs have the propensity to serve as predictor variables at a specific instance and, in another instance, as latent or dependent variables. In the opinion of Weston and Gore (2006), these characteristics of SEM render it like other forms of quantitative methods such as factor analysis, multivariate analysis of variance (MANOVA), multiple regression, analysis of variance (ANOVA), regression, etc. (Weston & Gore, 2006). The added advantage of SEM is that the technique permits the simultaneous evaluation of more than one regression model. It is also more rigorous for detecting errors in data that exaggerate path coefficients.

Moreover, SEM is best suited for confirmatory modelling and allows for empirical interpretation of causality under circumstances where the hypothesised paths or associations have significant theoretical bases (Hair et al., 2006; Kline, 2005). Reisinger and Turner (1999) assert that "all aspects of SEM modelling must be directed by theory, which is critical for model development and modification" (p. 72). Thus, a SEM model must be informed by appropriate constructs developed from existing theory, which in turn serves as the rationale for the proposed hypotheses. SEM therefore becomes the best technique available to assess the fidelity of the proposed causal relationships in a study that is informed by theory (Tobbin

& Kuwornu, 2011; Toma et al., 2011).

Again, SEM is useful for accessing measurement errors. The integration of confirmatory factor analysis (CFA) in SEM analysis makes it possible for SEM to incorporate latent or unobserved variables into the analysis. This accounts for measurement errors and the composite reliability of estimates (Hair et al., 1998). Finally, SEM has interactive graphical features that facilitate easy interpretation of the observed relationships among the variables tested.

4.18 Summary

This chapter provided a comprehensive account of the major research approach option employed. Arguments for using a quantitative approach were advanced, and a justification for the positivist philosophy that informed the method was provided. The chapter also described how data was collected using a questionnaire, as well as the validity and reliability analyses used to ensure data quality assurance. The chapter provided information on the study's population, the proportionate stratified sampling technique employed, and the 465-sample size used in the analysis. The collected primary data was analysed using structural equation modelling. The chapter also included a description of the latent variables developed for the study. In chapter seven, which follows, there is a discussion of the analysis and findings from the data collected.

CHAPTER FIVE

ANALYSIS AND FINDINGS

5.1 INTRODUCTION

Chapter five provides details of how the proposed research model was assessed. The analyses presented in this chapter is organised into three sections. The first part describes the demographic characteristics of the respondents. The second part assessed the extent to which respondents used mobile apps to access information on COVID-19. A comparative analysis of use of mobile apps to access information on COVID-19 during the peak of the pandemic and after the peak of the pandemic is also provided in this section.

The third part examined the research model. Structural Equation Modelling was employed to test the model fit and validity based on recommended thresholds. Also presented in the third section is the analysis of the research hypotheses. The moderating influences of gender, age and education were also analysed.

5.3. Demographic Profile of Respondents

This section provides a descriptive profile of the subjects of the research. This was helpful in presenting a fair appreciation of the representation of the sample in respect of the population of mobile app users in Ghana. Presented in Table 4 are the frequency distribution and percentage representations of all the demographic variables, including those that were used in testing for the best predictors of use of mobile apps to access information on COVID-19 among respondents.

Respondents spread across the 16 regions of Ghana. About a third (31.6%) of the respondents lived in either the Greater Accra region (15.6%) or the Ashanti region (16%) of Ghana. The respondents were predominantly (98.7%) Ghanaians, majority of who are Akan (52.1%). Other dominant ethnic groups include Ewe (14.1%) and Mole-Dagbon (11.4%). The respondents were aged from 18 to 72 years, a greater majority (79.5%) of who were aged 40 or younger, with approximately half (49.6%) aged 30 or younger. There were more (51%) females compared to males (49%). About half (49.9%) of the respondents were single while close to that number (44.6%) were married.

All the respondents had a minimum of primary level education, a greater majority (70%) of who had a minimum of secondary level education. The respondents were mostly (99.2%) religious with Christian majority (79.2%) followed by Islam (19.8%). Few (3.7%) of the respondents had at least one form of disability. These include mobility such as walking short distances or climbing stairs without aid (1.1%); dexterity for lifting and carrying objects (1.6%); total blindness or inability to see without aid (1.7%); and mental health (1.7%).

Less than half (45.9%) of the respondents were employed. The forms of employment are basically in civil or public sector (13.4%); private sector (15,2%); or self-employment (16.9%). At least two out of every five (44.9%) of the respondents were unemployed, as of the time of data collection, almost all that number (95.9%) were looking for work. Table 4 presents a summary of the background characteristics of respondents.

Table 4: Demographic Profile of Respondents

Variable	Categories	Frequency (N=455)	Percent (%)
Region of residence			
	Ahafo	15	3.3
	Ashanti	73	16
	Bono	15	3.3
	Bono East	15	3.3
	Central	45	9.9
	Eastern	43	9.5
	Greater Accra	71	15.6
	North East	15	3.3
	Northern	29	6.4
	Oti	15	3.3
	Savanna	15	3.3
	Upper East	15	3.3
	Upper West	15	3.3
	Volta	29	6.4
	Western	30	6.6
	Western North	15	3.3
Age			
	18-20	53	11.6
	21-25	81	17.8
	26-30	92	20.2
	31-35	64	14.1
	36-40	72	15.8
	41-45	38	8.4
	46-50	22	4.8
	51-55	17	3.7
	56-60	9	2
	61-65	5	1.1
	66+	2	0.4
Gender			
	Female	232	51
	Male	223	49
Nationality			
	Ghanaian	449	98.7
	Non-Ghanaian	6	1.3
Marital Status			
	Divorced	7	1.5
	Married	203	44.6
	Separated	4	0.9
	Single	227	49.9
	Widowed	14	3.1

Variable	Categories	Frequency (N=455)	Percent (%)
Highest Educational Level	Diploma	68	14.9
	HND/Degree	93	20.4
	JHS/Middle School	96	21.1
	Postgraduate	17	3.7
	Primary	23	5.1
	SHS/Technical/Vocational	158	34.7
Religion			
	Catholic	71	15.6
	Islam	90	19.8
	No Religion	4	0.9
	Other Religion	1	0.2
	Other Christian	64	14.1
	Pentecostal/Charismatic	190	41.8
	Protestant	35	7.7
Employment Status			
	Apprentice	28	6.2
	NGO Sector employed	2	0.4
	Private Sector employed	69	15.2
	Public/Civil Service employed	61	13.4
	Unemployed, looking for work	196	43.1
	Unemployed, not looking for work	8	1.8
	Retired	14	3.1
	Self employed	77	16.9
Ethnic Background			
	Akan	237	52.1
	Ewe	64	14.1
	Ga-Dangme	22	4.8
	Grusi	16	3.5
	Guan	24	5.3
	Gurma	9	2
	Kusaasi	11	2.4
	Mole-Dagbon	52	11.4
	Other	20	4.4
Disability Status			
	No	438	96.3
	Yes	17	3.7

Source: Field data, 2022

5.5 Measure analysis

This section of the chapter describes the statistical tools and approaches used in assessing the quality of the study data, as well as the determination of the data's accuracy and the identification of any possible sources of error.

5.5.1. Descriptive Statistics and Tests of Normality

This section of the chapter details the process of validating the constructs of the study and the analysis of the extent to which the study constructs answer research questions one and two. Thus, the extent to which performance expectancy, effort expectancy, social influence, facilitating conditions, perceived susceptibility, self-efficacy, and trust influence behavioural intention to use mobile apps in accessing information on infectious diseases like COVID-19. The variables and scale items measuring the constructs of use behaviour, behavioural intention, performance expectation, effort expectation, social influence, facilitating conditions, perceived susceptibility, Self-efficacy, and trust were subjected to a test of normality as indicated earlier using skewness and kurtosis.

The test results indicate that the dataset had a normal distribution, as shown in Table 5. Nonetheless, the study conducted measures of central tendencies such as means and standard deviation tests to aid analysis. Table 6 displays the descriptive statistics of the relevant variables covered by the research questionnaire and their respective test values for skewness and kurtosis.

Table 5: Descriptive Statistics and Test of Normality of Variables

Scale Item	Code	Mean	Std. Dev.	Skewness	Kurtosis
Use Behaviour					
I use mobile apps to share information on COVID-19	**UB1**	3.558	1.249	-.637	-.618
Using mobile apps to share information on COVID-19 is a pleasant experience	**UB2**	3.486	1.114	-.525	-.335
I currently use mobile apps to access information on COVID-19	**UB3**	2.563	1.284	.281	-1.167
I spend a lot of time using mobile apps to access information on COVID-19	**UB4**	2.174	1.116	.771	-.244
Behavioural Intention					
I intend to use mobile apps in the future to access information on COVID-19 and other future disease outbreaks	**BI1**	3.840	1.151	-.946	.148
I will always try to use mobile apps in my daily life to access information on COVID-19 and other future disease outbreaks	**BI2**	3.730	1.155	-.854	.009
I plan to use mobile apps frequently to access information on COVID-19 and other future disease outbreaks	**BI3**	3.545	1.206	-.628	-.449
Performance Expectancy					
I find mobile apps useful in my daily life	**PE1**	4.268	1.065	-1.682	2.346
Using mobile apps helps me get information on COVID-19 more quickly	**PE2**	4.059	1.116	-1.302	1.098
Using mobile apps to access information on COVID-19 helps me to stay safe	**PE3**	3.947	1.117	-1.066	.550
I get factual information on COVID-19 on my mobile apps	**PE4**	3.624	1.199	-.753	-.203
Effort Expectancy					
Learning how to use mobile apps is easy for me	**EE1**	3.985	1.169	-1.091	.311
My interaction with mobile apps is clear and understandable	**EE2**	3.919	1.132	-.965	.153
I find it easy using mobile apps to access information on COVID-19	**EE3**	3.725	1.188	-.746	-.316
Social Influence					
People who are important to me think that I should use mobile apps to access information on COVID-19	**SI1**	3.622	1.173	-.645	-.437

Scale Item	Code	Mean	Std. Dev.	Skewness	Kurtosis
People who influence my behaviour think that I should use mobile apps to access information on COVID-19	**SI2**	3.560	1.174	-.576	-.558
People whose opinion I value, prefer that I use mobile apps to access information on COVID-19	**SI3**	3.426	1.220	-.538	-.632
Facilitating Conditions					
I have a smart phone that supports the use mobile apps	**FC1**	4.259	1.059	-1.784	2.778
The network in my community supports the use mobile apps	**FC2**	4.279	0.922	-1.464	2.031
I have the knowledge necessary to use mobile apps	**FC3**	4.046	1.043	-1.215	1.104
Perceived Susceptibility					
I believe that the COVID-19 virus can spread from one person to another	**PS1**	4.257	1.100	-1.841	2.893
I believe that I can easily be infected by the COVID-19 virus	**PS2**	2.143	1.373	.490	-1.617
I believe that the COVID-19 is a killer disease	**PS3**	4.334	0.981	-1.960	3.969
Self-Efficacy					
I understand the COVID-19 information I receive from the mobile apps I use	**SE1**	3.897	1.047	-1.051	.750
I am able to perform the prescribed behaviours the mobile apps ask me to do to avoid COVID-19	**SE2**	3.807	1.019	-.774	.140
I am able to use the help functions of mobile apps whenever I need them for COVID-19 information	**SE3**	3.607	1.131	-.496	-.581
Trust					
I belief that mobile apps facilitate genuine information on COVID-19	**TR1**	3.804	1.070	-.666	-.224
Mobile apps are designed to ensure that information on COVID-19 is genuine	**TR2**	3.141	1.183	.047	-.970
Total Valid Responses (N) = 455; Missing = 0 for all variables presented.					

Source: Field data, 2022

The means of the observed variables ranged from 2.143 to 4.334. The standard deviation values also ranged from 0.922 to 1.373. This shows a normally distributed set of data.

The values of skewness and kurtosis represented in the data were within the acceptable threshold of -3 to 3 for skewness and -10 to 10 for kurtosis (Brown, 2006).

5.5.2. Confirmatory Factor Analysis

The measurement model is a crucial tool for determining whether a hypothesised model is viable for use in subsequent research when using structural equation modelling (SEM) to analyse data. The three primary methods used for model assessment are exploratory factor analysis (EFA), confirmatory factor analysis (EFA), or a combination of the two, also known as the hybrid approach, as suggested by Ahire and Devaraj (2001). The exploratory factor analysis approach can be used to extract components without knowing the count of predictors that make up the observed variable beforehand and is more useful for model assessment than the other two approaches.

However, using confirmatory factor analysis gives the researcher knowledge about the count of predictors in the collection of variables as well as the factors that each item loads heavily on before results are computed (Hair et al., 2006). The employment of CFA empowers researchers to validate or potentially disprove an established theory. It could be argued that CFA provides a fit assessment while EFA does not. This study therefore adopted the CFA methodology as the necessary approach to validating that the conceptual model's construct is accurately represented by the suggested items (Hair et al., 2006). A measurement model's CFA in Amos 23.0 is often composed of several steps that allocate items to the proposed

unobserved constructs, including the right error terms. These include model specification, iterative model modification, and estimations of the goodness of fit (GOF) statistics. The measurement models of the nine constructs (*use behaviour*, *behavioural intention*, *performance expectation*, *effort expectation*, *social influence*, *facilitating conditions*, *perceived susceptibility*, *self-efficacy*, and *trust*) were assessed through a confirmatory factor analysis using the maximum likelihood method. The CFA results of the initial model are displayed in Table 6.

Table 6: Initial Measurement Model for Constructs

Scale Item	Code	Standard Loadings	*t*-Values	R-Square
Use Behaviour				
	UB1	0.936	-	0.876
	UB2	0.901	29.222	0.812
	UB3	0.378	8.2480	0.143
	UB4	0.229	4.8190	0.053
Behaviour Intention				
	BI1	0.967	-	0.934
	BI2	0.956	48.689	0.915
	BI3	0.769	27.048	0.592
Performance Expectancy				
	PE1	0.759	-	0.576
	PE2	0.945	22.287	0.892
	PE3	0.930	21.885	0.865
	PE4	0.698	16.664	0.488
Effort Expectancy				
	EE1	0.940	-	0.883
	EE2	0.954	41.252	0.911
	EE3	0.850	28.729	0.723
Social Influence				
	SI1	0.926	-	0.858
	SI2	0.940	34.932	0.884
	SI3	0.759	24.150	0.576

Scale Item	Code	Standard Loadings	*t*-Values	R-Square
Facilitating Conditions				
	FC1	0.791	-	0.626
	FC2	0.641	16.892	0.411
	FC3	0.918	22.244	0.842
Perceived Susceptibility				
	PS1	0.873	-	0.763
	PS2	-0.278	-5.660	0.077
	PS3	0.805	19.078	0.647
Self-Efficacy				
	SE1	0.884	-	0.781
	SE2	0.820	22.974	0.672
	SE3	0.780	21.057	0.609
Trust				
	TR1	0.951	-	0.904
	TR2	0.710	8.226	0.184
Sample Size (N) = 455				

Source: Field data, 2022

The initial output produced by the SPSS AMOS software version 23 showed few unacceptable indicators (see Table 7). It therefore became necessary to refine and purify the dataset to enhance its suitability (Kline, 2005). Subsequently, based on alternative models suggested by the AMOS software, a few indicators that could not satisfy the minimum requirements in respect of model integrity, fitness, and validity were removed. The determination of minimum threshold points was informed by recommendations from Hair et al. (2010), Hu & Bentler (1999), and Schreiber et al. (2006).

All the constructs had a minimum of three observed variables, except for the trust construct. Hair et al. (2010) suggest that it is preferable to have a minimum of three observed variables under each construct so as "to provide minimum coverage of the construct's theoretical domain" (p. 676). Other scholars, however, have opined that a construct with two observed

variables could be retained if the items have a relatively high correlation (i.e., r >.70) and are relatively uncorrelated with other variables. (Yong & Pearce, 2013, p. 80). The trust construct was therefore maintained.

Table 7: Improvement in Measurement Model Fitness

		Fit Indices							
		Baseline Comparison							
Phase	**Modification**	**x^2/df**	**RMSEA**	**PClose**	**GFI**	**SRMR**	**RFI**	**NFI**	**CFI**
I	Original Measurement Model	3.405	.073	.000	.854	.078	.895	.914	.937
II	Deleted: **UB3**, **UB4**, **PS2**	2.674	.061	.854	.906	.047	.931	.946	.967

Source: Field data, 2022

Consequently, the initial measurement model was modified based on the sizes of factor loadings, cross loadings, measurement errors, and the correlation between the measurement errors. To improve fitness, scale items with regression weights less than 0.5 were dropped (Hair et al., 2010, p. 713). In all, 3 items were deleted after the CFA, leaving the constructs with 25 scale items that achieved the best fit indices (see Table 6). Specifically, two items from *Use Behaviour* (UB3 and UB4) and one item from *Perceived Susceptibility* (PS2)

5.5.3. Reliability and Validity of Final Measurement Model

Four (4) separate approaches were employed to test the reliability and validity of the measurement model. Specifically: composite reliability (CR); average variance extracted (AVE); Cronbach's alpha; and discriminant validity. These test options were adopted based on the suggestions of Hair et al. (2014). The convergence validity of the measurement indicators was determined using the respective factor loadings and average variance extracted

(AVE). Judging from Table 8, the factor loadings, which ranged from 0.654 to 0.967, indicate readings higher than the basic requirement of 0.50 as proposed by Hair et al. (2014). Therefore, provide appropriate evidence to justify convergent validity (Hair et al., 2014). Likewise, the AVE scores of 0.630 to 0.844 all fall within the least acceptable score of 0.50, as recommended by Fornell and Larcker (1981), thereby affirming convergent validity for all the variables assessed.

Table 8: CFA Results for Final Measurement Model

Construct	Items	Standardised Loadings	t-Values	R^2	(CR)	(AVE)	Cronbach's α
Use Behaviour					0.915	0.844	0.912
	UB1	0.939	-	0.881			
	UB2	0.898	28.713	0.806			
Behaviour Intention					0.927	0.811	0.923
	BI1	0.967	-	0.935			
	BI2	0.956	48.855	0.914			
	BI3	0.765	26.800	0.585			
Performance Expectancy					0.906	0.709	0.894
	PE1	0.785	-	0.616			
	PE2	0.945	23.720	0.893			
	PE3	0.931	21.893	0.867			
	PE4	0.679	16.622	0.461			
Effort Expectancy					0.941	0.842	0.937
	EE1	0.938	-	0.879			
	EE2	0.955	41.121	0.912			
	EE3	0.857	29.576	0.734			
Social Influence					0.909	0.771	0.900
	SI1	0.926	-	0.857			
	SI2	0.941	34.932	0.885			
	SI3	0.756	24.015	0.571			
Facilitating Conditions					0.833	0.630	0.851
	FC1	0.784	-	0.615			

Construct	Items	Standardised Loadings	t-Values	R^2	(CR)	(AVE)	Cronbach's α
	FC2	0.654	17.066	0.428			
	FC3	0.920	21.893	0.846			
Perceived Susceptibility					0.820	0.695	0.823
	PS1	0.872	-	0.761			
	PS3	0.794	18.552	0.630			
Self-Efficacy					0.868	0.686	0.866
	SE1	0.883	-	0.780			
	SE2	0.816	22.889	0.666			
	SE3	0.783	21.229	0.613			
Trust					0.780	0.649	0.802
	T1	0.949	-	0.900			
	T2	0.707	16.256	0.585			

Source: Field data, 2022

Cronbach's alpha (Cα) and composite reliability (CR) values were computed to examine the reliability of all the individual items. Table 8 indicates that the reliability scores for the enhanced measurement model were higher than the minimum recommended requirements (Cα >.70, AVE >.50, and CR >.70) as proposed by Hair et al. (2013). Thus, the internal consistencies (Cronbach's alpha values of 0.802 to 0.937 and composite reliability values of 0.780 to 0.941) for all the observed and latent variables were higher than the basic benchmark of 0.70.

Table 9: Model Fit of Final Measurement Model

Measure	Terrible	Acceptable	Excellent	Estimate	Threshold	Interpretation
CMIN				**604.237**	--	--
DF				**226**	--	--
CMIN/DF	> 5	> 3	> 1	**2.674**	>1<3	Excellent
CFI	<0.90	<0.95	>0.95	**0.937**	>0.95	Acceptable
SRMR	>0.10	>0.08	<0.08	**0.047**	<0.08	Excellent
RMSEA	>0.08	>0.06	<0.06	**0.061**	<0.06	Acceptable
PClose	<0.01	<0.05	>0.05	**0.854**	>0.05	Excellent

Source: Field data, 2022

Cut-off Criteria for Fit Indexes (Hu & Bentler, 1999) and (Schreiber *et al.*, 2006).

Subsequently, the Fornell-Lacker criterion and cross-loadings were employed to determine whether any of the constructs that had been theoretically proven not to be associated were not related (discriminant validity). This was determined using recommendations by Fornell and Lacker (1981), who stipulate discriminant validity is achieved when the square root value of the AVE is higher than the strength of association (correlation) between a construct and the other constructs. Table 10 shows the outcome of these relationships in a diagonal presentation.

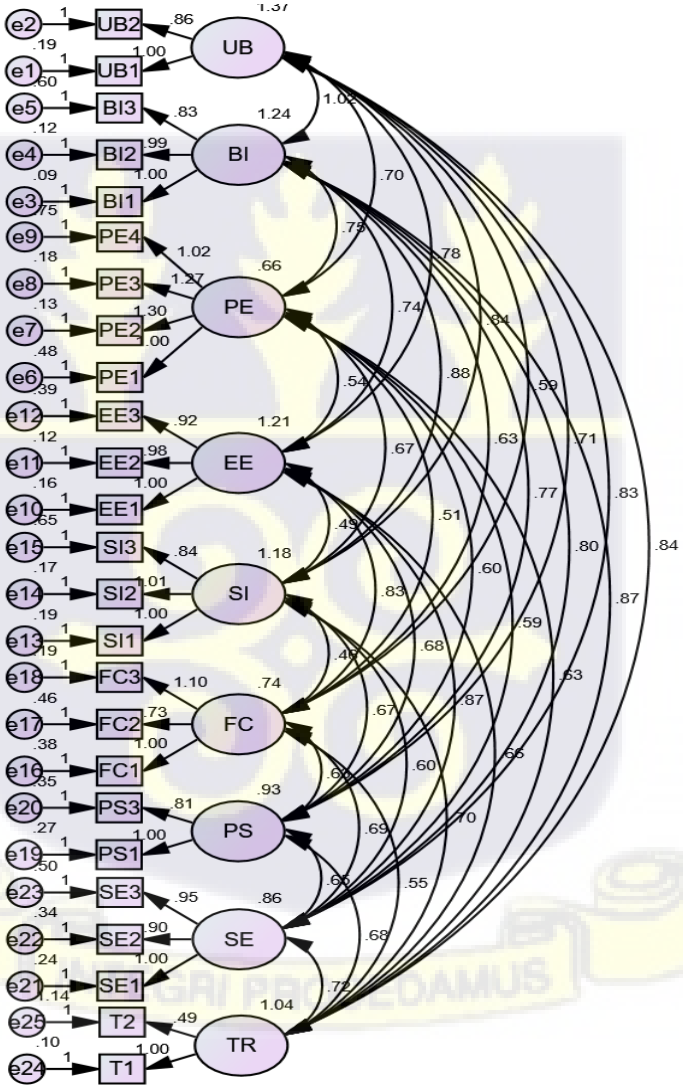

Figure 11: Final Measurement Model

Table 10: Pearson Correlation

	Use Behaviour	Behavioural Intention	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions	Perceived Susceptibility	Self-Efficacy	Trust
Use Behaviour	**0.919**								
Behavioural Intention	0.385	**0.901**							
Performance Expectancy	0.327	0.367	**0.842**						
Effort Expectancy	0.221	0.331	0.200	**0.917**					
Social Influence	0.209	0.334	0.248	0.401	**0.878**				
Facilitating Conditions	0.339	0.306	0.187	0.359	0.383	**0.793**			
Perceived Susceptibility	0.354	0.214	0.297	0.372	0.317	0.329	**0.834**		
Self-Efficacy	0.215	0.459	0.462	0.311	0.389	0.247	0.257	**0.828**	
Trust	0.318	0.238	0.239	0.387	0.359	0.186	0.207	0.256	**0.737**
Mean	3.765	3.874	3.351	4.121	3.527	3.532	4.117	3.837	3.770
SD	1.132	1.097	0.825	1.075	1.056	0.798	0.890	0.896	0.973
CR	0.915	0.927	0.906	0.941	0.909	0.833	0.820	0.868	0.780
AVE	0.844	0.811	0.709	0.842	0.771	0.630	0.695	0.686	0.649
Cα	0.912	0.923	0.894	0.937	0.900	0.851	0.823	0.866	0.802

Notes: ***. Correlation is significant at the 0.01 level (2-tailed); N = 455. Since the square root of the Average Variances Extracted (values on the diagonal) are greater than the corresponding inter-construct correlations (values off the diagonal), discriminant validity is achieved. (*Fornell & Larcker, 1981).

Field data, 2022

5.5.4. Structural Model

Following the determination of the reliability and validity of the construct measures, the structural model was evaluated. This process describes how the unobserved variables are associated with each other and among themselves, as well as the extent of interaction among the constructs. The structural model, according to Brown and Moore (2012), evaluates the statistical test and investigates the predicted statistical associations among the unobserved or dependent constructs.

5.5.5. Structural Model Assessment

Mueller and Hancock (2001) proposed major pointers of concern that are necessary in determining the validation of hypothesised paths. These are: (i) Ascertain if the arrows in the paths expressed among the independent and dependent constructs depict the hypotheses stated. This is assessed by observing the signs of the individual parameters: (ii) the level of influence among the hypothesised associations, as evidenced by the approximated specifications, which must be to the minimum and significant (thus the relative t-values must read higher than 1.96); and (iii) the degree to which the independent constructs or variables explain or influence the dependent constructs or latent variables. The best way of evaluating this is to look at the coefficient of determination (R2) for the individual structural equations.

This study proposed that *performance expectancy*, *effort expectancy*, *social influence*, *facilitating conditions*, *perceived susceptibility*, *self-efficacy*, and *trust* have a direct relationship with *behavioural intention* and *use behaviour*. The R^2 for *behavioural intention* was 0.751.

This value indicated that about 75 percent of the variance in *behavioural intention* was explained by *performance expectancy*, *effort expectancy*, *social influence*, *facilitating conditions*, *perceived susceptibility*, s*elf-efficacy*, and *rust.* This means that the independent variables could have a moderate capacity for determining *behavioural intention* (Chin, 1998). The signs and sizes of the estimates facilitated the assessment of the directional coefficients. The directional coefficient was significant for *performance expectancy*, *social influence*, *facilitating conditions*, *perceived susceptibility*, *self-efficacy*, and *trust*, but not for *effort expectancy* (Table 11).

Since the parameter estimates were significant at the anticipated levels, the test can be said to have the propensity to predict future outcomes, thus confirming the strong predictive validity of the model (Blunch, 2008). That notwithstanding, the proposed model was assessed through the measurement of its complete fitness as well as the model's incremental fit. All the test indicators produced acceptable results that show a perfect absolute fit for the model. Specifically, the outcome of the test values read as follows: Normed chi-square yielded a score of 2.188; root-mean-square-error of approximation (RMSEA) was recorded at 0.064; while goodness-of-fit index (GFI) produced a score of 0.990.

On the other hand, the incremental fit measures generated a normed fit index (NFI) score of 0.983 and a comparative fit index (CFI) value of 0.990. The outcome of these test measures affirms that the structural model had satisfactory fit and had therefore proven to predict and confirm the hypothesised associations and paths suggested in the conceptual framework of the study to an appreciable level. In other words, the recommended degree of nomological validity

was achieved (Hagger et al., 2002). The statistical outcome of the SEM analysis is presented in Table 11. Figure 12 also shows the graphical representation of the statistical outcome generated from the SEM assessment of the hypothesised paths.

Table 11: Structural Model Assessment

Hypothesis	Relationship	β Estimate	*t*-Value	*p*-Value	Interpretation
H1	Beh. Intention <----- Perf. Expectancy	.539	8.469	***	Significant
H2	Beh. Intention <----- Effort Expectancy	.084	1.558	.119	Not Significant
H3	Beh. Intention <----- Social Influence	.155	4.408	***	Significant
H4	Beh. Intention <----- Fac. Conditions	-.405	-4.743	***	Significant
H5	Beh. Intention <----- Perc. Susceptibility	.094	2.195	.028**	Significant
H6	Beh. Intention <----- Self-Efficacy	.534	11.082	***	Significant
H7	Beh. Intention <----- Trust	.154	3.887	***	Significant
H8	Use Behaviour <----- Beh. Intention	.853	26.330	***	Significant

N = 455; R^2 = .751; Structural Model Fit Indices: χ^2/df = 2.188, RMSEA = .064; GFI = .990; NFI = .983; CFI = .990

***. Correlation is significant at the 0.01 level (2-tailed)
**. Correlation is significant at the 0.05 level (2-tailed)

Source: Field data, 2022

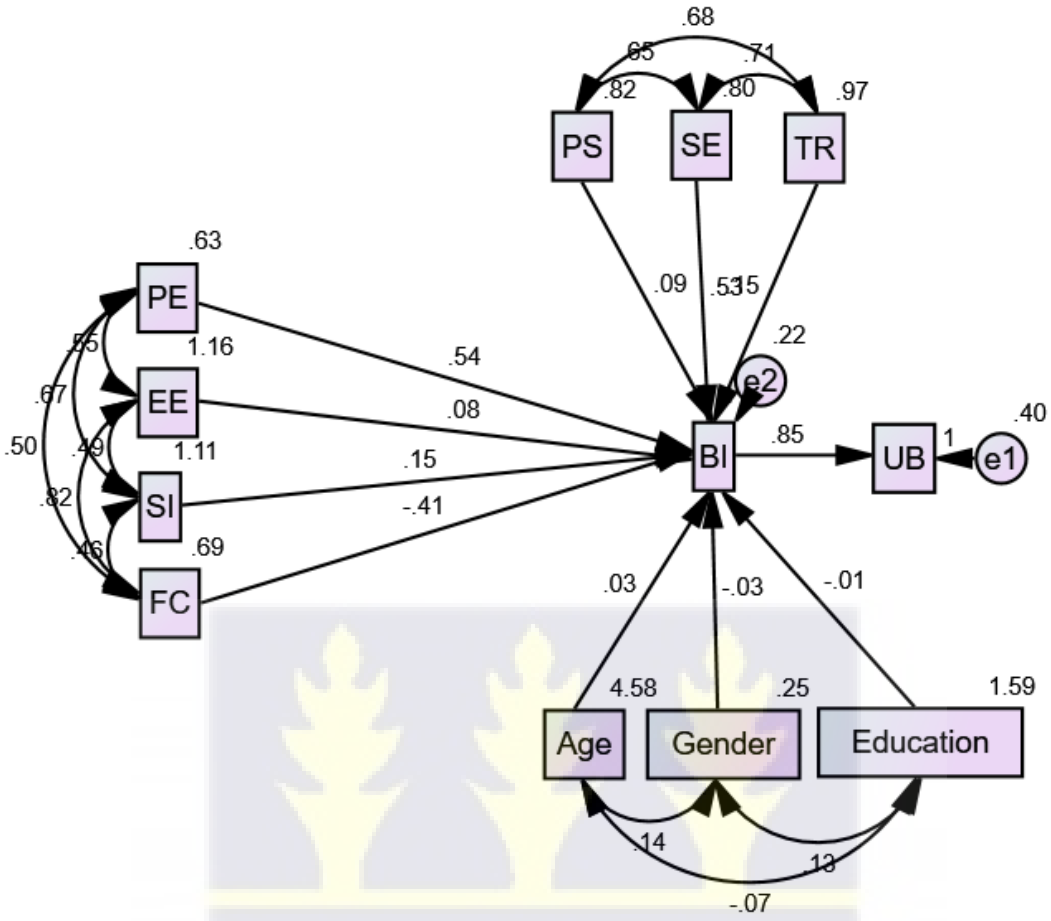

Figure 12: Structural Model Test Results

5.5.6. Assessment of Moderation

Researchers generally employ two distinct approaches to exploring group disparities using the structural equation modelling (SEM) technique: multi-group moderation and moderation interaction (Aiken et al., 1991). Multi-group moderation is primarily employed when dealing with categorical variables, while moderation interaction, as indicated by Memon et al. (2019), is best suited for scenarios involving continuous variables. The differential focus of these methodologies becomes apparent as multi-group moderation seeks to explore any possible difference in the structural relationships among variables across various groups, while

moderation interaction seeks to ascertain whether a moderating variable strengthens or weakens the direct influence between the independent and dependent variables. The moderators selected for this study were categorical in nature; therefore, the study adopted the multi-group moderation analysis approach in determining the moderating effect of age, gender, and education on the relationships between the observed constructs (PE, EE, SI, FC) and the unobserved construct BI.

The moderating effects of the various groups of age, gender, and education were assessed in the structural relationships proposed. Each of the moderating variables was grouped into two categories (Tables 16–18). For *age*, the *young* sample comprised all persons between 18 and 35 years old, while the *old* sample were persons above 35 years old in the given sample of data collected. There were 290 people in the *young* group and 165 people in the *old* group.

Similarly, *gender* was split into two groups: males and females. There were 232 males and 223 females. The *education* sample was also grouped into two categories: low education and high education. There were 119 persons in the low education group, which comprised persons with no or only basic education up to the junior high or middle school level (JHS or middle school). High education was considered for persons whose highest level of education was at the senior high school (SHS) level or higher. They made up 336 of the given sample of respondents.

The differences between the groups were further examined by statistically comparing the standardised linear regression weights (path coefficients) for the groups in relation to the

corresponding standardised linear regression weights for every construct in the established relationships (Chin, 1998). This study adopted the recommendation by Chin (1998, 2000) for developing multi-group analysis. The formula developed by Chin (2000) is described as follows:

$$\boldsymbol{t} = \frac{Path_{Group1} - Path_{Group2}}{\left[\sqrt{\frac{(n_1 - 1)^2}{(n_1 + n_2 - 2)} \times SE^2_{Group1} + \frac{(n_2 - 1)^2}{(n_1 + n_2 - 2)} \times SE^2_{Group2}}\right] \times \left[\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right]}$$

where $Path_{Group1}$ is the path coefficient in structural model (Group1); $Path_{Group2}$ is the path coefficient in structural model (Group2); n_1, sample size of Group1; n_2, sample size of Group2; SE_{Group1}, standard error of paths in structural model (Group1); SE_{Group2}, standard error of paths in structural model (Group2); t, t-statistic; and $(n_1 + n_2 - 2)$ is the degree of freedom.

Table 12: Moderating Effect of Age

H	Path	Young (35 Years and Below)			Old (Above 35 Years)			Statistical Comparison of Path		Interpretation
		β estimate	*S.E.*	*p*-value	*β* estimate	S.E.	*p*-value	*t*-value	*p*-value	
H9.1	BI <--- Perf. Expectancy	.550	.082	***	.200	.101	.026**	3.359	***	Accepted
H9.2	BI <--- Effort Expectancy	.150	.073	.049**	.031	.078	.769	1.070	.285	Rejected
H9.3	BI <--- Social Influence	.062	.044	.180	.459	.055	***	4.130	***	Accepted
H9.4	BI <--- Fac. Conditions	-.553	.108	***	.006	.131	.959	3.785	***	Accepted

Notes:

N = 455; Group 1 = 328; Group 2 = 127; R^2 = .751; Structural Model Fit Indices: χ^2/df = 2.188, RMSEA = .064; GFI = .990; NFI = .983; CFI = .990;

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

**. Correlation is significant at the 0.05 level (2-tailed)

*. Correlation is significant at the 0.10 level (2-tailed)

Source: Field data, 2022

From the results displayed in Table 12, the two age groups indicate significant differences in all the path relationships, except for the association between effort expectancy and behavioural intention. Performance Expectancy had a substantial and positively significant relationship with behavioural intention for the younger group (β = 0.550, p = 0.000) compared to the older (β = 0.200, p = 0.000) group.

The reverse was the case for social influence, where the older group had a relatively higher positive relationship (β = 0.459, p = 0.000) with behavioural intention when compared with the younger group (β = 0.062, p = 0.000). Facilitating conditions, on the other hand, had an inversely significant relationship (β = 0.553, p = 0.000) with behavioural intention for the younger group. The relationship between facilitating conditions and behavioural intention was, however, positively significant for the older group, though this was relatively weaker (β = 0.006, p = 0.000).

For the hypothesised relationships where gender was a moderating variable, there were no statistically significant differences between males and females, as displayed in Table 13. In much the same way, there were no statistically significant differences in the path relationships for educational levels, as shown in Table 14.

Table 13: Moderating Effect of Gender

H	Path	Males			Females			Statistical Comparison of Paths		Interpretation
		***β* estimate**	***S.E.***	***p*-value**	***β* estimate**	**S.E.**	***p*-value**	***t*-value**	***p*-value**	
H10.1	BI <--- Perf. Expectancy	.305	.089	***	.582	.092	***	1.793	.074*	Rejected
H10.2	BI <--- Effort Expectancy	.008	.072	.911	.221	.085	.035**	1.552	.121	Rejected
H10.3	BI <--- Social Influence	.153	.052	***	.189	.047	***	.086	.932	Rejected

Notes:

N = 455; Group 1 = 232; Group 2 = 223; R^2 = .751; Structural Model Fit Indices: χ^2/df = 2.188, RMSEA = .064; GFI = .990; NFI = .983; CFI = .990;

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

**. Correlation is significant at the 0.05 level (2-tailed)

*. Correlation is significant at the 0.10 level (2-tailed)

Source: Field data, 2022

Table 14: Moderating Effect of Education

H	Path	Low Education			High Education			Statistical Comparison of Paths		Interpretation
		β **estimate**	***S.E.***	***p*-value**	***β*** **estimate**	**S.E.**	***p*-value**	***t*-value**	***p*-value**	
H11.1	BI <--- Effort Expectancy	-.001	.100	.993	.108	.063	.128	.792	.429	Rejected
H11.2	BI <--- Social Influence	.384	.0774	***	.114	.037	.011**	3.224	***	Rejected

Notes:

N = 455; Group 1 = 119; Group 2 = 336; R^2 = .751; Structural Model Fit Indices: χ^2/df = 2.188, RMSEA = .064; GFI = .990; NFI = .983; CFI = .990;

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

**. Correlation is significant at the 0.05 level (2-tailed)

*. Correlation is significant at the 0.10 level (2-tailed)

Source: Field data, 2022

*** p< 0.001; *** p< 0.01; * p< 0.05

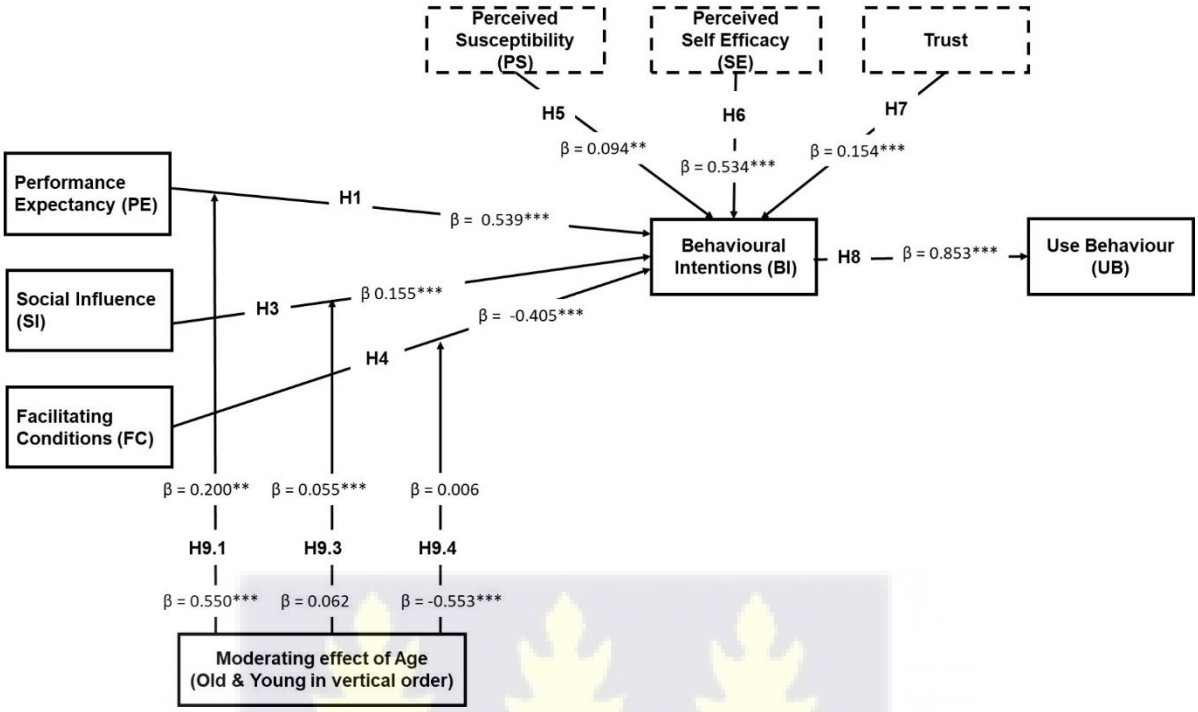

Figure 13: Post study-model

5.6. Summary

Chapter six (6) detailed how the proposed research model was evaluated and tested using structural equation modelling. The chapter thus concentrated on the demographics of the study's respondents as well as the screening, cleaning, and analysis of the data gathered via the Kobo Toolbox online data gathering app. The extent to which respondents used mobile apps was investigated. A comparison of the use of mobile apps to access information on COVID-19 during and after the pandemic was determined. Based on the satisfactory results, the structural equation modelling technique was used to examine the fitness of the proposed model as well as its validity.

The combined impact of the model validation and hypotheses testing results informed the confirmation of the influence of performance expectancy, effort expectancy, social influence, facilitating conditions, behavioural intention, trust, self-efficacy, and perceived susceptibility on respondents' intention to use and actual use of mobile apps for public health communication. The proposed model's moderating effect on gender, age, and education was also investigated. The next chapter presents a discussion of the results generated from the analysis.

CHAPTER SIX

DISCUSSIONS OF RESULTS

6.1 Introduction

The previous chapter of this thesis provided an analysis of the empirical results with respect to the purpose of the study. The discussion in this chapter is based on the outcomes and conclusions of the hypotheses testing as proposed using an adapted UTAUT model. This chapter is divided into two sections: the best predictors of behavioural intention to use and actual use of mobile apps to access information on COVID-19 among Ghanaians based on the respective contributions of the constructs of the study as informed by the modified UTAUT model. The second section of this chapter examines the influence of moderators on the relationships in the research model with respect to the behavioural intention to use mobile apps to access information on COVID-19 among Ghanaian residents.

6.3. Predictors of Use of mobile apps to access COVID-19 information

The purpose of the study was to identify key predictors of the use of mobile apps for communicating public health emergencies, using the context of the COVID-19 outbreak in Ghana as a case example. A modified version of the UTAUT model, introducing three variables of specific interest to the study, was empirically tested with randomly sampled primary data collected from 455 respondents across the 16 regions of Ghana. In response to research questions one and two, the study proposed that the substantive predictor constructs of the UTAUT model: performance expectancy, effort expectancy, social influence, and facilitating conditions (research question two), together with the three introduced variables of perceived susceptibility, self-efficacy, and trust, will have a direct relationship with

behavioural intention and use behaviour towards mobile apps.

Performance expectancy, effort expectancy, social influence, facilitating circumstances, perceived susceptibility, self-efficacy, and trust collectively accounted for three-quarters (75%) of the variation in behavioural intention. Thus, the capacity of the independent variables to predict behavioural intention can be described as strong, as suggested by Kirch (2008). Subsequently, path coefficients were found to be significant for perceived susceptibility, self-efficacy, trust, social influence, and performance expectancy but not for effort expectancy.

This study therefore concludes that, for an individual to intend to use mobile apps to access information on infectious diseases, the individual must experience fear or anxiety towards the disease (perceived susceptibility) and be confident to observe any relevant protocols that may be prescribed by health officials (self-efficacy). Also, the source of the information should be deemed genuine and authentic (trust). Moreover, significant others (social influence) in the life of the individual must show a positive attitude towards the use of mobile apps to access information on the infectious disease. And finally, the information sought should be relevant to, and offer useful information on, the disease (performance expectancy).

Sections 6.4.1 to 6.4.8 provide further discussions on the performance of the study constructs in relation to the extended UTAUT model. It must be noted, however, that the other two constructs—perceived susceptibility, self-efficacy, which are health-specific constructs, and trust—were additional constructs borrowed from existing theory to augment and help explain the predictors of the use of mobile apps for emergency public health communication.

6.3.1. Performance Expectancy

This study hypothesised that performance expectations will have a direct influence on the behavioural intention to use mobile apps for public health communication. This hypothesis was supported, implying that mobile app users in Ghana used mobile apps to access information on COVID-19 because they offered pertinent information about the infectious disease. The finding mirrors Riley et al., (2011), who posited that mobile apps facilitate the delivery of tailored and appropriate health message doses. The findings are also consistent with other studies like Slade et al. (2014) and Venkatesh et al. (2003; 2011), who, using UTAUT and UTAUT 2, found performance expectancy to have a direct positive influence on behavioural intention.

6.3.2. Effort Expectancy

Effort expectancy is operationalized in this study as the ease with which users navigate mobile apps on their phones. This study hypothesised that effort expectancy could significantly predict users' behavioural intentions to use mobile apps for public health communication. This hypothesis was not supported in the current study, contrary to findings in previous studies (Venkatesh et al., 2003; Sumak and Sorgo, 2016; Hoque & Sorwar, 2017; Khalilzadeh et al., 2017; Sumak et al., 2017). This suggests that the behavioural intention to use mobile apps for public health communication among Ghanaian residents is not influenced by the ease of use of mobile apps.

This result could be attributed to the fact that many of the respondents are literate and therefore have substantial knowledge of navigating mobile apps. It may also suggest a consideration in

developing apps for mass deployment to make them especially user-friendly and easy to use, even by people with little or no formal education. Previous studies concluded that individuals with basic or no formal education perceive higher barriers to technology adoption compared to those with higher formal education (Weijters et al., 2007; Liebermann & Stashevsky, 2002).

6.3.3. Social Influence

Social influence is defined in this study as the extent to which an individual believes that his or her significant other(s) could influence their intention to use mobile apps to access information on COVID-19. This study hypothesised that users' behavioural intention to use mobile apps for public health communication is influenced by what their significant others—family, friends, peers, among others—believe in respect of the use of mobile apps. The study found a direct relationship between social influence and behavioural intention to use mobile apps for public health communication.

This finding is in consonance with the findings of Guo et al. (2012) and Lu et al. (2005). It can therefore be inferred that the intention of an individual mobile app user in Ghana to use mobile apps to access information on infectious diseases does not only rest with the individual. That decision could be influenced by the opinions of family, friends, peers, and other important people in the life of the user. The underlying assumption is that social interactions play a vital role in information acquisition. Thus, in the realm of mobile applications, users actively interact with their social milieu as they endeavour to seek relevant information. This interaction is accompanied by a careful consideration of the possible outcomes associated with the utilisation or non-utilisation of a specific technology. Importantly, the anticipated

responses from the social environment hold substantial sway over an individual's attitudes and behaviours concerning the use of technology, particularly in the context of employing mobile apps to access information pertaining to infectious diseases such as COVID-19. The larger lesson is that effective behavioural campaigns must be directed at (or include) social and system-level motivators and barriers, not just individual behavioural factors and loci of control.

6.3.4. Perceived Self-Efficacy

Perceived self-efficacy is defined as the extent to which an individual perceives his or her ability to effectively perform the COVID-19 recommended protocols shared on mobile apps. This study predicted that an individual's perception of his or her ability to perform COVID-19 response behaviours will have a direct relationship with the individual's behavioural intention to use mobile apps to access information on COVID-19. This hypothesis was supported. Thus, mobile app users in Ghana are more likely to develop the intention to use mobile apps to access information on infectious diseases so long as they could perform prescribed response behaviours or protocols. The finding mirrors that of Bandura et al. (2003) and Schwarzer (2011), whose findings in similar studies indicated that perceived self-efficacy predicts an individual's intention to use technology.

6.3.5. Perceived Susceptibility

The term perceived susceptibility refers to the subjective evaluation of a person's likelihood of developing a health issue (Glanz et al., 2008). According to the health belief model, a person will participate in behaviours that are intended to reduce their chance of getting an

illness if they believe they are susceptible to that sickness or health concern (Rosenstock, 1974). This study hypothesised that perceived susceptibility would have a direct impact on behavioural intention to utilise mobile apps to get information on COVID-19. The hypothesis was confirmed in the affirmative.

This suggests that the more users of mobile apps appreciate the risk of the spread of an infectious disease, the more likely they will be determined to seek more information about the disease on their mobile apps. This result is consistent with the findings of Yun et al. (2010) as well as Dutta and Feng (2007). According to their reports, people who perceive themselves to be at a greater risk of illness show higher motivation to embrace health-oriented behaviours, such as utilising mobile apps to fulfil their requirements for health-related information and communication.

6.3.6. Trust

In this study, the UTAUT model was modified to include trust as a variable of particular concern to considerations of public health communication and messages. Accordingly, trust was hypothesised as a predictor of intention to use mobile apps for public health communication. This hypothesis was supported. This indicates that for users to develop the behavioural intention to access information on infectious diseases via mobile apps, the apps must facilitate genuine or authentic information about the disease. This outcome is like that of Khalilzadeh et al. (2017), who integrated trust among other variables into the UTAUT model to determine the predictors of users' intentions to patronise mobile payment platforms. Other studies have also reported trust as a major predictor of users' behavioural intentions to

use mobile applications in other contexts than health (Alalwan et al., 2017; Khalilzadeh et al., 2017).

The present investigation places a heightened focus on the construct of trust, prompted by concerns articulated by the World Health Organization (WHO) in response to the COVID-19 outbreak. The WHO expressed deep dismay over the detrimental impact of the pandemic, further exacerbated by the dissemination of what it termed an infodemic of misinformation and disinformation. Consequently, this study contributes empirical evidence to the existing body of research by substantiating the pivotal role of trust in the promotion of health information, in particular. Specifically, from a scholarly perspective, the study posits that the consumption of information pertaining to infectious diseases through mobile applications is significantly contingent upon the users' perception of the authenticity and genuineness of the information shared about the infectious disease.

6.3.7. Facilitating conditions

Facilitating conditions have been defined as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (Venkatesh et al. 2003, p. 450). In the context of this study, facilitating conditions are operationalized in terms of access to smart phones, together with the availability, access, and affordability of internet service. The study hypothesised a direct relationship between facilitating conditions and behavioural intention to use mobile apps to access information on COVID-19. The hypothesis generated a negative or inverse relationship between facilitating conditions and behavioural intention.

Thus, the more users had access to smart phones and the internet, the less they harboured the intention to use mobile apps to access information on COVID-19. In other words, users who have limited access to the internet tend to nurture the idea of spending more time seeking information about COVID-19 on their phones whenever they have the opportunity to use the internet. The result is inversely related to other studies (Boontarig et al., 2016; Yi et al., 2006; Hikmet et al., 2007) that found a positive direct relationship between facilitating conditions and behavioural intention to use technology.

This observation is of particular interest, given the fundamental significance of not only possessing a smartphone but also having access to other pertinent resources, such as stable and affordable internet connectivity. The underlying assumption of this construct posits that the availability and accessibility of these facilitating conditions may act as motivational factors in prompting users to seek information about infectious diseases. However, the present study did not find support for this assumption. One plausible explanation for this outcome could be that the prerequisite of owning a smartphone, which served as an inclusion criterion for this investigation, may have negated the challenge of smartphone accessibility for participants. Consequently, smartphone access per se may not have been a significant limiting factor in this context.

Nonetheless, it is noteworthy that the study did not find evidence to support the notion that other factors such as access to the internet—a factor previously reported in other studies as a barrier to the adoption and utilisation of mobile apps for accessing health information (Boontarig et al., 2016)—did not have a direct effect on the behavioural intention to use

mobile apps in accessing health information in the current study. This discrepancy warrants scholarly attention and further exploration in future studies. It is possible that the prevalence of internet access has evolved or improved since previous research, and contextual factors may have influenced the findings, indicating a need for a more nuanced investigation of the impact of internet accessibility on the adoption of health-related mobile applications in the context of infectious disease information seeking.

6.3.8. Behavioural Intention

Behavioural intention, according to Venkatesh et al. (2003), is "the degree to which a person has formulated conscious plans regarding whether to perform a specified future behaviour." (p. 450). Behavioural intention in the context of this study represents the willingness or behavioural intention of users to use mobile apps to access information on COVID-19. The study proposed that behavioural intention will have a direct influence on the actual use of mobile apps to access information on COVID-19.

This hypothesis was strongly supported, indicating that once the intention to use mobile apps to access information on infectious diseases like COVID-19 is conceived, there is a greater probability that this will culminate in the actual use of mobile apps. This observation aligns congruently with the foundational theories underpinning the intention models expounded upon in Chapter Four of this study, including the Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and TAM2. Moreover, these findings resonate with prior research reported by Vanketash et al. (2003) and Ally Gardiner (2012). The confluence of evidence from these sources bolsters the validity and credibility of

the outcomes of this study, as it corroborates and reinforces earlier empirical work that underscores the strong positive relationship between intention and actual use behaviours.

6.4. Test of Moderation

In their pioneering study, Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) by incorporating demographic and psychographic moderating variables such as age, gender, experience, and voluntariness. Importantly, they did not account for education as a potential moderator, presumably because the context of their study does not reckon with education as a strong discriminator. This extension aims to enhance the model's explanatory capacity. Building upon this foundational work, the current study sought to examine, in the context of a pandemic, the potential influence of specific demographic moderators as used by Venkatesh et al. (2003), particularly age and gender, while introducing education as an additional variable.

The rationale behind including education as a moderating factor is derived from existing literature, which suggests that individuals with limited or no formal education may encounter greater barriers to adopting technology compared to their counterparts with higher levels of formal education (Weijters et al., 2007; Liebermann & Stashevsky, 2002). Also, existing research suggests that digital skills and knowledge serve as effective instruments for protecting individuals from online risks associated with mis/disinformation, thereby enhancing their resilience against potential adverse consequences (European Regulators Group for Audiovisual Media Services [ERGA], 2021; Vissenberg et al., 2022). Moreover, proficiency in internet skills has been positively correlated with academic success (Pagani et

al., 2016). As a result, this study sought to illuminate the potential contributions of these identified demographic moderators concerning the expanded UTAUT constructs. This section provides a discussion of the impact of each of the three demographic variables on the UTAUT model, which was adapted for the study.

6.4.1. Moderating Effect of Age

This study hypothesised that age will significantly moderate the relationship between performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile apps to access COVID-19 information. Age was found to be a moderator of the behavioural intention to use technology, a finding that is consistent with those of several other scholars (Venkatesh et al., 2003, 2012; Magsamen-Conrad et al., 2015). The specific indirect effect of age on performance expectancy, effort expectancy, and social influence is discussed below.

Performance expectancy was not only observed as having a greater influence on the intention to use mobile apps to access COVID-19 information when moderated across all ages, but its effect was relatively stronger for younger individuals compared to the older group, as was reported by Venkatesh et al. (2012). Thus, in the context of this study, younger people are more likely to use mobile apps to access information on infectious diseases because they provide them with pertinent information (performance expectancy) on the infectious disease. Age was found to moderate the influence of effort expectancy and social influence on behavioural intention to use mobile apps to access information on COVID-19. The effect of effort expectancy was, however, not significant. This contrasts with findings by Venkatesh et

al. (2003). The moderating effect of age on social influence was stronger for the older group compared to the younger group. The implication is that older people are more likely to be influenced by their significant others to conceive the idea of using mobile apps to access information on the pandemic or for the search to be done on their behalf. This finding could be associated with the vulnerability and increased risk of COVID-19 infection among older people (Martín-Sánchez et al., 2020).

The moderating effect of facilitating conditions on behavioural intention to use mobile apps to access information on COVID-19 was also accepted. This finding agrees with findings from Venkatesh et al. (2003) and Cimperman et al. (2016). However, in contrast to suggestions by Venkatesh et al. (2003), facilitating conditions were not only relatively stronger for the younger group but also had a negative relationship. Thus, users aged 35 or younger show less intention to use mobile apps to access information on infectious diseases when they have more access to the internet and other accessories that enable use of mobile apps on their phones. This finding is interesting and raises curiosity for further research around the reasons why younger people would not prioritise searching for information on infectious diseases when they have the facilitating conditions to do so.

6.4.2. Moderating Effect of Gender

The UTAUT model stipulates gender as a moderator in the relationships between performance expectancy, effort expectancy, and social influence (Venkatesh et al., 2003). Similarly, this study predicted that gender would significantly moderate the relationship among performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile

apps to access information on COVID-19. The hypothesised relationships where gender was a moderating variable recorded no statistically significant difference between males and females. This is incongruent with the available literature on technology acceptance, which indicates that the decision to use a new technology by an individual is influenced by gender (Parameswaran et al., 2015; Morris, Venkatesh, & Ackerman, 2005; Venkatesh, 2006).

Perhaps, given the virulent nature of the COVID-19 virus and the fact that there were no immediate vaccines to curb the spread of the outbreak of the pandemic, gender dynamics were of little or no relevance as both males and females were equally at risk. Thus, the context of a pandemic might have negated the possible differences that could have emerged relative to the possible influence of performance expectancy, effort expectancy, and social influence on behavioural intention to use mobile apps in accessing information on COVID-19.

6.4.3. Moderating Effect of Education

The findings on the moderating effect of education showed no statistically significant differences in the path relationships for educational levels. This study tested the relationship between education and social influence, as well as effort expectancy. Despite the existing literature suggesting a positive and significant relationship between educational status and the behavioural intention to use mobile technology (Yusuf & Xiaoyun, 2016; Rabaa'I et al., 2016; Alshehri et al., 2012), the findings of this study diverged from those observations and conclusions. Specifically, educational status did not serve as a moderator or have any indirect impact on the influence of social factors and effort expectancy on behavioural intention. Also, contrary to the assumption that individuals with limited or no formal education may encounter

higher barriers to technology adoption than those with higher levels of formal education (Weijters et al., 2007; Liebermann & Stashevsky, 2002), this observation did not hold true in the context of this investigation.

One plausible explanation for this discrepancy could be attributed to the ease of searching and the interactive nature of online health information platforms (Asibey et al., 2017; Chu et al., 2017; Powel et al., 2011; Lagoe & Atkin, 2015). These user-friendly aspects of online health information resources might have negated the perceived barriers associated with lower educational attainment. Consequently, it could also be inferred that all one needs to navigate mobile apps to access health information is basic education—up to junior high school level—because this was the minimum level of education among the respondents of the study.

6.5. Summary

This chapter provides a discussion of the outcomes and conclusions of the hypotheses tested. The outcome of the comparative statistical test of the extent of use of mobile apps to access information on COVID-19 during the peak of the pandemic and after was also discussed in this chapter. Predictors of the behavioural intention to use and actual use of mobile apps to access information on COVID-19 among Ghanaian residents were also assessed, including the moderating effect of gender, age, and education on the relationships in the extended UTAUT model. This was helpful in proposing recommendations with respect to demographic factors that influence the use of mobile apps for emergency-risk public health communication.

Respondents were found to use mobile apps more frequently and to spend more time accessing

information on COVID-19 during the peak of the pandemic compared to the post-peak period of the pandemic. The path coefficients were significant for performance expectancy, social influence, facilitating conditions, perceived susceptibility, self-efficacy, and trust, but not for effort expectancy. Age was found to moderate the influence of effort expectancy and social influence on behavioural intention to use mobile apps to access information on COVID-19. In the next chapter, the conclusions, contributions to knowledge, and implications of this study for research and practice, as well as recommendations for future research, are discussed.

CHAPTER SEVEN

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

7.1 Introduction

The previous chapter discussed the empirical findings from the analysis of the data for the study. The discussion was organised according to the key research questions of the study and in relation to the literature and theoretical framework underpinning the study. This chapter concludes the study by recapping the pertinent issues discussed in the previous chapters. The chapter also provides a summary of the study's key findings based on the study objectives. Also discussed in this chapter are the contributions of the study to theory building on communication technologies in the service of public health. The implications of the findings for research, in respect of policy and practices, aimed at enhancing the effective utilisation of emergency-risk public health information through mobile apps among users are also discussed in this chapter.

7.2 Summary of Key Findings

This study sought to develop a model that predicts the use of mobile apps in accessing emergency-risk public health information within the context of the COVID-19 outbreak in Ghana and to contribute to research on the use of mobile apps for public health communication. This was achieved through the adaptation and extension of the UTAUT Model. The UTAUT model was integrated with the borrowed constructs of trust, perceived susceptibility, and perceived self-efficacy. The significance of the study was informed by the research gap indicated and justified by the research problem in Chapter One, and further explained in chapter Two of this study. This section of the chapter presents a summary of the

key findings in response to the three objectives of the study.

The first objective of this study was to examine the drivers of the use of mobile apps in accessing emergency-risk public health information within the unique context of pandemics by assessing the roles of performance expectancy, effort expectancy, social influence, and facilitating conditions in shaping use intentions. The second objective of the study was to explore how the value of trust and health-relevant constructs such as perceived susceptibility and self-efficacy, when combined with the predictive constructs of the UTAUT model (performance expectancy, effort expectancy, social influence, and facilitating conditions), could predict the behavioural intention to use mobile apps to access emergency-risk public health information. The study concludes that factors like perceived susceptibility, self-efficacy, trust, social influence, and performance expectancy strongly influence the behavioural intention to use mobile apps, as proposed by the UTAUT model.

Nonetheless, this study has empirically proven that within the context of health communication and health emergencies such as a global pandemic, health-specific constructs such as perceived susceptibility and self-efficacy are important in influencing the intention towards the use of mobile apps in accessing information on health. It is important to note that the trustworthiness of mobile apps as a tool for sharing health information is also a function of the intention to use mobile apps to access health information.

The third and final objective of the study was to explore any possible differences in the structural relationships between the predictive constructs of the UTUAT model (performance

expectancy, effort expectancy, social influence, and facilitating conditions) and behavioural intention to use mobile apps in accessing emergency risk public health information across gender, age, and education. While age tended to influence factors like performance expectancy, effort expectancy, and facilitating conditions, gender and education did not significantly impact these relationships.

Overall, this research contributes valuable insights into the use of mobile apps for emergency risk public health communication, particularly within the context of the outbreak of infectious diseases such as COVID-19. The study concludes that an individual's inclination to utilise mobile applications for accessing information on contagious illnesses hinges on several key factors. Firstly, the individual should possess a degree of concern or apprehension regarding the illness in question (susceptibility). Secondly, there should be a level of confidence in the ability to adhere to health authorities' recommended protocols (self-efficacy). Additionally, the credibility and authenticity of the information source play a pivotal role (trust). Furthermore, the influence of significant individuals in the person's life (social influence) should encourage a positive outlook on using mobile apps for disease-related information. Lastly, the information sought through these apps should be pertinent (usefulness) and offer valuable insights into the specific disease (performance expectancy) of public concern.

7.3 Implications for Policy and Practice

This study identified the best predictors of behavioural intention and actual use of mobile apps in accessing information on infectious diseases, using the incidence of the COVID-19 pandemic among Ghanaian residents as a proxy. The study expanded the UTAUT model to

include trust as well as perceived self-efficacy and perceived susceptibility (two constructs that are specific to health behaviours) to explore the extent to which these additional constructs could enhance the predictive power of the UTAUT model within the context of the use of mobile apps in accessing emergency-risk public health information.

These constructs were added in the current study to the original UTAUT model because users with a high sense of self-efficacy are more likely to seek information on infectious diseases via mobile apps to gain knowledge about appropriate actions to take and stay safe. On the other hand, users who perceive themselves as susceptible to COVID-19 are deemed to be more likely to seek information on their apps to inform behaviours aimed at mitigating the risk of contracting the disease. Finally, trust was also introduced into the model because the credibility or otherwise of infectious disease information could motivate or demotivate users' intention to use mobile apps as a source of information on infectious diseases.

These additional constructs, together with the substantive UTAUT constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions, explained 75 percent of the variance in behavioural intention to use mobile apps to access information on COVID-19. The path coefficient was significant for performance expectancy, social influence, facilitating conditions, perceived susceptibility, self-efficacy, and trust. The performance expectancy construct was confirmed to have a positively significant relationship with mobile app users' behavioural intention to access information on COVID-19 on mobile apps. This was stronger for people aged 35 or younger compared to the older group. It is recommended to infectious disease management bodies and communicators that they take

advantage of the availability and popularity of mobile apps among the Ghanaian populace to share pertinent information on infectious diseases. These messages must be relevant and applicable to the specific disease of public concern at any point in time and should be appealing to the youth.

Social influence was observed to have a positively significant variance in Ghanaian residents' intention to use mobile apps to access information on COVID-19. Though the relationship was relatively low, it was much stronger for people aged 36 or older, compared to the younger group. Public health communicators' efforts at sensitising citizens about diseases of public concern could be enabled through social influence on people. It must be noted, however, that in as much as social influence presents an opportunity for sensitising citizens about infectious diseases, social influence could also negatively influence the success of public health campaigns when people of influence in society are not converted by the public health messages.

Public health communicators are therefore encouraged to target not only social spaces but should be specific about targeting influential people in society—especially those that appeal to people aged 35 or older—to lead in spreading messages. Similarly, perceived susceptibility had a positively significant variance in Ghanaian residents' intention to use mobile apps to access information on COVID-19. Though this was relatively low, it still presents some evidence to inform policy and practice. The inference is that the more users of mobile apps appreciate the risk of the spread of an infectious disease, the more likely they will be to seek to acquire more information about the disease on their mobile apps. Developers and

communicators of public health messages that are designed for mobile app users should portray the potential risks associated with the disease of public concern.

Trust was also found to have a positively significant influence on Ghanaian residents' intention to use mobile apps to access information on COVID-19. This indicates that for users to access information on infectious diseases via mobile apps, the apps must facilitate genuine or authentic information about the disease. It is important that relevant bodies such as the Ministry of Health agencies responsible for monitoring health promotion, the media, and state cyber security agencies work together to monitor and disabuse fake news and misinformation. This will be useful in enhancing trust among citizens to access information on infectious diseases on their mobile apps.

Further, perceived self-efficacy was found to have a moderately positive relationship with the intention to use mobile apps to access COVID-19 information. The implication is that mobile app users in Ghana are more likely to develop the behavioural intention to use mobile apps to access information on infectious diseases in as much as they could perform prescribed response behaviours published on mobile apps. Developers of messages and content for public health campaigns and sensitization efforts are, therefore, encouraged to develop and/or target trusted mobile apps for the populace. The messages should, however, consider the context in which suggested behaviours or protocols are to be performed and the effort that would be required of the target audience to perform the behaviour(s).

A significant negative relationship was found between facilitating conditions and behavioural

intention. Thus, the more users have access to smart phones and the internet, the less they think of utilising mobile apps to access information on COVID-19. In other words, users who have limited access to smart phones and the internet tend to think of spending more time seeking information about COVID-19 on their phones whenever they have the opportunity to use the internet. This evidence was stronger for people aged 35 or younger. Public health communicators and developers of public health messages that are meant for mobile apps are encouraged to consider ways of improving smartphone and internet access among young people to enhance the consumption of public health messages among the youth.

Finally, the study established a relatively stronger, positively significant relationship between mobile app users' behavioural intention and the actual use of mobile apps to access information on COVID-19. To this end, public health communicators are encouraged to implement strategies that could influence behavioural intention. These strategies should include developing their own customised mobile apps and/or collaborating with existing apps that have credibility among users to enhance trust. These apps should also offer pertinent information about the diseases of public concern, promote protocols and behaviours that could be easily performed by the target audience, and highlight the potential risks associated with the diseases of public concern.

7.4 Contribution to Research

This study has contributed to research in several ways. Firstly, the validity of the UTAUT model—developed and validated among users in the North Americas—has been tested in explaining similar behaviour within the sub-Saharan Africa region. This study has validated

the hypothesised paths identified among the substantive constructs in the UTAUT model as proposed by Venkatesh et al. (2003) within a different geographical and user context.

Secondly, the study has also proposed a model that is more tailored to the application of technologies for emergency risk communication purposes by providing a sound empirical basis for predicting the use of mobile apps in accessing health information within the context of a global health crisis. This study has expanded the UTAUT model by integrating into it the new constructs of trust, self-efficacy, and perceived susceptibility to enhance understanding of the uses and usefulness of mobile apps in accessing emergency health risk information. Extant knowledge could not be enough to inform health communicators in the development of health promotion messages deployed via mobile apps. This is because, though the predictive constructs of the UTAUT model provide a theoretical basis for predicting the use of technology, the theory does not consider health relevant constructs such as self-efficacy, and perceived susceptibility. Moreover, the dynamics of an infodemic of mis/disinformation as bemoaned by the WHO present new and contemporary questions that could not be answered by the original UTAUT constructs.

Thirdly, this study employed the structural equation model analytical technique, which allowed for a concurrent assessment of the adequacy of the measurement model and the conceptual model used to determine the best predictors of the use of mobile apps in accessing emergency-risk public health information among Ghana residents. For example, this study used confirmatory factor analysis (CFA) to validate the measurement model in the proposed research model. Again, the study employed a sophisticated technique to answer questions on

demographic disparities such as gender, age, and education. This study leveraged two distinct types of group analyses to investigate the moderating effect of gender, age, and education on the behavioural intention to use mobile apps to access information on COVID-19 in Ghana. The empirical basis of the research therefore strengthens the research evidence for policy and practice and for future research.

7.5 Research Limitations

Notwithstanding the widespread support for the UTAUT model and the intriguing findings of this study, some limitations are acknowledged. Adapting the UTAUT model as a theoretical framework to assess the extent of use of mobile apps in accessing COVID-19 information among Ghanaian residents presents some limitations. The UTAUT model is not only heuristic in nature but was built within Western culture. The implication is that in implementing the model among people of non-western background, other factors that were not considered by the UTAUT model but peculiar to Ghana and the sub-Saharan Africa region at large could have been overlooked.

Examples of such possible peculiarities are: the role of religion and cosmic influences generally in the conviction and capacity of people to respond to disease and treatment recommendations; the potential mediating force of communalism and other factors in the sociology of communication and decision-making; the structural and infrastructural barriers (and enablers) of technology availability, acceptance, and access for mobile app adoption and application. Also, unlike the UTAUT model, this study is limited by its cross-sectional approach to research. The original UTAUT model was designed through a longitudinal study.

It is conceded that the behavioural intention to use technology is subject to change over time. This study only measured respondents' attitudes at one point in time.

7.6 Areas for Future Research

This study's findings suggest some avenues for future research. Those that are both relevant and significant for further research are outlined in this section of the thesis. The findings supported all but one of the constructs used to investigate Ghanaian residents' use of mobile apps to access COVID-19 information. Future researchers are encouraged to use the UTAUT model in exploring the use of mobile apps in emergency risk communication among different users within the sub-Saharan Africa region to enhance generalizability and further validation.

Again, this study expanded the UTAUT model to include perceived self-efficacy, perceived susceptibility, and trust, all of which were found to have positively significant influences on behavioural intention. Nonetheless, technology acceptance in developing countries could be influenced by several complexities, such as culture and religion. Therefore, future research should consider the introduction of new constructs and other demographic variables into the UTAUT model to enhance the model's explanatory power.

Also, the present study did not yield supportive evidence for the proposition advanced in earlier research, where access to the internet was identified as a potential impediment to the adoption and utilization of mobile applications for accessing health information (Boontarig et al., 2016). In the current investigation, no direct influence of internet accessibility on the behavioural intention to use mobile apps for accessing health information was observed. This

incongruity merits scholarly attention and underscores the importance of conducting further inquiries in subsequent studies.

It is plausible that the prevalence of internet access has undergone changes or advancements since the previous investigations, and contextual factors may have played a role in shaping the outcomes. These observations underscore the necessity for a more nuanced exploration of the relationship between internet accessibility and the adoption of health-related mobile applications in the specific context of seeking information on infectious diseases. Above all, a longitudinal study with a similar population could facilitate a deeper appreciation of the best predictors of the use of mobile apps in accessing emergency-risk public health communication.

7.7 Research Conclusion

In conclusion, this study sought to determine factors affecting the use of mobile apps in accessing emergency-risk public health information within the context of the COVID-19 outbreak in Ghana. This became necessary after a review of the literature (Chapter 2). The literature showed that mobile technologies and applications have been useful in dealing with infectious diseases in the 21st century, be it in detecting and monitoring pandemics, assessing their impact and evaluating corrective actions, or developing control strategies.

The advent of the COVID-19 pandemic saw the WHO take the lead in communicating and implementing pandemic-related recommendations via mobile apps. However, the deployment of these interventions did not consider cultural differences and other barriers that may hinder

access to this information. Previous research has identified barriers and enablers to the adoption of mobile applications for health information communication. This study, therefore, sought to understand these factors within the context of health information access during public health emergencies like COVID-19.

Moreover, a systematic review of journal articles published on or in relation to the use of mobile apps in public health communication, specifically during disease outbreaks, revealed that four out of every five articles did not utilise existing theories in the design of their research, indicating a gap in conceptualization. Hence, theoretical models that will ordinarily contribute conceptual rigour and prognostic power to the understanding and use of mobile applications in public health communication are limited. Moreover, there was limited research evidence, especially from the perspective of users, of the utility of mobile apps in accessing information on infectious diseases such as COVID-19 within the Sub-Saharan Africa region.

Consequently, the study sought to contribute to filling this gap in research by examining the factors that predict the use of mobile apps in accessing information on COVID-19 within the context of the sub-Saharan African region. The UTAUT model was adapted as the theoretical basis. This was useful because the UTAUT model has the propensity to identify the main individual-level factors that influence technology adoption. Also, the UTAUT model permits the identification of contingencies that moderate the effect of the substantive predictors. That notwithstanding, the heuristic nature of the UTAUT permitted its extension via integration of other constructs such as trust and health-relevant constructs of perceived susceptibility and perceived self-efficacy to help explain the possible predictors of the use of mobile apps in

accessing information on COVID-19.

Drawing from the positivist philosophy, a quantitative survey approach to research was adopted to explore the best predictors of mobile app utility in accessing emergency-risk public health mobile information. The survey data, randomly collected among mobile app users in Ghana, afforded a substantial appreciation of the relationships among the research constructs of the model. Performance Expectancy, Social Influence, Facilitating Conditions, Perceived Susceptibility, Self-Efficacy, and Trust all had significant relationships with the behavioural intention to use mobile apps to access COVID-19 information. On the contrary, effort expectancy did not. The influence of effort expectancy and social influence on behavioural intention to use mobile apps to access information on COVID-19 was found to be moderated by age.

In summary, the study draws the following conclusions following the discussion presented in Chapter Six of the study: Constructs such as performance expectancy, social influence, facilitating conditions, trust, perceived susceptibility, and self-efficacy are critical indicators of the behavioural intention to use mobile apps to access emergency-risk public health information. The study concludes that once the behavioural intention to use mobile apps to access information on COVID-19 is conceived, there is a greater probability that this will lead to the actual use of mobile apps. This is particularly useful from the perspective of the user.

The implications are that any public health communication that targets users, especially people aged 35 or younger, must be designed to offer pertinent information (performance

expectancy) about the infectious disease(s). Also, the message must be perceived to offer genuine or authentic information about the disease of public concern (trust). Nonetheless, this cannot be said to be exclusive, as this study has shown that the behavioural intention for an individual to use mobile apps to access information on infectious diseases does not only rest with the individual. That intention could be influenced by other important people in the life of the user (social influence). This is even more pronounced in the case of people aged 35 or older.

Therefore, the utilisation of pre-existing social spaces among Ghanaians is recommended as an effective means to disseminate messages aimed at curbing the transmission of infectious diseases. It is important to acknowledge, however, that while social influence provides a valuable avenue for raising awareness among citizens about infectious diseases, it can also potentially hinder the success of public health campaigns if influential individuals within these social spaces remain unconvinced by the conveyed messages. As a result, public health communicators are strongly advised to direct their efforts not only towards engaging social spaces but to be particularly attentive when targeting influential figures within society, especially those who wield significant appeal over the older population (36 years or older). By enlisting the support of such influential individuals, these communicators can effectively amplify the spread of essential messages pertaining to public health on mobile apps, thereby enhancing the likelihood of achieving successful outcomes in disease control and prevention initiatives.

Additionally, the study concludes that the more people could perform prescribed response

behaviours or protocols shared on mobile apps, the greater the chances of users embracing the idea of patronising such information on how to remain safe (perceived self-efficacy). Moreover, the study has shown that the more individuals perceive that they are susceptible to the disease of public concern, they tend to develop a positive intention towards using mobile apps to seek information about the disease of public concern.

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APPENDIX A: Ethical Approval Letter

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)
P. O. Box LG 74, Legon, Accra, Ghana

My Ref. No…ECH 345/ 21-22 …

1st August, 2022.

Mr. Daniel Kwame Ampofo Adjei
Department of Communication Studies
University of Ghana
Ghana

ETHICAL CLEARANCE
(ECH 345/ 21-22)

The protocol title below has been reviewed and approved by the ECH Committee.

TITLE OF PROTOCOL: **PREDICTORS OF PUBLIC HEALTH MOBILE APPS USAGE: THE CASE OF EMERGENCE OF COVID-19 IN GHANA**

PRINCIPAL INVESTIGATOR: **MR. DANIEL KWAME AMPOFO ADJEI**

Please note that the final review report must be submitted to the Committee at the completion of the study. Your research records may be audited at any time during or after the implementation. Any modification of this research project must be submitted to ECH for review and approval prior to implementation.

Please report all serious adverse events related to this study to ECH within seven (7) days verbally and in writing within fourteen (14) days.

This certificate is valid till July 19, 2023. You are required to submit annual reports for continuing review.

Please accept my congratulations.

Yours Sincerely,

Professor C. Charles Mate-Kole
ECH Chair

Cc: Dr Gilbert Tietaah, Department of Communication Studies, University of Ghana
Dr Abena Animwaa Yeboah-Banin, Dept. of Communication Studies, University of Ghana

Tel: +233-303933866 Email: ech@ug.edu.gh

APPENDIX B: Copy of Informed Consent Form

UNIVERSITY OF GHANA

Official Use only Protocol number

Ethics Committee for Humanities (ECH)

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study:	Predictors of Mobile Apps Use in Accessing Emergency Risk Public Health Information: The case of COVID-19 Pandemic in Ghana
Principal Investigator:	Daniel Kwame Ampofo Adjei
Certified Protocol Number	ECH 345/ 21-22

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

Dear respondent, this questionnaire seeks information on factors that affect the use of public health mobile apps within the context of the emergence of COVID-19 outbreak in Ghana. The estimated time required to complete this questionnaire is approximately 15minutues. You will be required to indicate your level of agreement or disagreement with statements, as well as providing feedback to predefined responses that relate to your circumstances as read out to you by the Field Officer. Please note: You must be 18 or older to participate in this study.

Benefits/Risks of the study

Though there are no direct benefits, there will be some indirect benefits. The results are principally for academic purposes; however, they will also offer empirical evidence to policy actors on the views and

concerns of residents of Ghana who are the target in any public health communication campaign efforts.

Confidentiality

The data will be treated with confidentially in accordance with the Data Protection Act, 2012 (Act 843) of Ghana, as well as the University of Ghana Research and Ethical requirements for conducting research throughout the research process. All personal information will be anonymized. If you consent to complete this survey, click on yes to move to the next phase of completing the questionnaire.

Compensation

There is no remuneration for completing this survey.

Withdrawal from Study

You are not obliged to respond to all the questions, and you may end the interview at any time.

Contact for Additional Information

If you have any questions about this study, please contact Daniel Kwame Ampofo Adjei: 0234767263, e-mail: dkaadjei@gmail.com If you have any questions about your rights as a research participant in this study you may contact the Administrator of the Ethics Committee for Humanities, ISSER, University of Ghana at ech@ug.edu.gh or 00233- 303-933-866.

Section C- PARTICIPANT AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____

Name of Participant

_____ _____

Signature or mark of Participant Date

APPENDIX C: Copy of Data Collection Instrument

Part 1: Demographic Information

Please type/tick/check the appropriate box/space that corresponds to your response

1. Please indicate your age as of last birthday: …….
2. Gender: [ ]Female [ ]Male [ ]Other
3. Nationality: [ ]Ghanaian [ ]Non-Ghanaian ECOWAS [ ]Non-Ghanaian Other African [ ]European

   [ ]American [ ]Asian/Oceanian
4. Marital status: [ ]Married [ ]Widowed [ ]Divorced [ ]Separated [ ]Single
5. Education: [ ]JHS/Middle School [ ]SHS/Vocational/Technical [ ]Diploma [ ]HND/Degree [ ]Masters' Degree [ ]PhD
6. Religious affiliation: [ ]Catholic [ ]Pentecostal/Charismatic [ ]Protestant [ ]Other Christian [ ]Traditional African religion [ ]Islam [ ]No Religion [ ]Other
7. Employment status: [ ]Employed, Public/Civil Servant [ ]Self Employed [ ]Retired [ ]Employed Private sector [ ]Not employed, looking for work [ ]Not employed, not looking for work
8. Region of residence: [ ]Greater Accra [ ]Eastern [ ]Volta [ ]Oti [ ]Central [ ]Western [ ]Western North [ ]Ashanti [ ] Ahafo [ ]Bono [ ]Bono East [ ]Savanna [ ]North East [ ]Northern [ ]Upper East [ ]Upper West
9. Ethnicity: [ ]Akan [ ]Mole-Dagbon [ ]Ewe [ ]Ga-Dangme [ ]Gurma [ ]Guan [ ]Grusi [ ]Kusaasi [ ]Mande
10. Do you have any physical or mental health conditions or illnesses that has lasted since January 2020, and is expected to last for the next 12 months or more? [ ]Yes [ ]No

Part 2: Extent of use of mobile apps during the peak of COVID-19 pandemic

This section of the questionnaire seeks information on the extent of use of mobile apps to access information on COVID-19 during the peak of the pandemic, thus from January 2020 to December 2021.

11. On the average, how **many** times within a day, did you use mobile apps/social media to access (read/watch/listen) information on COVID-19**?**
    [ ]Never [ ] Once a day [ ]2 to 5 times [ ]6 to 10 [ ]More than 10 times [ ]I don't know

12. On the average, how **much** time within a day, did you spend on mobile apps to access COVID-19 information**?**

[ ]Never [ ]Less than 1hour [ ]1-2 hours [ ]3-4 hours [ ]More than 4 hours [ ]I don't know

13. What kind of COVID-19 information do you use mobile apps to access**?**

[ ]Incidence rates [ ]Mode of transmission [ ]Face/nose masks [ ]Availability of vaccines [ ]Symptoms [ ]Safety of vaccines [ ]Treatment options [ ]Preventive mechanisms

Part 3: Extent of use of mobile apps

This section of the questionnaire seeks information on current (present-day) use of mobile apps to access information on COVID-19.

14. On the average, how **many** times within a day, do you use mobile apps/social media to access (read/watch/listen) information on COVID-19?

[ ]Never [ ] Once a day [ ]2 to 5 times [ ]6 to 10 [ ]More than 10 times [ ]I don't know

15. On the average, how **much** time within a day**,** do you spend on mobile apps to access COVID-19 information?

[ ]Never[ ]Less than 1hour [ ]1-2 hours [ ]3-4 hours [ ]More than 4 hours [ ]I don't know.

Part 4: Factors affecting use of COVID-19 mobile apps

Using a rating scale from the lowest point of 1 to the highest point of 5, indicate your level of agreement or disagreement with the following statements.

16	**Performance Expectancy (PE)**	**1**	**2**	**3**	**4**	**5**
16.1	PE1. I find mobile apps useful in my daily life					
16.2	PE2. Using mobile apps helps me get information on COVID-19 more quickly					
16.3	PE3. Using mobile apps to access information on COVID-19 helps me to stay safe					
16.4	PE4. I get factual information on COVID-19 on my mobile apps					
17	**Effort Expectancy (EE)**	**1**	**2**	**3**	**4**	**5**
17.1	EE1. Learning how to use mobile apps is easy for me					
17.2	EE2. My interaction with mobile apps is clear and understandable.					
17.3	EE3. I find it easy using mobile apps to access information on COVID-19					

18	**Social Influence (SI)**	**1**	**2**	**3**	**4**	**5**
18.1	SI1. People who are important to me think that I should use mobile apps to access information on COVID-19					
18.2	SI2. People who influence my behaviour think that I should use mobile apps to access information on COVID-19					
18.3	SI3. People whose opinion I value, prefer that I use mobile apps to access information on COVID-19.					
19	**Facilitating Conditions (FC)**	**1**	**2**	**3**	**4**	**5**
19.1	FC1. I have a smart phone that supports the use mobile apps.					
19.2	FC2. The network in my community supports the use mobile apps.					
19.3	FC3. I have the knowledge necessary to use mobile apps.					
20	**Behavioural Intention (BI)**	**1**	**2**	**3**	**4**	**5**
20.1	BI1. I intend to use mobile apps in the future to access information on COVID-19 and other future disease outbreaks.					
20.2	BI2. I will always try to use mobile apps in my daily life to access information on COVID-19 and other future disease outbreaks.					
20.3	BI3. I plan to use mobile apps frequently to access information on COVID-19 and other future disease outbreaks.					
21	**Trust**	**1**	**2**	**3**	**4**	**5**
21.1	T1. I belief that mobile apps facilitate genuine information on COVID-19					
21.2	T2. Mobile apps are designed to ensure that information on COVID-19 are genuine					
22	**Self-Efficacy (SE)**	**1**	**2**	**3**	**4**	**5**
22.1	SE1. I understand the COVID-19 information I receive from the mobile apps I use					
22.2	SE2. I am able to perform the prescribed behaviours the mobile apps ask me to do to avoid COVID-19					
22.3	SE3. I am able to use the help functions of mobile apps whenever I need them for COVID-19 information					
23	**Perceived Susceptibility (PS)**	**1**	**2**	**3**	**4**	**5**
23.1	PS1. I believe that the COVID-19 virus can spread from one person to another					
23.2	PS2. I believe that I can easily be infected by the COVID-19 virus					
23.3	PS3. I believe that the COVID-19 is a killer disease					

24	Use Behaviour (UB)	1	2	3	4	5
24.1	UB1: I use mobile apps to share information on COVID-19					
24.2	UB2: Using mobile apps to share information on COVID-19 is a pleasant experience					
24.3	UB3: I currently use mobile apps to access information on COVID-19					
24.4	UB4: I spend a lot of time using mobile apps to access information on COVID-19.					

Appendix D: List of systematically reviewed articles

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
1	Madianou (2020)	A Second-Order Disaster? Digital Technologies During the COVID-19 Pandemic	Social Media + Society	2020	COVID-19	Developed	Europe	UK	Atheoretical	Qualitative	Social inequalities, tracing
2	Walraveet al. (2020)	Adoption of a Contact Tracing App for Containing COVID-19: A Health Belief Model Approach	JMIR Public Health Surveill	2020	COVID-19	Developed	Europe	Belgium	Health Belief Model	Survey	Adoption
3	Yamin & Alyoubi, (2020)	Adoption of telemedicine applications among Saudi citizens during COVID-19 pandemic An alternative health delivery system	J Infect Public Health	2020	COVID-19	Developing	Asia	Saudi Arabia	UTAUT	Survey	Adoption
4	Narla et al. (2020)	Agile Application of Digital Health Interventions during the COVID-19 Refugee Response	Annals of Global Health	2020	COVID-19	Developing	Asia	Syria	Atheoretical	Survey	Adoption
5	Mao et al. (2020)	An integrated biosensor system	Biosens Bioelectr	2020	COVID-19	Global			Atheoretical	Experiment	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		with mobile health and wastewater-based epidemiology (iBMW) for COVID-19 pandemic	on								
6	Sekalala et al. (2020)	Analyzing the Human Rights Impact of Increased Digital Public Health Surveillance during the COVID-19 Crisis	Health and Human Rights Journal	2020	COVID-19	Global			Atheoretical	Qualitative	Human rights Contact tracing
7	Guillon et al. (2020)	Attitudes and opinions on quarantine and support for a contact-tracing application in France during the COVID-19 outbreak	Public Health Journal	2020	COVID-19	Developed	Europe	France	Health Belief Model	Survey - cross-sectional study	Contact tracing
8	Kariuki et al (2021)	Challenges in contact tracing by mining mobile phone location data for covid-19: implications for public governance in South Africa	Interdisciplinary Journal of Information, Knowledge, and	2021	COVID-19	Developing	Africa	South Africa	Atheoretical	Qualitative	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
9	Lin & Hou (2020)	Combat COVID-19 with artificial intelligence and bigdata	Management Journal of Travel Medicine	2020	COVID-19	Global			Atheoretical	Qualitative	Contact tracing, AI
10	Nachega at al. (2021)	Contact Tracing and the COVID-19 Response in Africa: Best Practices, Key Challenges, and Lessons Learned from Nigeria, Rwanda, South Africa, and Uganda	The American Journal of Tropical Medicine and Hygiene	2021	COVID-19	Developing	Africa	Nigeria, Rwanda, Uganda, South Africa	Atheoretical	Qualitative	Contact tracing
11	Rowe (2020)	Contact-tracing apps and alienation in the age of COVID-19	European Journal of Information Systems	2020	COVID-19	Developed	Europe	France	critical social theory, alienation,	Qualitative	Adoption
12	Echeverría et al, (2020)	COVIDApp as an Innovative Strategy for the Management and Follow-Up of COVID-19 Cases in Long-Term Care Facilities in Catalonia: Implementation	JMIR Public Health Surveill	2020	COVID-19	Developed	Europe	Spain	Atheoretical		

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
13	Maphosa (2021)	Study COVID-19 and the Digital Ecosystem Using a Mobile App to connect rural community	Aquademia	2021	COVID-19	Developing	Africa	Zimbabwe	Information System Development Methodology	Survey	Development of App
14	Goggin (2020)	COVID-19 apps in Singapore and Australia: reimagining healthy nations with digital technology	Media International Australia	2020	COVID-19	Developed	Asia	Singapore and Australia	Atheoretical		Contact tracing
15	Du et al. (2020)	COVID-19 Contact Tracing Apps A Technologic Tower of Babel and the Gap for International Pandemic Control	JMIR mHealth and uHealth	2020	COVID-19	Global			Atheoretical	Qualitative	Contact tracing
16	Zhang et al. (2020)	COVID-19 Contact-Tracing Apps Analysis of the Readability of Privacy Policies	Journal of medical Internet research	2020	COVID-19	Global		Ghana, Singapore, Australia, Columbia, Bahrain, Iceland,	Atheoretical	Qualitative	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
17	Liu (2020)	COVID-19 Information Seeking on Digital Media and Preventive Behaviors The Mediation Role of Worry	Cyberpsychology, behavior and social networking	2020	COVID-19	Developed	Asia	New Zealand China	Atheoretical	Quantitative	Contact tracing
18	Ekong et al. (2020)	COVID-19 Mobile Positioning Data Contact Tracing and Patient Privacy Regulations: Exploratory Search of Global Response Strategies and the Use of Digital Tools in Nigeria	JMIR Mhealth Uhealth	2020	COVID-19	Developing	Africa	Nigeria	Atheoretical	Qualitative (exploratory review)	Contact tracing
19	Verhagen et al. (2020)	COVID-19 response in low- and middle-income countries: Don't overlook the role of mobile phone communication	International Journal of Infectious Diseases	2020	COVID-19	Developed	Africa		Atheoretical	Qulitative	Contact tracing
20	Chatterjae et al. (2020)	COVID-19 Risk Assessment Tool: Dual application of	Progress in Disaster	2020	COVID-19	Global			Atheoretical	Qulitative	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		risk communication and risk governance	Science								
21	Fahey & Hino (2020)	COVID-19, digital privacy, and the social limits on data-focused public health responses	International Journal of Information Management	2020	COVID-19	Global			Atheoretical	Qulitative	Contact tracing
22	Le et al. (2020)	Demand for Health Information on COVID-19among Vietnamese	International Journal of Environmental Research and Public Health	2020	COVID-19	Developing	Asia	Vietnam	Atheoretical	Quantitative (Survey)	Health Information
23	Krausz et al. (2020)	Emergency Response to COVID-19 in Canada: Platform Development and Implementation for eHealth in Crisis Management	JMIR public health and surveillance	2020	COVID-19	Developed	North America	Canada	Atheoretical	Qualitative	Disease management/ Contact tracing
24	Fernández-Díaz et al.	Exploring WHO Communication	International	2020	COVID-19	Global			Atheoretical	Qualitative	Accessbility/Inclusion

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
	(2020)	during the COVID 19 Pandemic through the WHO Website Based on W3C Guidelines: Accessible for All?	journal of environmental research and public health								
25	Arghittu et al (2021)	Health Communication in COVID-19 Era: Experiences from theItalian VaccinarSìNetwork Websites	International Journal of Environmental Research and Public Health	2021	COVID-19	Developed	Europe	Italy	Atheoretical	Qualitative	Adoption
26	Yamamoto et al. (2020)	Health Observation App for COVID-19 Symptom Tracking Integrated With Personal Health Records Proof of Concept and Practical Use Study	JMIR mHealth and uHealth	2020	COVID-19	Developed	Asia	Japan	Atheoretical	Qualitative	Disease management/ Adoption
27	Kothari (2021)	How do Canadian public health agencies respond to the COVID-19	BMJ Open	2021	COVID-19	Developed	North America	Canada	Atheoretical	Qualitative (Case study)	Public engagement

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		emergency using social media a protocol for a case study using content and sentiment analysis									
28	Kretzschmar et al (2020)	Impact of delays on effectiveness of contact tracing strategies for COVID-19: a modelling study	Lancet Public Health	2020	COVID-19	Global			Atheoretical	Qualitative	Contact tracing
29	Urbaczewskia et al. (2020)	Information Technology and the pandemic: a preliminary multinational analysis of the impact of mobile tracking technology on the COVID-19 contagion control	European Journal of Information Systems	2020	COVID-19	Global		China, Germany, Italy, Singapore, South Korea, USA	Atheoretical	Qualitative (Experimental design)	Contact tracing
30	Bae et al. (2020)	Information Technology Based Management of Clinically Healthy COVID-19 Patients Lessons From a Living and Treatment Support	Journal of medical Internet research	2020	COVID-19	Developed	Asia	South Korea	Atheoretical	Quantitative	Disease management/ Adoption

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		Center Operated by Seoul National University Hospital									
31	Srikanth et al (2021)	Mobile App–Reported Use of Traditional Medicine for Maintenance of Health in India During the COVID-19 Pandemic: Cross-sectional Questionnaire Study	JMIRx med	2021	COVID-19	Developing	Asia	India	Atheoretical	Survey	Adoption
32	Alsyouf (2020)	Mobile Health for covid-19 Pandemic Surveillance in Developing Countries: the case of Saudi Arabia	Solid State Technology	2020	COVID-19	Developing	Asia	Saudi Arabia	Atheoretical	Qualitative	Contact Tracing
33	Pai et al. (2020)	Mobile health intervention and COVID-19 pandemic outbreak: insights from Indian context	IJHG	2020	COVID-19	Developing	Asia	India	Atheoretical	Qualitative, Quantitative	Adoption
34	Kaspar (2020)	Motivations for Social Distancing and App Use as Complementary	J Med Internet	2020	COVID-19	Developed	Europe	Germany	Protection Motivation	Survey	Privacy, Adoption

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		Measures to Combat the COVID-19 Pandemic: Quantitative Survey Study							Theory (PMT)		
35	Malik (2021)	Public health agencies outreach through Instagram during the COVID-19 pandemic: Crisis and Emergency Risk Communication perspective	International Journal of Disaster Risk Reduction	2021	COVID-19	Global				Qualitative	Public engagement
36	Li et al. (2020)	Social Media Use, eHealth Literacy, Disease Knowledge, and Preventive Behaviors in the COVID-19 Pandemic Cross-Sectional Study on Chinese Netizens	Journal of medical Internet research	2020	COVID-19	Developed	Asia	China		Quantitative	Public engagement
37	Lee et al. (2021)	Testing on the move: South Korea's rapid response to the COVID-19	Transportation Research Interdisciplinary	2020	COVID-19	Developed	Asia	South Korea		Qualitative	Contact Tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		pandemic	Perspectives								
38	Satre et al. (2021)	Opportunities to Integrate Mobile App–BasedInterventions Into Mental Health and Substance UseDisorder Treatment Services in the Wake of COVID-19	American Journal of Health Promotion	2021	COVID-19	Global					
39	Ali et al. (2020)	Trends and Predictors of COVID-19 Information Sources and Their Relationship With Knowledge and Beliefs Related to the Pandemic: Nationwide Cross-Sectional Study	JMIR Public Health Surveill	2020	COVID-19	Developed	North America	USA	Health Belief Model	Quantitative	Adoption
40	Rheault et al. (2021)	Explaining Support for COVID-19 Cell Phone Contact Tracing	Canadian Journal of Political Science	2021	COVID-19	Developed	North America	Canada	Framing, Disease Avoidance	Quantitative (Experimental design)	Contact Tracing
41	Oldeweme et al.	The Role of Transparency,	J Med Internet	2021	COVID-19	Developed	Europe	Germany	Uncertainty	Quantitative	Adoption, Contact

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
	(2021)	Trust, and Social Influence on Uncertainty Reduction in Times of Pandemics: Empirical Study on the Adoption of COVID-19 Tracing Apps							Reductio n Theory (URT)		Tracing
42	McCarthy (2017)	Check and Report Ebola (CARE) Hotline: The User Perspective of an Innovative Tool for Postarrival Monitoring of Ebola in the United States	JMIR Public Health Surveill	2017	Ebola	Develope d	North Americ a	USA	Atheoreti cal	Mixed	Public Engageme nt
43	Hines (2015).	Citizen science Exploring its application as a tool for prodromic surveillance of vector-borne disease	Canada communi cable disease report	2015	Lyme Disease	Develope d	North Americ a	Canada	Atheoreti cal	Qualitati ve	Contact tracing and souvillence
44	Tambo (2017)	Digital Technology and Mobile Applications Impact on Zika and Ebola	Journal of Health & Medical Informati	2017	Ebola/ Zika Virus	Global			Atheoreti cal	Qualitati ve	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		Epidemics Data Sharing and Emergency Response	cs								
45	Colubri (2016)	Transforming Clinical Data into Actionable Prognosis Models: Machine-Learning Framework and Field-Deployable App to Predict Outcome of Ebola Patients	PLoS neglected tropical diseases	2016	Ebola	Developing	Africa	Sierra Leone	Atheoretical	Quantitative	Disease management
46	Tom-Abaet al. (2015).	Innovative Technological Approach to Ebola Virus Disease Outbreak Response in Nigeria Using the Open Data Kit and Form Hub Technology	PloS one, 10(6)	2015	Ebola	Developing	Africa	Nigeria	Atheoretical	Quantitative	Disease management
47	Danquah et al. (2019)	Use of a mobile application for Ebola contact tracing and monitoring in northern Sierra Leone: a	BMC Infectious Diseases	2019	Ebola	Developing	Africa	Sierra Leone	Atheoretical	Mixed	Contact tracing

No.	Author(s)	Tittle of Paper	Journal	Year	Public Health Issue	Area of Study	Region	Country	Theories used	Method	Key Themes
		proof-of-concept study									
48	Do et al. (2016)	Modeling the Spread of Ebola.	Osong public health and research perspectives, 7(1), 43–48.	2016	Ebola	Global			Atheoretical	Mixed	Disease management
49	Marin-Gomez et al. (2018)	Social Networking App Use Among Primary Health Care Professionals: Web-Based Cross-Sectional Survey	JMIR mHealth and uHealth, 6(12), e11147	2018	Ebola	Developed	Europe	Spain	Atheoretical	Quantitative	Disease management
50	Wilhide et al., (2016)	Evidence-Based mHealth Chronic Disease Mobile App Intervention Design: Development of a Framework	JMIR Research Protocol	2016		global			Atheoretical	Qualitative	Disease management

Source: Field data, 2022

Appendix E: Sampling Frame for the study

No.	Region	District	Structure No.
1	Ashanti	SUAME MUNICIPAL	2
2	Ashanti	SUAME MUNICIPAL	6
3	Ashanti	SUAME MUNICIPAL	6
4	Ashanti	SUAME MUNICIPAL	10
5	Ashanti	SUAME MUNICIPAL	19
6	Ashanti	SUAME MUNICIPAL	40
7	Ashanti	SUAME MUNICIPAL	48
8	Ashanti	SUAME MUNICIPAL	52
9	Ashanti	SUAME MUNICIPAL	53
10	Ashanti	SUAME MUNICIPAL	54
11	Ashanti	SUAME MUNICIPAL	54
12	Ashanti	SUAME MUNICIPAL	56
13	Ashanti	SUAME MUNICIPAL	62
14	Ashanti	SUAME MUNICIPAL	64
15	Ashanti	SUAME MUNICIPAL	69
16	Ashanti	SUAME MUNICIPAL	70
17	Ashanti	SUAME MUNICIPAL	77
18	Ashanti	SUAME MUNICIPAL	82
19	Ashanti	SUAME MUNICIPAL	83
20	Ashanti	SUAME MUNICIPAL	86
21	Ashanti	SUAME MUNICIPAL	90
22	Ashanti	SUAME MUNICIPAL	90
23	Ashanti	SUAME MUNICIPAL	90
24	Ashanti	SUAME MUNICIPAL	93

No.	Region	District	Structure No.
25	Ashanti	SUAME MUNICIPAL	96
26	Ashanti	SUAME MUNICIPAL	5
27	Ashanti	SUAME MUNICIPAL	10
28	Ashanti	SUAME MUNICIPAL	11
29	Ashanti	SUAME MUNICIPAL	11
30	Ashanti	SUAME MUNICIPAL	14
31	Ashanti	SUAME MUNICIPAL	21
32	Ashanti	SUAME MUNICIPAL	30
33	Ashanti	SUAME MUNICIPAL	38
34	Ashanti	SUAME MUNICIPAL	49
35	Ashanti	SUAME MUNICIPAL	52
36	Ashanti	SUAME MUNICIPAL	54
37	Ashanti	SUAME MUNICIPAL	54
38	Ashanti	SUAME MUNICIPAL	54
39	Ashanti	SUAME MUNICIPAL	69
40	Ashanti	SUAME MUNICIPAL	73
41	Ashanti	SUAME MUNICIPAL	79
42	Ashanti	SUAME MUNICIPAL	82
43	Ashanti	SUAME MUNICIPAL	90
44	Ashanti	SUAME MUNICIPAL	91
45	Ashanti	SUAME MUNICIPAL	91
46	Ashanti	SUAME MUNICIPAL	92
47	Ashanti	SUAME MUNICIPAL	93
48	Ashanti	SUAME MUNICIPAL	96
49	Ashanti	SUAME MUNICIPAL	98
50	Ashanti	SUAME MUNICIPAL	102

No.	Region	District	Structure No.
51	Ashanti	SUAME MUNICIPAL	19
52	Ashanti	SUAME MUNICIPAL	19
53	Ashanti	SUAME MUNICIPAL	20
54	Ashanti	SUAME MUNICIPAL	21
55	Ashanti	SUAME MUNICIPAL	21
56	Ashanti	SUAME MUNICIPAL	23
57	Ashanti	SUAME MUNICIPAL	24
58	Ashanti	SUAME MUNICIPAL	26
59	Ashanti	SUAME MUNICIPAL	26
60	Ashanti	SUAME MUNICIPAL	27
61	Ashanti	SUAME MUNICIPAL	28
62	Ashanti	SUAME MUNICIPAL	28
63	Ashanti	SUAME MUNICIPAL	32
64	Ashanti	SUAME MUNICIPAL	32
65	Ashanti	SUAME MUNICIPAL	33
66	Ashanti	SUAME MUNICIPAL	33
67	Ashanti	SUAME MUNICIPAL	33
68	Ashanti	SUAME MUNICIPAL	34
69	Ashanti	SUAME MUNICIPAL	51
70	Ashanti	SUAME MUNICIPAL	53
71	Ashanti	SUAME MUNICIPAL	53
72	Ashanti	SUAME MUNICIPAL	55
73	Ashanti	SUAME MUNICIPAL	55
74	Ashanti	SUAME MUNICIPAL	55
75	Ashanti	SUAME MUNICIPAL	84
76	Ashanti	SUAME MUNICIPAL	1

No.	Region	District	Structure No.
77	Ashanti	SUAME MUNICIPAL	2
78	Ashanti	SUAME MUNICIPAL	15
79	Ashanti	SUAME MUNICIPAL	22
80	Ashanti	SUAME MUNICIPAL	22
81	Ashanti	SUAME MUNICIPAL	23
82	Ashanti	SUAME MUNICIPAL	27
83	Ashanti	SUAME MUNICIPAL	44
84	Ashanti	SUAME MUNICIPAL	44
85	Ashanti	SUAME MUNICIPAL	47
86	Ashanti	SUAME MUNICIPAL	52
87	Ashanti	SUAME MUNICIPAL	53
88	Ashanti	SUAME MUNICIPAL	60
89	Ashanti	SUAME MUNICIPAL	66
90	Ashanti	SUAME MUNICIPAL	67
91	Ashanti	SUAME MUNICIPAL	67
92	Ashanti	SUAME MUNICIPAL	78
93	Ashanti	SUAME MUNICIPAL	81
94	Ashanti	SUAME MUNICIPAL	81
95	Ashanti	SUAME MUNICIPAL	84
96	Ashanti	SUAME MUNICIPAL	84
97	Ashanti	SUAME MUNICIPAL	85
98	Ashanti	SUAME MUNICIPAL	86
99	Ashanti	SUAME MUNICIPAL	90
100	Ashanti	SUAME MUNICIPAL	91
101	Ashanti	SUAME MUNICIPAL	1
102	Ashanti	SUAME MUNICIPAL	1

No.	Region	District	Structure No.
103	Ashanti	SUAME MUNICIPAL	1
104	Ashanti	SUAME MUNICIPAL	11
105	Ashanti	SUAME MUNICIPAL	12
106	Ashanti	SUAME MUNICIPAL	13
107	Ashanti	SUAME MUNICIPAL	28
108	Ashanti	SUAME MUNICIPAL	41
109	Ashanti	SUAME MUNICIPAL	63
110	Ashanti	SUAME MUNICIPAL	100
111	Ashanti	SUAME MUNICIPAL	100
112	Ashanti	SUAME MUNICIPAL	100
113	Ashanti	SUAME MUNICIPAL	102
114	Ashanti	SUAME MUNICIPAL	105
115	Ashanti	SUAME MUNICIPAL	116
116	Ashanti	SUAME MUNICIPAL	117
117	Ashanti	SUAME MUNICIPAL	117
118	Ashanti	SUAME MUNICIPAL	126
119	Ashanti	SUAME MUNICIPAL	128
120	Ashanti	SUAME MUNICIPAL	129
121	Ashanti	SUAME MUNICIPAL	130
122	Ashanti	SUAME MUNICIPAL	131
123	Ashanti	SUAME MUNICIPAL	134
124	Ashanti	SUAME MUNICIPAL	138
125	Ashanti	SUAME MUNICIPAL	144
126	Bono	SUNYANI MUNICIPAL	1
127	Bono	SUNYANI MUNICIPAL	2
128	Bono	SUNYANI MUNICIPAL	3

No.	Region	District	Structure No.
129	Bono	SUNYANI MUNICIPAL	11
130	Bono	SUNYANI MUNICIPAL	13
131	Bono	SUNYANI MUNICIPAL	13
132	Bono	SUNYANI MUNICIPAL	16
133	Bono	SUNYANI MUNICIPAL	21
134	Bono	SUNYANI MUNICIPAL	24
135	Bono	SUNYANI MUNICIPAL	28
136	Bono	SUNYANI MUNICIPAL	36
137	Bono	SUNYANI MUNICIPAL	40
138	Bono	SUNYANI MUNICIPAL	42
139	Bono	SUNYANI MUNICIPAL	46
140	Bono	SUNYANI MUNICIPAL	55
141	Bono	SUNYANI MUNICIPAL	55
142	Bono	SUNYANI MUNICIPAL	59
143	Bono	SUNYANI MUNICIPAL	65
144	Bono	SUNYANI MUNICIPAL	66
145	Bono	SUNYANI MUNICIPAL	68
146	Bono	SUNYANI MUNICIPAL	68
147	Bono	SUNYANI MUNICIPAL	69
148	Bono	SUNYANI MUNICIPAL	76
149	Bono	SUNYANI MUNICIPAL	82
150	Bono	SUNYANI MUNICIPAL	83
151	Bono East	TECHIMAN MUNICIPAL	1
152	Bono East	TECHIMAN MUNICIPAL	13
153	Bono East	TECHIMAN MUNICIPAL	20
154	Bono East	TECHIMAN MUNICIPAL	21

No.	Region	District	Structure No.
155	Bono East	TECHIMAN MUNICIPAL	28
156	Bono East	TECHIMAN MUNICIPAL	35
157	Bono East	TECHIMAN MUNICIPAL	51
158	Bono East	TECHIMAN MUNICIPAL	69
159	Bono East	TECHIMAN MUNICIPAL	74
160	Bono East	TECHIMAN MUNICIPAL	83
161	Bono East	TECHIMAN MUNICIPAL	87
162	Bono East	TECHIMAN MUNICIPAL	100
163	Bono East	TECHIMAN MUNICIPAL	105
164	Bono East	TECHIMAN MUNICIPAL	111
165	Bono East	TECHIMAN MUNICIPAL	124
166	Bono East	TECHIMAN MUNICIPAL	133
167	Bono East	TECHIMAN MUNICIPAL	146
168	Bono East	TECHIMAN MUNICIPAL	156
169	Bono East	TECHIMAN MUNICIPAL	162
170	Bono East	TECHIMAN MUNICIPAL	179
171	Bono East	TECHIMAN MUNICIPAL	188
172	Bono East	TECHIMAN MUNICIPAL	191
173	Bono East	TECHIMAN MUNICIPAL	198
174	Bono East	TECHIMAN MUNICIPAL	200
175	Bono East	TECHIMAN MUNICIPAL	225
176	Bono East	ATEBUBU AMANTIN	1
177	Bono East	ATEBUBU AMANTIN	3
178	Bono East	ATEBUBU AMANTIN	3
179	Bono East	ATEBUBU AMANTIN	8
180	Bono East	ATEBUBU AMANTIN	14

No.	Region	District	Structure No.
181	Bono East	ATEBUBU AMANTIN	16
182	Bono East	ATEBUBU AMANTIN	18
183	Bono East	ATEBUBU AMANTIN	24
184	Bono East	ATEBUBU AMANTIN	30
185	Bono East	ATEBUBU AMANTIN	38
186	Bono East	ATEBUBU AMANTIN	42
187	Bono East	ATEBUBU AMANTIN	44
188	Bono East	ATEBUBU AMANTIN	53
189	Bono East	ATEBUBU AMANTIN	53
190	Bono East	ATEBUBU AMANTIN	54
191	Bono East	ATEBUBU AMANTIN	59
192	Bono East	ATEBUBU AMANTIN	61
193	Bono East	ATEBUBU AMANTIN	61
194	Bono East	ATEBUBU AMANTIN	66
195	Bono East	ATEBUBU AMANTIN	69
196	Bono East	ATEBUBU AMANTIN	72
197	Bono East	ATEBUBU AMANTIN	74
198	Bono East	ATEBUBU AMANTIN	83
199	Bono East	ATEBUBU AMANTIN	84
200	Bono East	ATEBUBU AMANTIN	92
201	Central	EFFUTU	3
202	Central	EFFUTU	13
203	Central	EFFUTU	20
204	Central	EFFUTU	27
205	Central	EFFUTU	37
206	Central	EFFUTU	48

No.	Region	District	Structure No.
207	Central	EFFUTU	52
208	Central	EFFUTU	65
209	Central	EFFUTU	71
210	Central	EFFUTU	76
211	Central	EFFUTU	84
212	Central	EFFUTU	91
213	Central	EFFUTU	105
214	Central	EFFUTU	111
215	Central	EFFUTU	120
216	Central	EFFUTU	125
217	Central	EFFUTU	133
218	Central	EFFUTU	138
219	Central	EFFUTU	156
220	Central	EFFUTU	161
221	Central	EFFUTU	172
222	Central	EFFUTU	178
223	Central	EFFUTU	186
224	Central	EFFUTU	191
225	Central	EFFUTU	196
226	Central	EFFUTU	2
227	Central	EFFUTU	11
228	Central	EFFUTU	32
229	Central	EFFUTU	35
230	Central	EFFUTU	43
231	Central	EFFUTU	49
232	Central	EFFUTU	54

No.	Region	District	Structure No.
233	Central	EFFUTU	66
234	Central	EFFUTU	81
235	Central	EFFUTU	87
236	Central	EFFUTU	96
237	Central	EFFUTU	102
238	Central	EFFUTU	108
239	Central	EFFUTU	114
240	Central	EFFUTU	123
241	Central	EFFUTU	124
242	Central	EFFUTU	130
243	Central	EFFUTU	146
244	Central	EFFUTU	156
245	Central	EFFUTU	165
246	Central	EFFUTU	170
247	Central	EFFUTU	182
248	Central	EFFUTU	190
249	Central	EFFUTU	212
250	Central	EFFUTU	213
251	Central	EFFUTU	44
252	Central	EFFUTU	60
253	Central	EFFUTU	62
254	Central	EFFUTU	64
255	Central	EFFUTU	77
256	Central	EFFUTU	101
257	Central	EFFUTU	105
258	Central	EFFUTU	122

No.	Region	District	Structure No.
259	Central	EFFUTU	124
260	Central	EFFUTU	125
261	Central	EFFUTU	125
262	Central	EFFUTU	125
263	Central	EFFUTU	129
264	Central	EFFUTU	134
265	Central	EFFUTU	135
266	Central	EFFUTU	155
267	Central	EFFUTU	161
268	Central	EFFUTU	175
269	Central	EFFUTU	198
270	Central	EFFUTU	221
271	Central	EFFUTU	228
272	Central	EFFUTU	228
273	Central	EFFUTU	228
274	Central	EFFUTU	232
275	Central	EFFUTU	237
276	Eastern	NEW JUABEN SOUTH	26
277	Eastern	NEW JUABEN SOUTH	97
278	Eastern	NEW JUABEN SOUTH	155
279	Eastern	NEW JUABEN SOUTH	219
280	Eastern	NEW JUABEN SOUTH	285
281	Eastern	NEW JUABEN SOUTH	338
282	Eastern	NEW JUABEN SOUTH	390
283	Eastern	NEW JUABEN SOUTH	443
284	Eastern	NEW JUABEN SOUTH	471

No.	Region	District	Structure No.
285	Eastern	NEW JUABEN SOUTH	536
286	Eastern	NEW JUABEN SOUTH	584
287	Eastern	NEW JUABEN SOUTH	651
288	Eastern	NEW JUABEN SOUTH	683
289	Eastern	NEW JUABEN SOUTH	737
290	Eastern	NEW JUABEN SOUTH	782
291	Eastern	NEW JUABEN SOUTH	817
292	Eastern	NEW JUABEN SOUTH	857
293	Eastern	NEW JUABEN SOUTH	885
294	Eastern	NEW JUABEN SOUTH	932
295	Eastern	NEW JUABEN SOUTH	994
296	Eastern	NEW JUABEN SOUTH	1060
297	Eastern	NEW JUABEN SOUTH	1101
298	Eastern	NEW JUABEN SOUTH	1152
299	Eastern	NEW JUABEN SOUTH	1199
300	Eastern	NEW JUABEN SOUTH	1242
301	Eastern	NEW JUABEN SOUTH	3
302	Eastern	NEW JUABEN SOUTH	20
303	Eastern	NEW JUABEN SOUTH	22
304	Eastern	NEW JUABEN SOUTH	23
305	Eastern	NEW JUABEN SOUTH	29
306	Eastern	NEW JUABEN SOUTH	36
307	Eastern	NEW JUABEN SOUTH	38
308	Eastern	NEW JUABEN SOUTH	43
309	Eastern	NEW JUABEN SOUTH	48
310	Eastern	NEW JUABEN SOUTH	59

No.	Region	District	Structure No.
311	Eastern	NEW JUABEN SOUTH	63
312	Eastern	NEW JUABEN SOUTH	67
313	Eastern	NEW JUABEN SOUTH	73
314	Eastern	NEW JUABEN SOUTH	81
315	Eastern	NEW JUABEN SOUTH	89
316	Eastern	NEW JUABEN SOUTH	97
317	Eastern	NEW JUABEN SOUTH	100
318	Eastern	NEW JUABEN SOUTH	103
319	Eastern	NEW JUABEN SOUTH	108
320	Eastern	NEW JUABEN SOUTH	112
321	Eastern	NEW JUABEN SOUTH	118
322	Eastern	NEW JUABEN SOUTH	124
323	Eastern	NEW JUABEN SOUTH	126
324	Eastern	NEW JUABEN SOUTH	129
325	Eastern	NEW JUABEN SOUTH	142
326	Eastern	NEW JUABEN SOUTH	5
327	Eastern	NEW JUABEN SOUTH	9
328	Eastern	NEW JUABEN SOUTH	12
329	Eastern	NEW JUABEN SOUTH	13
330	Eastern	NEW JUABEN SOUTH	15
331	Eastern	NEW JUABEN SOUTH	15
332	Eastern	NEW JUABEN SOUTH	27
333	Eastern	NEW JUABEN SOUTH	29
334	Eastern	NEW JUABEN SOUTH	36
335	Eastern	NEW JUABEN SOUTH	47
336	Eastern	NEW JUABEN SOUTH	49

No.	Region	District	Structure No.
337	Eastern	NEW JUABEN SOUTH	50
338	Eastern	NEW JUABEN SOUTH	54
339	Eastern	NEW JUABEN SOUTH	54
340	Eastern	NEW JUABEN SOUTH	55
341	Eastern	NEW JUABEN SOUTH	56
342	Eastern	NEW JUABEN SOUTH	57
343	Eastern	NEW JUABEN SOUTH	61
344	Eastern	NEW JUABEN SOUTH	65
345	Eastern	NEW JUABEN SOUTH	66
346	Eastern	NEW JUABEN SOUTH	67
347	Eastern	NEW JUABEN SOUTH	67
348	Eastern	NEW JUABEN SOUTH	67
349	Eastern	NEW JUABEN SOUTH	97
350	Eastern	NEW JUABEN SOUTH	100
351	Greater Accra	AYAWASO WEST MUNICIPAL	5
352	Greater Accra	AYAWASO WEST MUNICIPAL	7
353	Greater Accra	AYAWASO WEST MUNICIPAL	12
354	Greater Accra	AYAWASO WEST MUNICIPAL	18
355	Greater Accra	AYAWASO WEST MUNICIPAL	28
356	Greater Accra	AYAWASO WEST MUNICIPAL	28
357	Greater Accra	AYAWASO WEST MUNICIPAL	28
358	Greater Accra	AYAWASO WEST MUNICIPAL	30
359	Greater Accra	AYAWASO WEST MUNICIPAL	33
360	Greater Accra	AYAWASO WEST MUNICIPAL	34
361	Greater Accra	AYAWASO WEST MUNICIPAL	38
362	Greater Accra	AYAWASO WEST MUNICIPAL	38

No.	Region	District	Structure No.
363	Greater Accra	AYAWASO WEST MUNICIPAL	38
364	Greater Accra	AYAWASO WEST MUNICIPAL	43
365	Greater Accra	AYAWASO WEST MUNICIPAL	50
366	Greater Accra	AYAWASO WEST MUNICIPAL	53
367	Greater Accra	AYAWASO WEST MUNICIPAL	56
368	Greater Accra	AYAWASO WEST MUNICIPAL	59
369	Greater Accra	AYAWASO WEST MUNICIPAL	61
370	Greater Accra	AYAWASO WEST MUNICIPAL	65
371	Greater Accra	AYAWASO WEST MUNICIPAL	70
372	Greater Accra	AYAWASO WEST MUNICIPAL	91
373	Greater Accra	AYAWASO WEST MUNICIPAL	97
374	Greater Accra	AYAWASO WEST MUNICIPAL	111
375	Greater Accra	AYAWASO WEST MUNICIPAL	115
376	Greater Accra	AYAWASO WEST MUNICIPAL	1
377	Greater Accra	AYAWASO WEST MUNICIPAL	26
378	Greater Accra	AYAWASO WEST MUNICIPAL	51
379	Greater Accra	AYAWASO WEST MUNICIPAL	74
380	Greater Accra	AYAWASO WEST MUNICIPAL	84
381	Greater Accra	AYAWASO WEST MUNICIPAL	91
382	Greater Accra	AYAWASO WEST MUNICIPAL	105
383	Greater Accra	AYAWASO WEST MUNICIPAL	117
384	Greater Accra	AYAWASO WEST MUNICIPAL	133
385	Greater Accra	AYAWASO WEST MUNICIPAL	161
386	Greater Accra	AYAWASO WEST MUNICIPAL	177
387	Greater Accra	AYAWASO WEST MUNICIPAL	190
388	Greater Accra	AYAWASO WEST MUNICIPAL	207

No.	Region	District	Structure No.
389	Greater Accra	AYAWASO WEST MUNICIPAL	221
390	Greater Accra	AYAWASO WEST MUNICIPAL	236
391	Greater Accra	AYAWASO WEST MUNICIPAL	272
392	Greater Accra	AYAWASO WEST MUNICIPAL	295
393	Greater Accra	AYAWASO WEST MUNICIPAL	317
394	Greater Accra	AYAWASO WEST MUNICIPAL	330
395	Greater Accra	AYAWASO WEST MUNICIPAL	348
396	Greater Accra	AYAWASO WEST MUNICIPAL	357
397	Greater Accra	AYAWASO WEST MUNICIPAL	366
398	Greater Accra	AYAWASO WEST MUNICIPAL	373
399	Greater Accra	AYAWASO WEST MUNICIPAL	397
400	Greater Accra	AYAWASO WEST MUNICIPAL	409
401	Greater Accra	AYAWASO WEST MUNICIPAL	7
402	Greater Accra	AYAWASO WEST MUNICIPAL	12
403	Greater Accra	AYAWASO WEST MUNICIPAL	26
404	Greater Accra	AYAWASO WEST MUNICIPAL	34
405	Greater Accra	AYAWASO WEST MUNICIPAL	45
406	Greater Accra	AYAWASO WEST MUNICIPAL	55
407	Greater Accra	AYAWASO WEST MUNICIPAL	67
408	Greater Accra	AYAWASO WEST MUNICIPAL	73
409	Greater Accra	AYAWASO WEST MUNICIPAL	81
410	Greater Accra	AYAWASO WEST MUNICIPAL	88
411	Greater Accra	AYAWASO WEST MUNICIPAL	92
412	Greater Accra	AYAWASO WEST MUNICIPAL	99
413	Greater Accra	AYAWASO WEST MUNICIPAL	107
414	Greater Accra	AYAWASO WEST MUNICIPAL	118

No.	Region	District	Structure No.
415	Greater Accra	AYAWASO WEST MUNICIPAL	129
416	Greater Accra	AYAWASO WEST MUNICIPAL	144
417	Greater Accra	AYAWASO WEST MUNICIPAL	151
418	Greater Accra	AYAWASO WEST MUNICIPAL	166
419	Greater Accra	AYAWASO WEST MUNICIPAL	177
420	Greater Accra	AYAWASO WEST MUNICIPAL	184
421	Greater Accra	AYAWASO WEST MUNICIPAL	193
422	Greater Accra	AYAWASO WEST MUNICIPAL	205
423	Greater Accra	AYAWASO WEST MUNICIPAL	220
424	Greater Accra	AYAWASO WEST MUNICIPAL	239
425	Greater Accra	AYAWASO WEST MUNICIPAL	254
426	Greater Accra	AYAWASO WEST MUNICIPAL	4
427	Greater Accra	AYAWASO WEST MUNICIPAL	18
428	Greater Accra	AYAWASO WEST MUNICIPAL	33
429	Greater Accra	AYAWASO WEST MUNICIPAL	46
430	Greater Accra	AYAWASO WEST MUNICIPAL	62
431	Greater Accra	AYAWASO WEST MUNICIPAL	69
432	Greater Accra	AYAWASO WEST MUNICIPAL	84
433	Greater Accra	AYAWASO WEST MUNICIPAL	93
434	Greater Accra	AYAWASO WEST MUNICIPAL	101
435	Greater Accra	AYAWASO WEST MUNICIPAL	119
436	Greater Accra	AYAWASO WEST MUNICIPAL	135
437	Greater Accra	AYAWASO WEST MUNICIPAL	136
438	Greater Accra	AYAWASO WEST MUNICIPAL	141
439	Greater Accra	AYAWASO WEST MUNICIPAL	157
440	Greater Accra	AYAWASO WEST MUNICIPAL	162

No.	Region	District	Structure No.
441	Greater Accra	AYAWASO WEST MUNICIPAL	166
442	Greater Accra	AYAWASO WEST MUNICIPAL	176
443	Greater Accra	AYAWASO WEST MUNICIPAL	192
444	Greater Accra	AYAWASO WEST MUNICIPAL	212
445	Greater Accra	AYAWASO WEST MUNICIPAL	219
446	Greater Accra	AYAWASO WEST MUNICIPAL	233
447	Greater Accra	AYAWASO WEST MUNICIPAL	243
448	Greater Accra	AYAWASO WEST MUNICIPAL	249
449	Greater Accra	AYAWASO WEST MUNICIPAL	261
450	Greater Accra	AYAWASO WEST MUNICIPAL	281
451	Greater Accra	AYAWASO WEST MUNICIPAL	22
452	Greater Accra	AYAWASO WEST MUNICIPAL	22
453	Greater Accra	AYAWASO WEST MUNICIPAL	28
454	Greater Accra	AYAWASO WEST MUNICIPAL	28
455	Greater Accra	AYAWASO WEST MUNICIPAL	54
456	Greater Accra	AYAWASO WEST MUNICIPAL	127
457	Greater Accra	AYAWASO WEST MUNICIPAL	135
458	Greater Accra	AYAWASO WEST MUNICIPAL	138
459	Greater Accra	AYAWASO WEST MUNICIPAL	143
460	Greater Accra	AYAWASO WEST MUNICIPAL	146
461	Greater Accra	AYAWASO WEST MUNICIPAL	149
462	Greater Accra	AYAWASO WEST MUNICIPAL	150
463	Greater Accra	AYAWASO WEST MUNICIPAL	153
464	Greater Accra	AYAWASO WEST MUNICIPAL	173
465	Greater Accra	AYAWASO WEST MUNICIPAL	202
466	Greater Accra	AYAWASO WEST MUNICIPAL	203

No.	Region	District	Structure No.
467	Greater Accra	AYAWASO WEST MUNICIPAL	225
468	Greater Accra	AYAWASO WEST MUNICIPAL	231
469	Greater Accra	AYAWASO WEST MUNICIPAL	232
470	Greater Accra	AYAWASO WEST MUNICIPAL	232
471	Greater Accra	AYAWASO WEST MUNICIPAL	233
472	Greater Accra	AYAWASO WEST MUNICIPAL	233
473	Greater Accra	AYAWASO WEST MUNICIPAL	236
474	Greater Accra	AYAWASO WEST MUNICIPAL	237
475	Greater Accra	AYAWASO WEST MUNICIPAL	238
476	North East	EAST MAMPRUSI	6
477	North East	EAST MAMPRUSI	20
478	North East	EAST MAMPRUSI	23
479	North East	EAST MAMPRUSI	23
480	North East	EAST MAMPRUSI	31
481	North East	EAST MAMPRUSI	36
482	North East	EAST MAMPRUSI	40
483	North East	EAST MAMPRUSI	47
484	North East	EAST MAMPRUSI	54
485	North East	EAST MAMPRUSI	62
486	North East	EAST MAMPRUSI	76
487	North East	EAST MAMPRUSI	89
488	North East	EAST MAMPRUSI	102
489	North East	EAST MAMPRUSI	121
490	North East	EAST MAMPRUSI	131
491	North East	EAST MAMPRUSI	140
492	North East	EAST MAMPRUSI	149

No.	Region	District	Structure No.
493	North East	EAST MAMPRUSI	167
494	North East	EAST MAMPRUSI	171
495	North East	EAST MAMPRUSI	176
496	North East	EAST MAMPRUSI	182
497	North East	EAST MAMPRUSI	186
498	North East	EAST MAMPRUSI	186
499	North East	EAST MAMPRUSI	187
500	North East	EAST MAMPRUSI	193
501	Northern	TAMALE CENTRAL	1
502	Northern	TAMALE CENTRAL	1
503	Northern	TAMALE CENTRAL	1
504	Northern	TAMALE CENTRAL	1
505	Northern	TAMALE CENTRAL	3
506	Northern	TAMALE CENTRAL	3
507	Northern	TAMALE CENTRAL	6
508	Northern	TAMALE CENTRAL	6
509	Northern	TAMALE CENTRAL	6
510	Northern	TAMALE CENTRAL	6
511	Northern	TAMALE CENTRAL	10
512	Northern	TAMALE CENTRAL	10
513	Northern	TAMALE CENTRAL	10
514	Northern	TAMALE CENTRAL	10
515	Northern	TAMALE CENTRAL	11
516	Northern	TAMALE CENTRAL	11
517	Northern	TAMALE CENTRAL	11
518	Northern	TAMALE CENTRAL	13

No.	Region	District	Structure No.
519	Northern	TAMALE CENTRAL	13
520	Northern	TAMALE CENTRAL	13
521	Northern	TAMALE CENTRAL	15
522	Northern	TAMALE CENTRAL	15
523	Northern	TAMALE CENTRAL	15
524	Northern	TAMALE CENTRAL	15
525	Northern	TAMALE CENTRAL	15
526	Northern	TAMALE CENTRAL	2
527	Northern	TAMALE CENTRAL	3
528	Northern	TAMALE CENTRAL	3
529	Northern	TAMALE CENTRAL	3
530	Northern	TAMALE CENTRAL	4
531	Northern	TAMALE CENTRAL	5
532	Northern	TAMALE CENTRAL	5
533	Northern	TAMALE CENTRAL	7
534	Northern	TAMALE CENTRAL	7
535	Northern	TAMALE CENTRAL	12
536	Northern	TAMALE CENTRAL	34
537	Northern	TAMALE CENTRAL	35
538	Northern	TAMALE CENTRAL	37
539	Northern	TAMALE CENTRAL	42
540	Northern	TAMALE CENTRAL	42
541	Northern	TAMALE CENTRAL	42
542	Northern	TAMALE CENTRAL	43
543	Northern	TAMALE CENTRAL	43
544	Northern	TAMALE CENTRAL	44

No.	Region	District	Structure No.
545	Northern	TAMALE CENTRAL	44
546	Northern	TAMALE CENTRAL	45
547	Northern	TAMALE CENTRAL	45
548	Northern	TAMALE CENTRAL	46
549	Northern	TAMALE CENTRAL	46
550	Northern	TAMALE CENTRAL	47
551	Oti	KRACHI EAST	4
552	Oti	KRACHI EAST	16
553	Oti	KRACHI EAST	33
554	Oti	KRACHI EAST	48
555	Oti	KRACHI EAST	61
556	Oti	KRACHI EAST	67
557	Oti	KRACHI EAST	79
558	Oti	KRACHI EAST	87
559	Oti	KRACHI EAST	91
560	Oti	KRACHI EAST	93
561	Oti	KRACHI EAST	97
562	Oti	KRACHI EAST	104
563	Oti	KRACHI EAST	106
564	Oti	KRACHI EAST	109
565	Oti	KRACHI EAST	117
566	Oti	KRACHI EAST	121
567	Oti	KRACHI EAST	124
568	Oti	KRACHI EAST	134
569	Oti	KRACHI EAST	141
570	Oti	KRACHI EAST	146

No.	Region	District	Structure No.
571	Oti	KRACHI EAST	160
572	Oti	KRACHI EAST	164
573	Oti	KRACHI EAST	171
574	Oti	KRACHI EAST	180
575	Oti	KRACHI EAST	187
576	Savannah	BOLE	5
577	Savannah	BOLE	16
578	Savannah	BOLE	28
579	Savannah	BOLE	36
580	Savannah	BOLE	47
581	Savannah	BOLE	63
582	Savannah	BOLE	74
583	Savannah	BOLE	80
584	Savannah	BOLE	84
585	Savannah	BOLE	88
586	Savannah	BOLE	94
587	Savannah	BOLE	103
588	Savannah	BOLE	113
589	Savannah	BOLE	121
590	Savannah	BOLE	128
591	Savannah	BOLE	135
592	Savannah	BOLE	140
593	Savannah	BOLE	148
594	Savannah	BOLE	155
595	Savannah	BOLE	163
596	Savannah	BOLE	176

No.	Region	District	Structure No.
597	Savannah	BOLE	205
598	Savannah	BOLE	263
599	Savannah	BOLE	267
600	Savannah	BOLE	274
601	Upper East	BOLGATANGA MUNICIPAL	1
602	Upper East	BOLGATANGA MUNICIPAL	1
603	Upper East	BOLGATANGA MUNICIPAL	2
604	Upper East	BOLGATANGA MUNICIPAL	4
605	Upper East	BOLGATANGA MUNICIPAL	12
606	Upper East	BOLGATANGA MUNICIPAL	15
607	Upper East	BOLGATANGA MUNICIPAL	16
608	Upper East	BOLGATANGA MUNICIPAL	18
609	Upper East	BOLGATANGA MUNICIPAL	20
610	Upper East	BOLGATANGA MUNICIPAL	22
611	Upper East	BOLGATANGA MUNICIPAL	23
612	Upper East	BOLGATANGA MUNICIPAL	26
613	Upper East	BOLGATANGA MUNICIPAL	28
614	Upper East	BOLGATANGA MUNICIPAL	29
615	Upper East	BOLGATANGA MUNICIPAL	29
616	Upper East	BOLGATANGA MUNICIPAL	30
617	Upper East	BOLGATANGA MUNICIPAL	32
618	Upper East	BOLGATANGA MUNICIPAL	33
619	Upper East	BOLGATANGA MUNICIPAL	33
620	Upper East	BOLGATANGA MUNICIPAL	34
621	Upper East	BOLGATANGA MUNICIPAL	35
622	Upper East	BOLGATANGA MUNICIPAL	37

No.	Region	District	Structure No.
623	Upper East	BOLGATANGA MUNICIPAL	39
624	Upper East	BOLGATANGA MUNICIPAL	40
625	Upper East	BOLGATANGA MUNICIPAL	41
626	Upper West	WA MUNICIPAL	9
627	Upper West	WA MUNICIPAL	10
628	Upper West	WA MUNICIPAL	15
629	Upper West	WA MUNICIPAL	15
630	Upper West	WA MUNICIPAL	18
631	Upper West	WA MUNICIPAL	23
632	Upper West	WA MUNICIPAL	33
633	Upper West	WA MUNICIPAL	36
634	Upper West	WA MUNICIPAL	41
635	Upper West	WA MUNICIPAL	50
636	Upper West	WA MUNICIPAL	55
637	Upper West	WA MUNICIPAL	66
638	Upper West	WA MUNICIPAL	70
639	Upper West	WA MUNICIPAL	79
640	Upper West	WA MUNICIPAL	85
641	Upper West	WA MUNICIPAL	90
642	Upper West	WA MUNICIPAL	95
643	Upper West	WA MUNICIPAL	101
644	Upper West	WA MUNICIPAL	107
645	Upper West	WA MUNICIPAL	110
646	Upper West	WA MUNICIPAL	114
647	Upper West	WA MUNICIPAL	130
648	Upper West	WA MUNICIPAL	142

No.	Region	District	Structure No.
649	Upper West	WA MUNICIPAL	151
650	Upper West	WA MUNICIPAL	157
651	Volta	HO	13
652	Volta	HO	29
653	Volta	HO	33
654	Volta	HO	36
655	Volta	HO	55
656	Volta	HO	63
657	Volta	HO	69
658	Volta	HO	83
659	Volta	HO	89
660	Volta	HO	95
661	Volta	HO	99
662	Volta	HO	107
663	Volta	HO	113
664	Volta	HO	117
665	Volta	HO	121
666	Volta	HO	124
667	Volta	HO	128
668	Volta	HO	143
669	Volta	HO	154
670	Volta	HO	157
671	Volta	HO	162
672	Volta	HO	164
673	Volta	HO	168
674	Volta	HO	171

No.	Region	District	Structure No.
675	Volta	HO	174
676	Volta	HO	11
677	Volta	HO	15
678	Volta	HO	20
679	Volta	HO	20
680	Volta	HO	20
681	Volta	HO	20
682	Volta	HO	20
683	Volta	HO	20
684	Volta	HO	28
685	Volta	HO	33
686	Volta	HO	34
687	Volta	HO	35
688	Volta	HO	35
689	Volta	HO	43
690	Volta	HO	43
691	Volta	HO	43
692	Volta	HO	43
693	Volta	HO	46
694	Volta	HO	46
695	Volta	HO	47
696	Volta	HO	48
697	Volta	HO	48
698	Volta	HO	49
699	Volta	HO	50
700	Volta	HO	55

No.	Region	District	Structure No.
701	Western North	BIBIANI ANHWIASO BEKWAI	1
702	Western North	BIBIANI ANHWIASO BEKWAI	9
703	Western North	BIBIANI ANHWIASO BEKWAI	12
704	Western North	BIBIANI ANHWIASO BEKWAI	17
705	Western North	BIBIANI ANHWIASO BEKWAI	29
706	Western North	BIBIANI ANHWIASO BEKWAI	42
707	Western North	BIBIANI ANHWIASO BEKWAI	50
708	Western North	BIBIANI ANHWIASO BEKWAI	72
709	Western North	BIBIANI ANHWIASO BEKWAI	84
710	Western North	BIBIANI ANHWIASO BEKWAI	90
711	Western North	BIBIANI ANHWIASO BEKWAI	99
712	Western North	BIBIANI ANHWIASO BEKWAI	113
713	Western North	BIBIANI ANHWIASO BEKWAI	119
714	Western North	BIBIANI ANHWIASO BEKWAI	134
715	Western North	BIBIANI ANHWIASO BEKWAI	146
716	Western North	BIBIANI ANHWIASO BEKWAI	153
717	Western North	BIBIANI ANHWIASO BEKWAI	173
718	Western North	BIBIANI ANHWIASO BEKWAI	183
719	Western North	BIBIANI ANHWIASO BEKWAI	203
720	Western North	BIBIANI ANHWIASO BEKWAI	220
721	Western North	BIBIANI ANHWIASO BEKWAI	239
722	Western North	BIBIANI ANHWIASO BEKWAI	253
723	Western North	BIBIANI ANHWIASO BEKWAI	264
724	Western North	BIBIANI ANHWIASO BEKWAI	282
725	Western North	BIBIANI ANHWIASO BEKWAI	294