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# Assessing Public Health Workforce Informatics Competencies: A Study Of Three Health Departments In Metro Atlanta

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ASSESSING PUBLIC HEALTH WORKFORCE INFORMATICS COMPETENCIES: A STUDY OF THREE HEALTH DEPARTMENTS IN METRO ATLANTA

by

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## ABSTRACT

**Background**: The evolution and widespread use of technology have made it necessary for the public health workforce to be current and versatile in technology usage. Public health leveraging technology usage in service delivery has the potential to improve efficiency and bring it to the forefront in the provision of healthcare services. The purpose of this study was to assess public health workforce informatics competencies in select Atlanta health districts and determine the correlates of public health informatics proficiency.

**Methods**: A 10-item instrument adapted from the recommendations of a Working Group document by the Centers for Disease Control and Prevention and the 2015 Informatics Capacity and Needs Assessment Survey was validated and used to assess proficiency and relevance of informatics competency items. Three hundred and thirty-three respondents completed the survey. A gap score was calculated as a proxy to identify the area of training needs. A path analysis was conducted to assess the relationships among contextual factors and competency domains.

**Results**: Respondents reported relatively high proficiency in foundational PHI competency. Psychometric testing of the instrument revealed two informatic competency domains – Effective IT Use and Effective Use of Information. Effective use of IT mediated the relationship between employee-level factors and the effective use of information.

**Conclusion**: The study provides baseline informatics competency data for the assessed local health departments. Periodic assessment of staff informatics competencies will contribute to proactively identifying and addressing training needs, thus positioning employees for maximum productivity when using informatics technology and informatic systems to perform their job responsibilities. LHDs can use the short, validated tool used in this study for such assessments.

INDEX WORDS**:** Informatics, Public Health, Workforce, Proficiency, Competency, Competencies, Health department, Information systems, Technology, Technology systems, Management, Structural equation model, Technology acceptance model

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by

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DOCTOR OF PUBLIC HEALTH

# ASSESSING PUBLIC HEALTH WORKFORCE INFORMATICS COMPETENCIES: A STUDY OF THREE HEALTH DEPARTMENTS IN METRO ATLANTA

by

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DEDICATION

This dissertation is dedicated to Almighty God for making my dream come true.
I am forever grateful, Lord!

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# CHAPTER 1

# INTRODUCTION

## Background of the Problem

Public health, as implied by the phrase, concerns itself with the health of the population as compared with the private medical sector that deals more with individual health. Considering the number of people public health deals with, employees must work efficiently to achieve the mission of the agencies or entities for which they work. Technology, when appropriately used, facilitates the delivery of efficient and effective health services (O'Lawrence, 2017).

The continuous evolution and the widespread use of technology in the society at large has created a need for public health also to be current with technology usage. By leveraging the use of technology, public health can improve efficiency and be at the forefront of the provision of healthcare services. An excellent example of this leverage is the push for the use of Electronic Health Records (EHRs) across public health agencies and the creation of the Public Health Information Network (PHIN) by the Centers for Disease Control and Prevention (CDC, 2004). There is, therefore, the need for adequately trained public health workforce that is highly skilled in information technology (Dean, Myles, Spears-Jones, Bishop-Cline, & Fenton, 2014).

Public Health Informatics (PHI) is “the systematic application of information and computer science technology to Public Health practice, research, and learning” (Hsu et al., 2012, pg. 67). PHI improves public health responsiveness, productivity, accessibility to data, creation of more partnership opportunities, and enables quicker disease outbreak investigations (Gibson, Shah, Streichert, & Verchick 2016). Health informatics has been and still is an efficiency tool health provider’s use to make better clinical decisions and facilitate the coordination of patient care (Hsu et al., 2012). Health informatics, if used effectively, can be the tool to support the broader public health service mission to protect, promote and advance the health and safety of the population (USPHS).

Informatics as a tool to enhance performance and productivity in the public health workforce is not a novel idea. However, while other federal, state, and private sectors leverage its use to a significant extent, broad applications of informatics at the local public health level is limited (Ruwanpura, Hewage, & Silva, 2012). The review of the literature shows that most public health entities focus on training as a means for developing employees and ensuring improved performance, job satisfaction and retention with a little emphasis on the technology and informatics competencies of employees (Dutton & Kleiner, 2015; O'Lawrence, 2017; Zareie & Navimipour, 2016). As the role of health informatics in the delivery of public health services continues to evolve, there is a need for skilled workers trained in its application. Thus, understanding PHI competencies will further strengthen the effectiveness of public health workers and clinicians on the job (Wyatt & Sullivan, 2005; Hsu et al., 2012).

**Statement of Problem**

PHI, as defined previously, is “the systematic application of information and computer science technology to public health practice, research, and learning” (Hsu et al., 2012, p. 67). Public health entities play a significant role in the prevention of diseases and health promotion, and the maintenance and enhancement of this role using information technology and systems should be a core competency for the public health workforce. However, informatics has not widely been recognized as a core public health competency (Baker, 2015), and although a part of the essential foundational capabilities for local health departments (LHDs) includes informatics capacities, most public health professionals may not have the necessary skills to leverage the use of information for public health purposes (Massoudi, Chester, & Shah, 2016). Further, a significant portion of public health employees may not be aware of the importance of informatics (Massoudi, Chester, & Shah, 2016).

Public health agencies are continuously searching for strategies to maximize dwindling resources, and most turn to the use of the internet, technology tools, and information processing systems to achieve this (Khampasong, 2016; Zareie & Jafari Navimipour, 2016). However, according to O'Lawrence (2017), “technology is only as good as the ingenuity of those who can both maintain and use it to the fullest potential” (p. 068), thus calling for the need for a skilled workforce that is competent in the public health application of technology, including PHI. Achieving this may require organizational investment in ongoing training to enable employees to adapt to the changing technological atmosphere (O’Lawrence, 2017). Accordingly, assessing and enhancing public health informatics competencies become essential, especially given its association with performance (Hsu et al., 2012).

Very few studies have assessed informatics competencies among public health workers. Massoudi, Chester, and Shah (2012) and Hsu et al.’s (2012) studies to identify informatics training needs within local health departments, represent two of the foundational studies in the area of informatics workforce capacity assessments. However, both studies assessed LHD competency gaps from the perspectives of informatics staff. They did not assess foundational informatics competencies for all public health employees, as has been done for nurses, for example (e.g., Hwand & Park, 2011, Kleib and Nagle, 2018). Overall, there remains a dearth of evidence as it pertains to the measurement of core informatics competency among public health professionals. Further, PHI competency assessment tools are generally lacking for general public health professionals. The Public Health Informatics Competencies Working Group’s development of a core set of public health informatics competencies for general public health professionals remains one of the only existing tools available for this workgroup demographic. The tool has, however, previously not been validated. As technology and informatics continue to evolve, there is a need to ensure that measurement approaches remain consistent with changing technological trends.

**Purpose of the Study**

The purpose of this study is to assess public health workforce informatics competency levels and informatics training needs for the metro Atlanta health districts. The study will also assess factors associated with informatics competency. The findings can assist health districts in creating training programs and will provide information on baseline informatics competency levels for future comparison.

**The Significance of the Study**

The field of public health is growing continuously, and therefore there is a need to have a formidable workforce trained and equipped to work efficiently for maximum performance and productivity. However, with dwindling funds and resources, public health is forced to find the best practices to optimize functioning without incurring additional costs. Leveraging the use of internet tools and technology may represent one way to increase productivity and cost-efficiency within public health entities.

Unfortunately, the PHI competency of the public health workforce has not been examined extensively in the literature and have been referred to as "unanswered workforce research questions" (Tilson & Gebbie 2004 p.353). The CDC Public Health Informatics Competencies working group in 2002 determined that it is essential that public health professionals in the 21st century have informatics competencies, especially given the increased use of informatics applications to gather, analyze and disseminate information in public health agencies (Joshi & Puricelli Perin, 2012). Significant drivers of modern public health are the rapidly evolving informatics and information science technology and systems; therefore, it is beneficial for organizations to examine proficiency levels on informatics competencies due to the evolution of technology and internet tools (Shah, 2016). There is, therefore, an increasing need for the public health workforce to be up to date on these tools.

Further, the determination of the level of informatics expertise should enhance targeted training aimed at improving employee productivity, which is expected to cause a ripple effect resulting in increased job performance, job satisfaction, and indirectly impact staff retention (Joshi & Puricelli Perin, 2012; Bartel, 1994).

**Study Scope**

To assess foundational PHI competency level and its correlates among public health professionals, the study will survey all employees, eighteen years and older, in the three one-county-one-district health departments in the metro area of Atlanta. The one-district-one-county means that the three health departments do not have multiple counties within the districts as do all other counties in the state of Georgia. The study utilizes a quantitative approach to collect and analyze the data for this research. A quantitative approach will allow for the empirical testing of the study hypotheses. The intended outcome is to assess the PHI competency level of the health department employees; calculate a gap score to determine areas of training needs, and determine the correlates of PHI proficiency.

## Research Questions

The research questions for this study are as follows:

1. What are the gaps in PHI competencies among public health professionals in health departments in the metro Atlanta area?
2. What are the employee characteristics associated with PHI competencies?
3. How are PHI domains related?

## Conceptual Framework

The conceptual framework (Figure 1) for this study was developed based on the review of the existing literature on information technology use, including those assessing informatics competencies among health professionals (e.g., Hwand & Park, 2011; Hsu et al., 2012; Massoudi, Chester, & Shah, 2016; Kleib et al., 2018). The PHI domains assessed in the model are informed by the afore-mentioned PHI competency development working document advanced by the CDC Public Health Informatics Competencies working group. The document hereafter referred to as the Informatics Competencies for Public Health Professionals working document (ICPHP working document) is a consensus of competencies complementing the broad set of competencies for public health professionals developed by the Council on Linkages Between Academia and Public Health Practice.

The ICPHP working document identifies three informatics competency domains: (a) Effective Information Use, (b) Effective Information Technology Use, and (c) Effective Development, Deployment, and Management of Information Systems. The competencies are designed to be cross-cutting and generally applicable to all public health professionals in the United States as well as other countries (O'Carroll et al., 2002). However, the instrument has not been validated and may be dated, having been developed in 2002. Thus, for this study, ICPHP was updated with items from a more recent PHI workforce development study (Massoudi, Chester, & Shah, 2016). Psychometric testing of the resulting instrument identified 2 PHI domains (Use of Information Technology and Use of Information), which are subsequently assessed in this study.

While studies have explored factors associated with informatics competencies, within the nursing sector, the relationships among informatics competency domains have largely remained unexplored. With previous studies linking familiarity with information computer technology with informatics proficiency in general, the present study theorizes that (a) the two domains are inter-related, with (b) competence in the effective use of information technology increasing one's ability to use and manage public health information effectively. Further, the existing literature indicates that the acceptance and use of health information technology and systems are influenced by user-related factors, as well as organizational and environmental factors (Najaftorkaman et al., 2015). These same factors have been found to be associated with informatics competencies (Hwand & Park., 2011; Kleib et al., 2018). Taken together, the conceptual framework hypothesizes relationships between user and organizational characteristics, information technology use proficiency, and information use proficiency, with the respective relationships between user and organizational factors and information use proficiency being mediated by information technology use proficiency.

**Hypotheses**

The following hypotheses are tested in this study:

***To determine the relationship between employee and organizational factors on IT use proficiency***

H1: Age will be negatively associated with IT use proficiency

H2: Previous informatics training will be positively associated with IT use proficiency

H3: IT use proficiency will vary across Local Health Departments (LHDs)

***Relationship between IT use proficiency and information use proficiency***

H4: IT use proficiency is positively associated with information use proficiency

***IT use proficiency as a mediator in the relationship between employee and organizational factors and information use proficiency***

H5: The relationship between employee age and information use proficiency is mediated by IT use proficiency

H6: The relationship between employee previous informatics training and Information use proficiency is mediated by IT use proficiency

H7: LHDs association with information use proficiency is mediated by IT use proficiency

**Research Plan**

Quantitative survey research was conducted to measure the attributes associated with core public health informatics competencies. The study was a cross-sectional study of local health department employees in the three one-county-one-district health departments in the metro area of Atlanta. All employees, 18 years and older, were invited to participate in the survey, with twice-weekly follow-up reminders for four weeks. Data for the study were collected via an online survey using the survey portal, Qualtrics. The human resource department of each health department facilitated the dissemination of the survey.

The survey instrument was developed by the researcher and was based on the document "Informatics Competencies for Public Health Professionals" (ICPHP working document) produced by the working group of 45 professionals, and supported by the Centers for Disease Control and Prevention (CDC) in 2002. The ICPHP document has 45 competencies divided into three domains: use of information, use of information technology, and the development, deployment, and maintenance of information systems. In addition to the ICPHP document, the survey includes an adaptation of some questions from the National Survey of Local Health Departments that focused on informatics (Massoudi, Chester, & Shah, 2016). The final administered survey included 18 competency items across the three original ICPHP domains, assessed on a five-point Likert scale (Appendix 1). Upon psychometric assessment, ten items assessing two informatics domains (IT use, and Information use) were retained and used in subsequent analyses.

### *Analytical Plan*

The unit of analysis of this study was the individual employee. The study's analytical approach involved the use of descriptive analysis (i.e., means, standard deviation, frequency) to describe participant characteristics and current competency levels. There was the computation of gap scores, and path analysis to assess the inter-relationships among PHI domains and user and organizational characteristics. Data analyses was completed using Stata statistical software version 16.0, with statistical significance set at $p < 0.05$ level.

## Outline of the Remaining Chapters

Chapter 2 will include a review of the literature for a comprehensive exposition on the evolution of public health informatics and its relevance to public health and its workforce. The chapter will also discuss the gaps that currently exist in the existing literature and describe the conceptual framework the study is founded upon and its application in this study. Chapter 3 describes the research study design and study methodology. It describes the subject recruitment process, instrumentation, data collection, and analysis. The results of the study are presented in Chapter 4. The final Chapter, 5, discusses the research findings as well as the strengths and limitations of the study. It also provides recommendations for future public health education, research, and practice.

# CHAPTER 2

# LITERATURE REVIEW

## Introduction

The use of the internet as an information sharing and data gathering hub has increased tremendously in the last decade, and this increase has indirectly increased the reliance of organizations on the internet for staff training and engagement, with subsequent enhancement of employee satisfaction (Carter, Kaiser, O'hare, and Callister, 2006). The delivery of healthcare and practice of public health is also facing a revolution fueled by development and use of technology and information systems, and the increased rate of information dissemination across public health programs (Dixon, McFarlane, Dearth, Grannis, and Gibson, 2015; Joshi & Puricelli-Perin, 2012). To this end, there is the need for a versatile and sustainable information infrastructure to meet the needs of the public health workforce as it relates to the access to and the appropriate dissemination of information (Banks, Cogdill, Selden, & Cahn, 2005). For public health workers to provide services, improve efficiency, and sustain positive outcomes, there is a need for enhancing both process skills and technical competencies, including in the area of public health informatics (Ghimire, Suvedi, Kaplowitz, & Richardson, 2017).

Public Health Informatics (PHI) is one of the significant developments in public health in the last century with the foundational capacity for improving efficiencies. Existing studies show that informatics improves public health agencies service delivery, can be a tool to meeting the core functions of public health, and enable better responsiveness and productivity on limited budgets (Gibson, Shah, Streichert, & Verchick, 2016; Leider, Shah, Williams, Gupta, & Castrucci, 2017; Lovelace & Shah, 2016). Indeed, the practice of Public Health in the 21$^{st}$

century will be incomplete without informatics, which has become a central piece for supporting the process of surveillance and informed decision making for improving population health. For many decades to come, it is anticipated that informatics will continue to be an essential component of the public health enterprise (Baker, Fond, Hale, & Cook, 2016).

Informatics can be a tool used to support the broader United States' public health service mission to protect, promote, and advance the health and safety of populations (usphs.gov). The challenges faced by public health, which has been on the increase in the last decade, (mainly due to increased gaps in disparities, increase in the occurrence of natural and human disasters and the need for effective and efficient management of public health practice) have all contributed to the attention that health informatics has received currently (Hsu et al., 2012; usphs.gov; Weiner & Trangenstein, 2006). Accessing information is increasingly become vital to Local Health Departments (LHDs), with the increasing data access needs driving LHDs' participation in electronic exchange of health information (EEHI) (Lovelace & Shah, 2016).

Recent advances in Information Technology/Information Systems ( IT/IS) has made the quantity and quality of population-based information available accurate and timely; however, such information can be leveraged by LHDs only if they have adequate IT/IS capabilities and engage its use to their fullest capacity to fulfill the core public health functions of assurance and assessment (Vest, Menachemi, & Ford, 2012; Williams & Shah, 2016). Given the advances in current information technology applications (including those for information collection and storage), the volume of information being generated,  and the need to ensure that information systems are helpful and not burdensome, it has become necessary for public health to have both organizational and workforce capabilities (Gibson et al., 2016; Shah, Vest, Lovelace, & Mac

McCullough, 2016) to effectively harness the potential of information technology and informatics.

Although evidence is available on the usefulness of public health informatics in providing LHDs with the essential tools needed to address and eliminate health disparities, public health is still behind in the adoption of information systems and technology usage compared to other healthcare institutions, with some local health departments lacking primary e-mail and internet access (Shah, Mase, & Waterfield, 2018; Vest et al., 2012). Further, although informatics capacity is essential in public health functions and services, most professionals in public health may not have the necessary skills to use this information effectively, and a good number may not be aware of the importance of informatics. (Massoudi, Chester, & Shah, 2016). Some experts have noted that the overall low level of LHDs informatics capacity in public health, places value on information systems technology “as more of an afterthought” (Vest et al., 2012, P.161). However, experts also note that public health’s lag in the application of informatics may reflect some of the unique challenges the discipline experiences (Shah et al., 2016; Vest et al., 2012).

Some of the challenges facing public health, such as shortages in the public health workforce, potentially exacerbated by pending retirement by an aging workforce, and the expectations that LHDs will continue to provide for their community while operating with reduced budgets, have increased demand for innovation and quality improvement, and the need for increased efficiency (Leider et al., 2017; Lovelace & Shah, 2016). To this effect, there is, therefore, the need to have a health department that is informatics-savvy, described as one that can electronically obtain, use and exchange information to attain improvements in organizational processes and population health outcomes (LaVenture, Brand, Ross, & Baker, 2014).

Having a skilled public health workforce is a critical component of building an informatics-savvy public health department (LaVenture et al., 2014; Massoudi et al., 2016). Indeed, the success of an organization is relative to its ability to engage its workforce in contributing to its vision and mission by ensuring they are highly skilled and adequately trained (Dean et al. 2014). Without investments in IT/IS infrastructure and workforce development, public health systems researchers warn that current capacity levels of LHDs information systems and technology usage will leave LHDs struggling to play a “meaningful role in the integration and exchange of health information” (Vest et al., 2012, p.160).

**Overview and history of informatics**

Informatics' first usage was in 1957, coined as a combination of two words “information” and “automatic” to describe the processing of information automatically (Baker, Fond, Hale, & Cook, 2016). Informatics supports the ability of the system to function appropriately in the collection, analysis, and use of the information pertaining to the health of the population. Informatics has been in use in the medical field for about 30 years but is a relatively new idea for the public health system. The first appearance of “Public Health Informatics” in the scientific literature was not until 1995 ((Chronic Disease Notes & Reports, (2001); Dixon, McFarlane, Dearth, Grannis, and Gibson, 2015; Baker et al., (2016)) report that since the first appearance of “Public Health Informatics” in the scientific literature in 1995, the term had been mentioned approximately 3000 times, by 2016, in scientific publication.

The Center for Disease Prevention and Control (CDC) since the early 1990s has been working fervently to advance the use of informatics with a focus on public health providers, professional associations, and the healthcare informatics community. Despite the recommendations made in 1997 in the report “*The Public Health Workforce: An Agenda for the*

*21st Century*" calling for a robust public health workforce grounded in the use of technology, this remains a much-untapped area (Cunningham et al. 2007). The first set of known Public Health Informatics competencies was not drafted until 2002 by the U.S. Centers for Disease Control and Prevention (CDC) Public Health Informatics Competencies Working Group (Hsu et al., 2012).

In 2009, the Health Information Technology for Economic and Clinical Health Act (HITECH) was passed. The act allows for providers and hospitals to be compensated for health "information technology with the purpose of meaningful use of Electronic Medical Records (EHRs) and health system interoperability including interoperability with public health entities" (Drenzer, McKeown & Shah, 2016, p. 852). The increased incentivized adoption of Electronic Health Records (EHRs) and Health Information Exchange (HIE) systems facilitated by the HITECH Act, which was enacted as part of the American Recovery and Reinvestment Act of 2009, has made the evolution health information technology in the field of public health more visible through active participation and the leveraging of informatics (Savel & Foldy, 2012).

Arguably, the increased availability of data electronically and the dynamism of the field of technology necessitates that Local Health Departments (LHDs) focus on developing a skilled workforce, form, and leverage strong partnerships, and inform policies that will foster the fair use of informatics through the implementation of health information systems (HIS) (Whittaker, Hodge, Mares & Rodney, 2015). To remain leaders in the healthcare sector with regards to population health, LHDs must adapt to the evolution of information technology, which lies in the improvement of their public health informatics capability and usage (Drenzer, McKeown & Shah, 2016; Gibson et al., 2016). Over time, and across all strata of health systems, health information, continues to be an essential component useful for improving patient care resource allocation, measuring health outcomes, and for strategic planning (Whittaker, Hodge, Mares &

Rodney, 2015). To ensure the maximal use of the available health information, there is a need for a workforce that is highly skilled in “collecting, analyzing, interpreting, presenting and disseminating health information” and studies have rated informatics proficiency in public health workforce as essential but much quantitative data is not available to validate this (Cunningham et al., 2007; Whittaker et al., 2015).

**What informatics is and is not**

Informatics has been confused to be merely the use of a computer to perform various occupational activities, and therefore there is a need to clarify and define informatics for what it is (Friedman, 2012). Informatics is not merely: (i) the analysis of large datasets (ii) working of computers by scientists and clinicians (iii) roles related to use and configuration of EHRs to meet meaningful use stipulations (iv) the profession of Health Informatics Management, and (v) is not simply defined as anything done using a computer, as widely believed (Friedman, 2012). Informatics is not the mere use of technology but a broader use of technology to make data more meaningful to use as information (Weiner & Trangenstein, 2006). Informatics should be regarded as a cross-training domain, a meeting point for basic sciences and professional practice, and a capacity tool that can be used to improve the practice of public health (Cunningham et al. 2007; Friedman, 2012).

**Public Health Informatics**

Public Health Informatics (PHI), though a relatively new subfield, is contained within the broader discipline of informatics and is not merely the automation of existing technological activities (Yasnoff, O’Carroll, Koo, Linkins & Kilbourne, 2000). PHI is a combination of knowledge from diverse disciplines to include science, communications, political science and incorporates knowledge and ideas from other public health fields such as Epidemiology, Statistics, etc. However, the primary underlying discipline for PHI is Computer and Information Sciences (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000). As Joshi and Puricelli Perin (2012) state, "PHI is the field in which today's information revolution meets the specific needs of public health" (p. 2). Public Health Informatics applies informatics technology and science to prevent diseases and improve population health positively by facilitating decision making and enabling the development of improved policies, interventions, and programs (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000; Poprish, Tate, & Whitehead, 2017). Information technology solutions and information systems can further be used to effectively improve care coordination and billing functions of LHDs (Massoudi, Chester, & Shah, 2016).

Public health is shifting from direct delivery of health care to ensuring that services not available within the system are made accessible for the public through other health care providers. Informatics/information systems can facilitate the data sharing and collaboration process in public health's role as a guarantor of health services (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000). For public health to remain relevant and sustain the improvements in service delivery that has been seen over the years, public health needs access to accurate and timely information and should be able to analyze and disseminate the information to appropriate stakeholders; PHI is expected to facilitate these processes (Chronic Disease Notes & Reports, 2001). PHI is important now more than ever because of improvement in information technology, the emergence of the internet as a universal community and because of new and emerging public health challenges, including those related to antibiotic resistance, emerging infections, and chemical and biological terrorism (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000). To maximize the potential information technology has in public health activities, there must be a streamlined application utilizing systematic and informed approaches (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000).

**Adoption of Informatics in Public Health**

The studies that have examined informatics adoption in public health show an association between an increase in information technology staff and increased use of public health information systems (Shah et al., 2016). Further, the use of informatics by LHDs has been shown to significantly increase effectiveness and efficiency (Lovelace, & Shah, 2016; Shah et al., 2016). Health informatics capacity, utilization, and integration into public health has also been identified as being associated with activities and initiatives for addressing health disparities and the achievement of success in this area. (Shah, et al., 2018; Vest et al., 2012). Further, informatics skills, at least at the primary level, has been described as essential for the public health workforce at all levels, especially because the burden on staff due to resources can be alleviated through the effective use of information systems and tools (Gibson et al., 2016; Lovelace & Shah, 2016).

Despite these benefits, LHDs have reported low informatics capacity. In their study, Massoudi, Chester and Shah (2016) reported low to moderate levels of LHD informatics capacity, including in the use and interpretation of data, in extracting reports from information systems, in project management and the use of applications such as statistical and analytical software and geographical information systems applications. The authors further observed variation in LHD capacity depending on governance and jurisdiction size. Hsu et al. (2012) also found a need for additional workforce training in the area of informatics, including basic computer skills training. Chester, Massoudi, and Shah (2016), also identified limited physical IT infrastructure that was largely within the control of external entities. Other identified barriers to the use of informatics in public health include the lack of funding and lack of staff capacity or training (Leider et al., 2017).

Given that IT functions are mostly completed by LHD staff (Drezner, McKeown, and Shah, 2016), efforts to boost LHD informatics capacity will require an investment in workforce development. It is vital to keep employees' informatics skills up to date through training, and information users should have knowledge of and understand the system operation (LaVenture et al., 2014; Leider et al., 2017; Lovelace & Shah, 2016).

*Examples of Applied Public Health Informatics*

Described below are examples of informatics applications in public health practice, including its use in surveillance, environmental health, emergency preparedness, and the delivery of public health services. Notably, the Center for Disease Control and Prevention has several initiatives mostly dependent on informatics support with examples such as: (i) The National Electronic Disease surveillance system (NEDSS)- a surveillance system interoperable with the federal, state, and local surveillance systems; (ii) The Laboratory and Response Network (LRN) – to ensure an effective response to bioterrorism by the laboratory; and (iii) The CDC's Division of Public Health Surveillance tasked with providing and improving the access and use of public health information (Weiner & Trangenstein, 2006).

Surveillance is the public health field that has pioneered and benefited immensely from informatics for analysis and finding solutions and was the initial focus of the application of informatics in public health. However, there has been an expansion of this focus due mainly to the "development of information and communication technologies, changes in policy, and creative approaches to information needs and public health interventions" (White, 2013, p.27; Savel & Foldy, 2012). The foundation of Syndromic Surveillance (SyS) is informatics, and in more recent times, its use and application have expanded to monitor trends in disease, detect outbreaks timely, track drug overdoses, and other areas of public health surveillance (DeVore, Chughtai, Kan & Streichert, 2016). SyS transforms electronic Health-related data collected into information that is usable promptly (DeVore, Chughtai, Kan & Streichert, 2016).

The Environmental Health field uses informatics to no small extent, and examples of its usage span across the United States (Poprish, Tate, & Whitehead, 2017). The CDC National Environmental Public Health tracking network is for viewing data specific to jurisdictions on how human health is affected by environmental health hazards (Poprish, Tate, & Whitehead, 2017). The state of Utah, Minnesota, & California has used the tracking system for different environmental health-related programs to affect the population positively (Poprish, Tate, & Whitehead, 2017).

Informatics use in Emergency Preparedness has received a lot of focus nationally, hence the need for a competent workforce trained in informatics application ready to deliver essential services and respond when these emergencies occur (Lichtveld & Cioffi, 2003). It is proposed that Twitter, which has an informatics base, can be used as a tool for notification during emergency response for the dissemination of information, considering social media has and is changing communication patterns (Yeager, Cooper Jr, Burkle Jr, & Subbarao 2015).

PHI allows for using systems previously created for more than its initial practical use with some redesigning. For instance, Arizona used a central registry for immunization to identify geographically statewide where children at risk of infection due to inadequate vaccination reside. A computerized database in an organization in California enabled the organization precisely identify four children that received vaccine from a sub-potent lot and ensure the revaccination of the children to save the organization an estimated $100,000 that would have been spent to recall the almost 15,000 children unaffected by the sub-potent lot (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000).

Health services delivery has improved with the use of health informatics, and a great example is the expanded use of telehealth programs, which make use of satellite communications and has afforded health providers the ability to deliver quality medical services even to remote locations (Joshi & Puricelli Perin, 2012). Further, at the national level, informatics helps to ensure that the healthcare system protects individual's healthcare information under the Health Insurance Portability and Accountability Act (HIPAA) by creating standards of collection, managing, assessing, and disseminating information (Chronic Disease Notes & Reports, 2001).

**Informatics and the Public Health Workforce**

PHI has become more critical, mainly because information technology has evolved and improved over time. In addition, changes in the delivery of medical care have contributed to its necessity as well (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000). Having a robust information technology infrastructural base enables public health systems to effectively respond to disease outbreaks and function adequately in fulfilling its mission to prevent, protect, and promote population health (Lichtveld & Cioffi, 2003; Walker & Diana, 2016).

The 21st-century public health workforce is expected to be competent in informatics skills application and knowledge to function in the ever-changing technology-laden world while operating with limited resources (Tilson & Gebbie, 2004; Cunningham et al. 2007). This skilled public health workforce is necessary for the successful use of informatics to foster policies and partnerships and improve LHDs' ability to effectively use informatics to improve health programs, conduct surveillance activities, and emergency response activities (Drenzer, McKeown & Shah, 2016). For instance, the public health surveillance system can be enhanced by using informatics for planning, system design, data collection, management, collation, analysis, interpretation, dissemination, and application to public health programs (Savel & Foldy, 2012).

A well-developed public health workforce is the key for the system to meet its goals, and the training needs of employees may be as broad and varied as the various system they work in (Tilson & Gebbie, 2004). Although the field of PHI is relatively new, recently, many public health organizations are defining and bringing to limelight the value of informatics competencies for public health professionals (White, 2013). Unfortunately, the existing evidence suggests that the average public health employee may not fully understand the relevance of prescribed informatics competencies relative to the job functions performed (Massoudi, Chester, & Shah, 2016). However, considering that technology has come to stay and cannot be done away with, public health systems should identify employee skills relevant to technology and develop these skills in the employees (Cunningham et al. 2007).

For public health organizations to maintain and function in its role as leaders in the prevention of diseases and promotion of health, it must include the use of information and information management systems as one of its core competencies for the public health workforce (Baker, 2015). When hospitals, for example, are not able to report to public health systems electronically, it has the tendency to worsen health disparities in existence. Engaging new technologies can facilitate and improve the ability to collect, analyze, and act on public health data to improve population health outcomes (Walker &Diana, 2016).

There are many reasons for the need to enhance the informatics skill set and competencies of public health professionals, including facilitating collaboration with other health organizations, maximizing scarce resources through improvements in efficiency, productivity, and effectiveness, and improving coordination across public health programs. Collectively, these outcomes will result in better population outcomes for the communities served by public health.

Strengthening and sustaining the public health infrastructure/system requires a competent public health workforce with informatics skills. (Lichtveld & Cioffi, 2003). The ratio of public health workers to the population has seen slow growth, and unfortunately, the number does not seem to rise, although the last attempt at enumeration was made in the year 2000 (Tilson & Gebbie, 2004). An estimated 219 workers/100,000 population in 1979 dwindled to about 160/100,000 population in 2000, and given this potential workforce shortage, there is a need for having a competent workforce in public health that can leverage existing information technology to improve efficiency, effectiveness, and productivity (Tilson & Gebbie, 2004).

Informatics can be a useful tool for Public Health in strengthening this limited workforce through the integration of programs, such as the partnership between Environmental Health and software technology firms which equips EH practitioners with the tools/training needed to provide data in a meaningful and timely manner (Poprish, Tate, & Whitehead, 2017). Poprish et al. (2017) identified the lack of adequate training as contributing to delayed data analysis and review, and delayed partnership formations in environmental health agencies at the local level, specifically in the rural or small counties. However, to adequately address these inadequacies in informatics-related training, the identification of current competency proficiency levels and gaps are essential.

**Public Health Informatics (PHI) Competencies**

Competencies are the ability humans possess to attain both individual and organizational goals (Ghimire, Suvedi, Kaplowitz, & Richardson 2017). PHI competency is “the ability to extrapolate from specific pieces of data to the broader socioeconomic trends that these data reflect" (Banks, Cogdill, Selden, & Cahn, 2005, p.341). PHI competencies are a set of skills, knowledge, and attitudes essential for practicing broad-based public health and fostering workforce development. It can also be used as a framework in the process of hiring and evaluation of staff as well as used as a tool to assess gaps that exist between organizational skills and knowledge (Hsu et al., 2012; Yeager, Cooper Jr, Burkle Jr, & Subbarao, 2015).

According to Ghimire et al. (2017), individual competency is related to performance, and there is an increasing need to assess human resource competencies. Cunningham et al. (2007), in their study, noted that public health workers' competencies assessment, in general, have not been explored extensively. Their study identified a gap in the public health workforce's understanding of the relevance of competencies as it relates to their day to day job functions. One of the six strategic elements proposed to be the framework of action in developing a sustainable, competent public health workforce is the identification of competencies relative to public health and developing programs corresponding to the competencies (Lichtveld & Cioffi, 2003). The identification and understanding of these competencies will ensure that agencies are guided to develop appropriate training programs to develop a competent, skilled workforce in the light of dwindling public health financial resources which indirectly affect "recruitment, retention, and development of top-quality staff" (Lichtveld & Cioffi, 2003 p. 448).

To this end, there was a renewed focus on public health competency assessment, spearheaded by the development of the Council on Linkages Between Academia and Public Health Practice Core Competencies (Council on Linkages). The development of this competency set led to broader assessments of public health workforce competencies. This work was driven by the Public Health Training Centers (e.g., Stewart et al., 2010; Grimm et al., 2015). However, the Council on Linkages competencies, which span across eight domains, did not include a focus on aspects of public health practices, including informatics.

This omission is notable, given the need for leaders in public health to ensure that their workforce is well prepared in informatics competencies (Savel & Foldy, 2012). It is recommended that HIS be viewed as a core component and competence of all roles in the health system, and all personnel should be made aware of their role in HIS in public health (Whittaker, Hodge, Mares & Rodney, 2015). Similarly, Walker & Diana, (2016), in a study, focused on assessing hospital capability to transmit health information electronically, recommended that future research should be focused on whether public health departments can receive this information electronically, a process that should include examining both organizational capacity and workforce competency.

Despite the value of informatics competency assessment and training, this area has received limited focus. A few studies (e.g., Hsu et al., 2012; Massoudi et al., 2016; Shah et al., 2016) have made attempts at assessing informatics competency or capacity in LHDs. These studies have generally limited these assessments specifically to the informatics workforce, without a focus on the general public health professional. Shah et al., 2016, showed there was a positive association between the number of information technology staff and the use of health information systems. Massoudi et al.'s., (2016) study reported that although informatics was a valuable skill set for public health employees, a significant number of employees were not aware of the importance. The study also identified a shortfall in the number of public health informatics service professionals. Hsu et al. (2012) identified that basic computer literacy training was a need for public health practitioners and noted that the proper identification of PHI competency needs is key to improving overall informatics skills.

Further, the Informatics Competencies for Public Health Professionals working document developed in 2002 under the leadership of the CDC, remains one of the only attempts to develop cross-cutting PHI competencies for public health. The competency set, has, however, not been validated broadly among public health professionals. With the rapid evolution of technology and the informatics discipline, in general, ensuring that competencies remain up-to-date and relevant is essential.

**Summary and Gaps in the Literature**

Informatics provides timely information gathering from all relevant sectors to address health disparities and for policy and practice. There is evidence of the positive impact of informatics on LHDs engagement in the prevention of health disparities, which can strengthen their need for investing in informatics for programmatic use (Shah et al., 2018). Building informatics capacity is both personnel and resource-intensive, but informatics capacity provides the efficiency and effectiveness necessary to provide high-quality public health service in the face of dwindling resources (Lovelace & Shah, 2016). National policy changes have pushed forward public health technical and analytic capacity, making public health informatics a critical element in the future of public health (Leider et al., 2017). As informatics capacity increases and the development of informatics skills among the workforce is enhanced, a direct positive impact on the flexibility and efficiency of the health department is expected (Lovelace & Shah, 2016). This may, in turn, lead to the protection and improvement of the public's health in the years to come, thus, building an entity that can better meet the public health needs of the communities they serve (Lovelace & Shah, 2016; Miller, Ishikawa, DeLeon, Huang, Ising, & Bakota, 2015).

With the rate of technological advances and reliance of public health on data to fulfill its functions of protecting and promoting health, it has become pertinent for public health professionals at all levels to possess core informatics skills and capabilities (Miller et al., 2015). This is because the quality and effectiveness of public health informatics are as good as the workforce capacity allows. In other words, if the workforce is not adequately trained, the informatics capacity of LHDs is of no use (Miller et al., 2015). To create an informatics-savvy health department, the competencies needed for the critical roles should be examined, and personnel trained to translate data into information that can be used in protecting the public's health (LaVenture et al., 2014; Miller et al., 2015).

The existing literature clearly demonstrates the value of PHI but identifies a gap in knowledge about the current level of informatics competency among general public health professionals, who are not specialized informatics professionals. Further, the existing measures for PHI competencies may also need to be updated and validated. This study, therefore, attempts to fill this gap in the existing literature by assessing cross-cutting or foundational informatics competencies that are applicable to public health professionals across all job levels, using and validating an updated assessment tool.

## Conceptual Foundations

### Defining Competency

Competence is defined as the activity, while competency is the ability to do the work/job (skills and qualifications), that is, it is related to the behavior – competency describes what an individual can do (Armstrong, 2009; Lišková & Tomšík, 2013; Rowe 1995**).** Competency-based assessments assess how competent the employee is in performing the skills (competencies), while competence is a point on the performance spectrum (Khan & Ramachandran, 2012). Competencies are generally a cluster of Knowledge, Skills, and Attitudes (KSAs) and should fulfill four criteria namely: (a) be an integral part of one's job; (b) be correlated to a job;(c) is measurable against established standards; (d) can be improved upon with training (Armstrong 2009; Chong, Ho, Tan, & Ng, 2000). Assessment of competence and assessment of performance are technically the same, and therefore no distinction should be made between the two (Khan & Ramachandran, 2012). Competency assessment is used to inform the development of a training curriculum for new and existing workers, facilitate performance appraisal to identify training needs, and identify recruitment needs (Chong, Ho, Tan, & Ng, 2000).

**Measuring Competency- Competency-Based Models**

Competency models became prominent about 40 years ago in response to the consistent use of intelligence tests as a judge for personal decisions (Bradley& Keating, 2014). Many companies, however, started to develop their own "competency models" due to the confusion around existing models (Rowe, 1995). Competency-based models have been used in management in three areas: first, in recruitment to identify a candidate who possesses the established "behavioral traits" needed for a specific job; secondly in skill assessment to assess competence on the job; and thirdly in workforce development to develop existing staff by identifying their strengths and weaknesses (Rowe, 1995).

According to Leigh et al. (2007), models of assessment can be grouped into four categories based on what they assess: 1. measures of knowledge – multiple-choice, essay and short answer questions – fundamental assessment component of any assessment system; 2. measures of decision making – evaluates the ability to make a sequential and interactive judgment – a case-based oral examination for certification; 3. measures of performance and personal attributes - the objective is to reflect growth and development of professional competencies; and 4. integrated assessments of practice-based skills and tasks. There are several widely applied competency models, including the Competency Outcomes and Performance Assessment (COPA) and the Competency-Based Human Resource Management (CBHRM).

## Existing Models for Competency Assessment

### *Competency Outcomes and Performance Assessment (COPA)*

The Competency Outcomes and Performance Assessment (COPA) model was developed in the early 1990s by Lenburg and "is designed and structured as a theoretical curriculum framework to promote competence for practice" (Lenburg, Klein, Abdur-Rahman, Spencer, & Boyer, 2009, P. 312). The COPA model has a simple organizing framework and is focused on practice competencies, which is why it is used mostly in nursing education and in nursing practice settings. It has been credited to be an alternative to promote nursing practice competence in both educational and practice environments (Lenburg, 1999; Lenburg et al., 2009). The constructs are collectively called Lenburg's Eight Core Practice Competency and are Assessment and Intervention Skills, Communication Skills, Critical Thinking Skills, Human Caring and Relationship Skills, Management Skills, Leadership Skills, Teaching Skills, and Knowledge Integration Skills (Lenburg, 1999).

### *Competency-Based Human Resource Management (CBHRM)*

The Competency-Based Approach Human Resource Management (CBHRM) is used to improve employee and organizational outputs (Ghimire, Suvedi, Kaplowitz, & Richardson 2017). CBHRM uses results from competency assessments to "inform and improve the processes of performance management, recruitment, and selection, employee development, and employee reward" (Armstrong 2009, P. 202). The concept is primarily based on behavioral and technical competencies, but also is associated with the use of National and Scottish National Vocational Qualifications (NVQs/SNVQs). Behavioral Competency refer to behaviors required to do a job and show results to include personal qualities, motives, experience, and behavioral characteristics, while technical competencies refer to the knowledge and skills that people have to know to perform effectively in their assigned roles. The NVQs/SNVQs competences approach is the UK originating competence approach, which specifies minimum standards laid out for the achievement of set tasks usually expressed in a way that allows for observation and assessment (Armstrong, 2009).

*The Informatics Competencies for Public Health Professionals working document (ICPHP working document)*

While this is not a model for competency assessment, it is a foundational document for developing the process for the evaluation of public health informatics competencies. The document was produced by the working group of 45 professionals led by Patrick O' Carroll and supported by the Centers for Disease Control and Prevention (CDC) in 2002. The document was developed to fulfill the need for informatics competencies that cut across all public health professional spheres (O'Carroll et al., 2002). The ICPHP working document is a consensus of competencies complementing the broad set of competencies for public health professionals developed by the Council on Linkages Between Academia and Public Health Practice. These competencies developed cuts across public health professionals and are supposed to apply to public health professionals in the United States, and public health professionals in other countries can implement the competencies (O'Carroll et al., 2002). According to the ICPHP working document**,** "the informatics competencies presented in the document should provide a useful starting point in the development of new learning resources for public health professionals" (p. 5).

**Conceptual Framework of the Study**

The conceptual framework for the study (Figure 2.1) is an adaptation of the ICBHP working document and evidence from the existing literature on IT acceptance and use. Even though widely used, the COPA and CBHRM models for competency assessment are not used for this study, due to the lack of broad applicability to public health practice. The COPA model is more geared towards the assessment of competencies in clinical practice-based organizations. The COPA model, because of its practice-based assessment feature, is often used in nursing and described as able to delineate the core clinical behaviors and show evidence of competence in the roles they play (Lenburg et al., 2011). The CBHRM, on the other hand, though generalizable, is geared more towards human resource management and used mostly as an assessment tool on employee's performance across several organizations. The adapted conceptual model for the current study (Figure 2) allows for the development of a competency assessment model that is tailored to public health education, practice and enables the examination of the influence of external variables.

The processes of PHI evaluation as specified in the adapted model (Figure 2.1), include the identification of the core competencies. The core competency areas were broadly defined following those suggested by the ICPHP working document. Specifically, the ICPHP working document categorizes competencies into three competency areas:

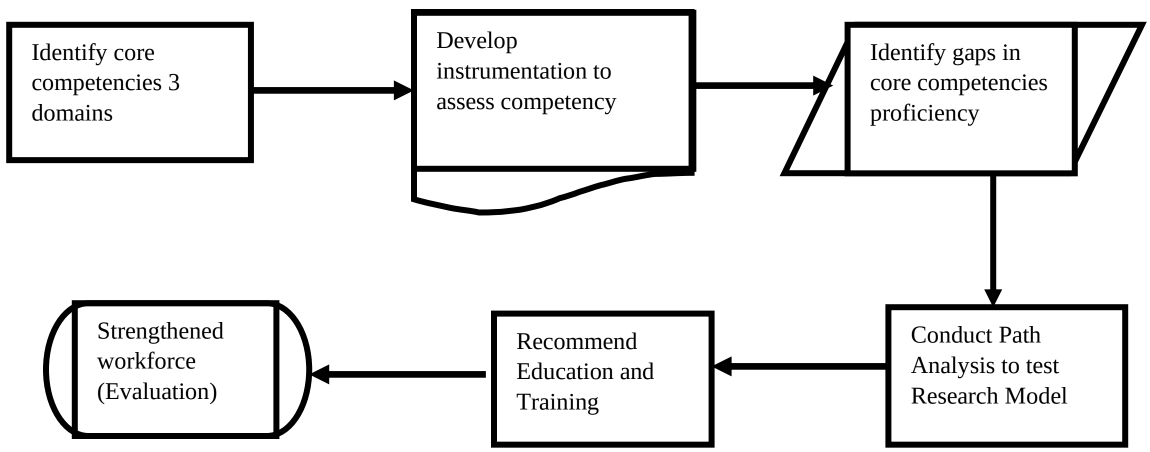
- Domain I: related to the use of information for public health practice;
- Domain II: related to the use of information technology to increase individual effectiveness; and
- Domain III: related to the development, deployment, and maintenance of information systems to improve the organization itself.

However, only domains I and II were retained in this study, following psychometric testing and were used for subsequent analyses.

The other processes based on the adapted model include delineating the relationships between the domains and contextual variables, gap identification, delineation of education and training recommendation, and the provision of and evaluation of education and training. The resulting outcome of the process is anticipated to be a strengthened workforce (Figure 2.1).

In summary, the framework/process outlines an approach for assessing public health information competencies, which was applied in this current study, beginning with (a) identifying relevant competencies (a task initiated by ICPHP working document); (b) examining competency proficiency levels and relevance to job responsibilities; (c) identifying competency gap areas; (d) understanding factors associated with proficiency in informatics competency domains (e) developing education and training activities to fill gaps; and (e) a continuous improvement process to strengthen the workforce (Figure 2.1). While some of the outlined competency assessment processes are within the scope of this study, the last two processes (provision of education and training, and strengthened workforce (evaluation piece)) are outside the study's scope and will be the responsibility of the health departments to be completed at a later date.

**Figure 2.1: Conceptual Framework for Competency Assessment**




## Hypotheses

Research questions 2 and 3 in this study, primarily focus on the identification of factors associated with proficiency in competency domains and exploring the relationships between the assessed PHI competency domains (illustrated in Figure 2). The hypotheses are derived based on evidence in the existing scientific literature, as described next.

*Relationship between employee and organizational factors on IT use proficiency*

The present-day public health in making adequate use of modern-day technology will be empowered by being proficient in these competencies (O'Carroll et al., 2002). However, there is a dearth of information on factors associated with technology use and informatics proficiency among public health workers. Evidence from other health disciplines, including nursing, suggests that employee and organizational factors may be associated with IT use and proficiency. In particular, the existing literature has linked informatics proficiency to select user demographic characteristics, such as age (Kleib et al., 2018), and at least undergraduate education (Palkie, 2013; Kleib et al., 2018; Kinnunen et al., 2019), and in particular, specialized informatics training (Hwang and Park, 2011). Previous studies have also linked organizational factors, such as organizational structure, IT capacity, and organizational culture with IT use and proficiency. For example, Massoudi, Chester, and Shah (2016) identified variation in informatics capacity by governance and LHD jurisdiction's size. The 3 LHDs in this study have different jurisdiction sizes, may differ in their scope of services as well as their IT infrastructural capacity. Taken together, hypothesis 1 through 3 were derived as follows:

***To determine the relationship between employee and organizational factors on IT use proficiency***

H1: Age will be negatively associated with IT use proficiency

H2: Previous informatics training will be positively associated with IT use proficiency

H3: IT use proficiency will vary across LHDs

*Relationship between IT use and information use proficiency*

While previous studies have not examined the inter-relationship between informatics competency domains, this study advances the proposition that the domains of IT use, and information use are related, such that IT use proficiency enhances one's ability to effectively use information for population health management. In support of this notion, Shah et al. (2016) showed an association between an increase in information technology staff and increased use of public health information system usage. This study, therefore, proposes that the increased usage of these systems will increase proficiency in the use of information. Accordingly, hypothesis 4 was postulated as follows:

***Relationship between IT use and information use proficiency***

H4: IT use proficiency is positively associated with information use proficiency

***IT use as a mediator in the relationship between employee and organizational factors and information use proficiency***

The final hypotheses test the notion that effective IT use mediates the relationship between external factors (employee and organizational factors) and information use proficiency. The study proposes that employee demographic characteristics and organizational factors impact employee's ability to effectively use information by first shaping their ability to use technology, leading to hypothesis 5 through 7:

***IT use as a mediator in the relationship between employee and organizational factors and information use***

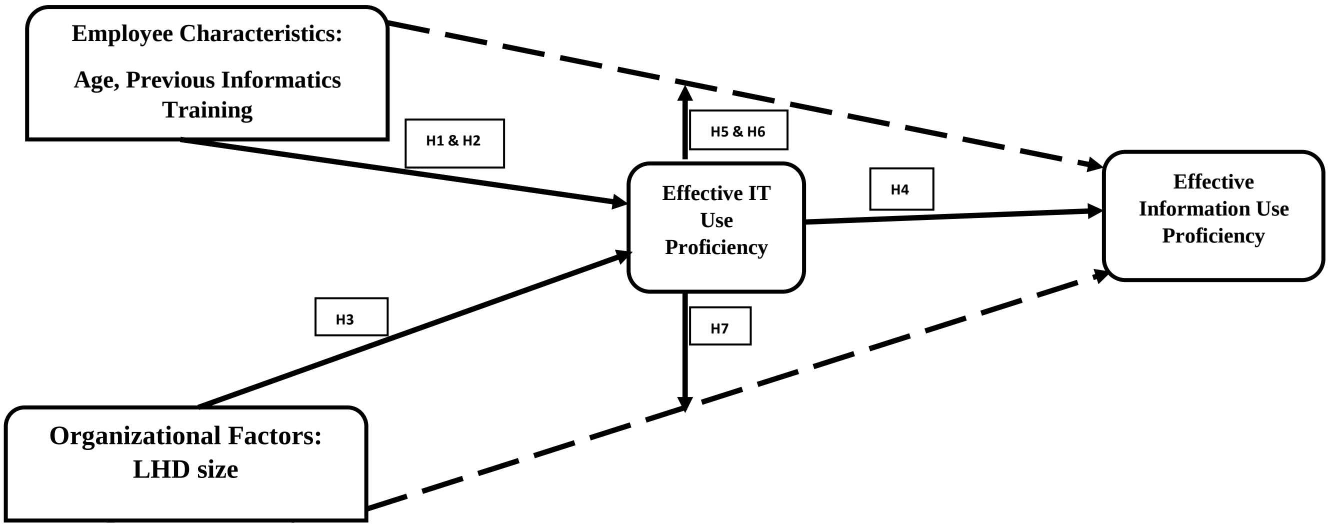
H5: The relationship between employee age and Information use proficiency is mediated by IT use proficiency

H6: The relationship between employee previous informatics training and Information use proficiency is mediated by IT use proficiency

H7: LHDs association with Information use proficiency is mediated by IT use proficiency

The empirical model for this study is illustrated in Figure 2.1.

**Figure 2.2**: Research Approach – Path Analysis




The public health system is critically affected by information technology. Thus, the understanding of PHI, development of appropriate practice-based training, and adoption of informatics competencies at the basic level for the entire public health workforce should be an integral part of the system, targeted at both new and old workforce (Yasnoff, O'Carroll, Koo, Linkins & Kilbourne, 2000; Dixon, McFarlane, Dearth, Grannis, and Gibson, 2015). The future of PH workforce will depend mainly on a workforce competency in informatics; therefore research on PHI competencies are needed to ensure that training programs in informatics competencies are designed and made accessible to meet the needs of the broader workforce (Dixon, McFarlane, Dearth, Grannis, and Gibson, 2015).

This study responds to a critical need for core or foundational PHI competency assessments among general public health employees. It is significant and distinguished from previously conducted studies in that most studies focused on the LHDs capacity to use informatics as an organization (e.g., Massoudi et al. 2016), whereas this study will focus on foundational competencies for all public health employees. An organization that has informatics capacity but no adequately trained employees to use these infrastructures remains at a disadvantage.

## Chapter Summary

In summary, this chapter presented an overview of the existing literature on PHI, the conceptual framework for the study, and its application in the development of the study hypothesis was introduced. Chapter 3 describes the study methodology and research study design. It describes the subject recruitment process, instrumentation, data collection, and analysis.

# CHAPTER 3

# METHODOLOGY

## Introduction

This study will utilize a quantitative approach to collect and analyze primary data for answering the stated research questions. This chapter will discuss the study design, data collection method, hypothesis, and the analytical approach employed.

## Research Design and Study Sample

The research design is a cross-sectional survey. The study sample includes all employees of the three one-district-one-county district metro Atlanta health departments who are 18 years and older. The selected three health departments are similar in that they do not have multiple counties within the districts as all other counties in the state of Georgia. The three selected health districts, Clayton, Dekalb, and Fulton Counties, are all included in the Atlanta-Sandy Springs-Roswell, GA Metropolitan Statistical Area.

The Clayton County Health Department is in Clayton County, located in the north-central portion of the state, with an estimated population of 285,153 in 2017. The Clayton county board of health department has about 125 employees. The DeKalb County Health Department is in Dekalb County with an estimated population of 753,253 in 2017 and is the 4$^{th}$ most populous county in the state of Georgia. The DeKalb county board of health consist of approximately 500 employees. The Fulton County Health Department is in Fulton County, and the 2017 population estimate was 1,041,423, and it is the most populous county in the state of Georgia. The Fulton county board of health has about 400 employees. Collectively, these three counties employ approximately 1025 employees.

## Data Collection Procedure

An online survey instrument was created using the Qualtrics online survey software provided by the Georgia Southern University, and an anonymous survey completion link was generated for each health department and disseminated to employees through the Human Resources (HR) department. The anonymous link ensured that responses could not be linked to individual research participants. The HR director sent a reminder email twice a week for four weeks.

## Instrumentation

The survey instrument was developed by the researcher and is an adaptation of questions from two different sources. The first is the document "Informatics Competencies for Public Health Professionals (ICPHP)," produced in 2002 by the working group of 45 professionals led by Patrick O' Carroll and supported by the Centers for Disease Control and Prevention (CDC). The group recommended the document for use as a tool to assess informatics competencies for public health workers. The document has 45 competencies divided into three domains: (a) Use of Information (for public health practice); (b) Use of information technology (for effectiveness as a public health professional); and (c) Development, deployment, and maintenance of Information systems (to improve public health enterprise effectiveness).

The ICPHP document divided the workforce into three distinct segments. The three separate tiers are defined as:

1. Tier I (Front Line Staff/Entry level): "Individuals who carry out the bulk of the day to day tasks," for example, health educators, clinicians, lab technicians, nurses. Their responsibilities may include basic data collection and analysis, program planning, and support.

2. Tier II (Senior Level staff): This individual has specialized staff functions, and they have increased technical knowledge, and responsibilities include data collection, program planning, and evaluation, budget development, and so on.
3. Tier III (Supervisory and Management Staff): Individuals in this tier are expected to have increased skills in program development, implementation, evaluation, they are responsible for running the organization, and have staff who report to them.

In order to update the ICPHP working document with more contemporary competencies, the survey further adapted additional items from Massoudi, B. L. et al., (2016) informatics competency domain in the National Survey of Local Health Departments. Furthermore, the present study was interested in assessing public health competencies in foundational or “core” informatics competencies, defined as competencies that are cross-cutting across all staffing tiers. These represent basic competencies that general public health professionals are expected to demonstrate. Accordingly, only survey items that cut-across all tiers were retained.

The final administered competency set included 18 items across the 3 ICPHP domains of interest. For each item, respondents rated their level of proficiency and the relevance of the competency item to their current job responsibility.  In addition, the survey included questions on demographic and practice characteristics, such as gender, age, race education, tenure at the organization, and position.

**Validity and Reliability**

A construct validation using Exploratory Factor Analysis (EFA) was performed on the survey instrument, which allows the researcher to establish that the instrument measures the constructs they were proposed to measure and allows for legitimate conclusions to be drawn from findings (Burton & Mazerolle, 2011). An important consideration when using EFA is the sample size; experts propose at least 300 respondents (Burton & Mazerolle, 2011).

The EFA was performed to ensure that the survey instrument developed contains the minimum number of items but still explains the constructs adequately (Burton & Mazerolle, 2011). To determine if the EFA was an appropriate approach given the data, Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) sampling adequacy tests were performed. Bartlett's test of sphericity evaluates the correlation matrix of all survey items to determine if the matrix can be analyzed using factor analysis, and KMO measures sampling adequacy, which is how strongly items are correlated with each other in the matrix. (Burton & Mazerolle, 2011). A KMO correlation above .60-.70 is considered adequate, and a Bartlett test with significant chi-square output indicates the matrix is not an identity matrix, and therefore, factor analysis can be conducted on the instrument (Burton & Mazerolle, 2011). Reliability testing of the instrument was performed using the Cronbach's α coefficient, which measures the consistency or repeatability of the survey instrument (Burton & Mazerolle, 2011). Cronbach's α coefficient benchmark of $\alpha > 0.70$ was used to assess scale and instrument reliability (Nunally, 1975).

## Variable Construction and Definition

### *Dependent variable*

The intended goals of this study were to (a) assess the core public health informatics competencies level of the health department employees using an updated and validated instrument, (b) assess gaps in competencies to determine areas of training needs;(c) determine the factors associated with proficiency in informatics competencies, and (d) determine the relationships about the informatics competency domains. As such, the primary outcome variables in this study were informatics competency gap and competency proficiency for each of the informatics competency domains.

**Competency Measures**. Informatics competencies were initially using 18 items, assessed across three domains. However, the final competency set was subsequently reduced to 10 items, across two domains following psychometric assessment. The third domain – Development, deployment, and maintenance of Information systems – was subsequently dropped due to inadequate factor loading. An evaluation of the items in this domain suggested that competency in the domain may be more specialized and not necessarily foundational and cross-cutting. The final domains included: effective IT use (6 items), and effective information use (4 items). Proficiency for each domain was measured on a five-point scale of increasing expertise level from “not proficient” to “very proficient.”

**Competency Gaps**. For each competency item, employees also assessed the relevance to their job role on a five-point Likert scale from “very important” to “not important at all.” Following past public health workforce, training needs assessment studies, competency gap scores are used as a proxy for determining workforce training needs, and are computed for each item using the following equation: Proficiency – Relevance to Job (Cunningham, Ascher, Viola, & Visintainer, 2007).

*Independent variables*

The independent variables assessed include age, gender, race, education level, job classification, and past informatics training and organization (LHD). The variables and measures are listed below:

Table 3.1. Variables and Measures

| Variable | Measure |
|---|---|
| Dependent Variables | |
| Proficiency | 1- Not Proficient<br>2- Somewhat Proficient<br>3- Moderately Proficient<br>4- Proficient<br>5- Very Proficient |
| Relevance | 1- Not Important<br>2- Somewhat Important<br>3- Moderately Important<br>4- Important<br>5- Very Important |
| Competency Gap | (Proficiency Score – Relevance Score) |
| Covariates | |
| Age | 45 years and older (1)<br>Under 45 years (0) |
| Gender | Female (1)<br>Male (0) |
| Race | White (1)<br>Other (0) |
| Education Level | Master degree and above (1)<br>Other (0) |
| Job Classification | Senior Management or Supervisory Role (1)<br>Other (0) |
| Past Informatics Training | Yes (1)<br>No (0) |
| Organization/LHD | Clayton<br>DeKalb<br>Fulton |

**Data Analysis**

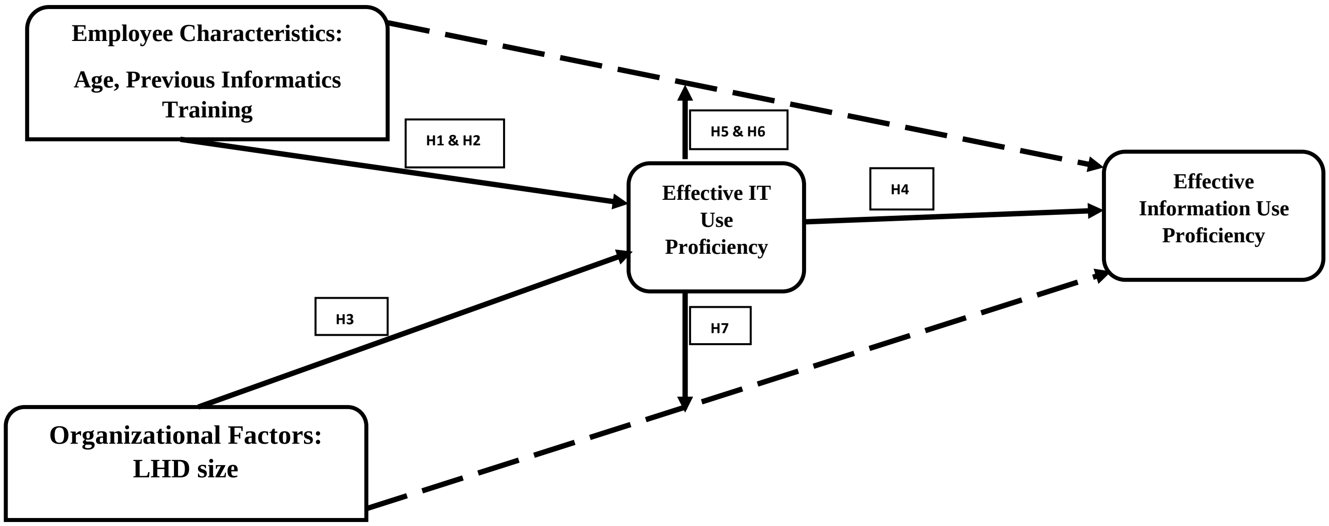
The unit of analysis for the study was the individual. However, data were also aggregated at the health department level to allow the agencies to be able to develop facility-specific training programs based on the gap scores. Descriptive statistics, including frequencies, means, standard deviation, and ranges, were computed as appropriate,  to describe the population of study and the distribution of assessed attributes. Training needs were evaluated using a gap score, computed as the difference between the proficiency and relevance score (Cunningham, Ascher, Viola, & Visintainer, 2007).

*Path Analysis*

The study's research approach (Figure 3.1 ) was tested by path analysis using STATA structural equation modeling (SEM) program. Path analysis is often used for the analysis of structural relationships that exist among variables. It is a common modeling technique commonly used in studies examining information technology usage and information systems modeling (Taherdoost, 2018).

Path analysis was chosen for this study because similar studies have shown it as appropriate for establishing structural relationships existing between variables (Kamal et al., 2020; Taherdoost, 2018). Following previous studies (e.g., Kamal et al., 2020), the data analysis for this study was conducted as a two-stage process. First, an EFA was performed to confirm validity and reliability, followed next by conducting a path analysis to test the relationship among variables. All analyses were completed using the STATA statistical software, version 16.0. The statistical significance level was set at $p = <0.05$ level for all statistical analyses.

**Figure 3.1**: Research Approach – Path Analysis




## Ethical Considerations and IRB

Institutional Review Board approval to conduct research was obtained from the Georgia Southern University Institutional Review Board and the Georgia Department of Public Health Institutional Review Board. The study was assessed to pose minimal risk to participants. However, voluntary participation was emphasized, and adequate protocols were put in place to secure the data and to protect the confidentiality of the participants.

## Summary of the Chapter

This chapter described the research design, the subject recruitment process, instrumentation, data collection, and analytical plan for the study. In the next chapter, Chapter Four, the results of the study are presented.

# CHAPTER 4

# RESULTS

This chapter presents the findings of all statistical analyses and hypotheses testing. The chapter begins by presenting the descriptive demographic characteristics of the survey participants, followed by results from the psychometric assessment of the instrument. Results from competency gap assessment and the structural equation model are subsequently presented.

## Demographic Characteristics of Respondents

The survey was sent to all employees of the three selected health departments, and 333 surveys were returned as completed, 32.5% response rate. Table 4.1 describes the characteristics of the study participants. About 48% of participants were Dekalb County employees, 30.4% from Fulton county and 21.3% from Clayton county. Respondents were mostly female (83.8%), 55 years and older (30.3%), and mostly Black (76.5%). About one in three (34.2%) reported having a masters' degree, and 29.9% reported having a bachelor's degree. Most respondents were Frontline or Entry-Level staff (42.7%), with about 8.0% occupying senior management or executive-level position. Thirteen percent of respondents indicated they had previous informatics training (Table 4.1).  Table 4.2 is a breakdown of respondents by job classification and county. Distribution pattern for individual county showed the same trend as the overall, with frontline or entry-level staff having the most representation.

**Table 4:1 Characteristics of participants**

| Variable | Measurement Categories | Frequency | Percentage |
|---|---|---|---|
| *County* | | | |
| | Clayton | 70 | 21.28 |
| | DeKalb | 159 | 48.33 |
| | Fulton | 100 | 30.40 |
| *Age* | | | |
| | 18-34 | 66 | 20.18 |
| | 35-44 | 70 | 21.41 |
| | 45-54 | 92 | 28.13 |
| | 55+ | 99 | 30.28 |
| *Gender* | | | |
| | Female | 275 | 83.84 |
| | Male | 53 | 16.26 |
| *Race* | | | |
| | Black | 250 | 76.45 |
| | White | 41 | 12.54 |
| | Other (Asian/Pacific Islander, Multiracial) | 36 | 11.01 |
| *Education* | | | |
| | High school /Some college | 66 | 20.12 |
| | Associate degree in college | 36 | 10.98 |
| | Bachelor's degree in college | 98 | 29.88 |
| | Master's degree | 112 | 34.15 |
| | Doctoral/Professional degree | 16 | 4.88 |
| *Job Classification* | | | |
| | Front Line Staff/ Entry Level | 140 | 42.68 |
| | Senior Level Staff/Supervisory Level | 110 | 33.54 |
| | Senior Management Executive Level | 26 | 7.93 |
| | Other | 52 | 15.85 |
| *Previous informatics Training* | | | |
| | Yes | 24 | 13.00 |
| | No | 280 | 87.00 |

Note: Percentages may not add up to 100 due to rounding

**Table 4.2: Study Participants by Job Classification and County**

| Job Classification | County | | | |
|---|---|---|---|---|
| | Clayton<br>N (%) | DeKalb<br>N (%) | Fulton<br>N (%) | Total<br>N (%) |
| *Front Line Staff/ Entry Level* | 29 (41.4) | 69 (43.4) | 42 (42.4) | 140 (42.7) |
| *Senior Level Staff/ Supervisory Level* | 19 (27.1) | 53 (33.3) | 38 (38.4) | 110 (33.5) |
| *Senior Management Executive Level* | 6 (8.6) | 11 (6.9) | 9 (9.1) | 26 (7.9) |
| *Other* | 16 (22.9) | 26 (7.9) | 10 (10.1) | 52 (15.9) |

Note: Percentages may not add up to 100 due to rounding

**Psychometric Properties of Instrument**

Table 4.3 shows the final item loading after exploratory factor analysis (EFA) was conducted on all items, using respondents' proficiency ratings. Items loading at <.4 were not retained in the final survey instrument and are not reported. Following the EFA, ten items were retained across two domains: Effective use of information had six items, and effective use of information technology, four items (Table 4.4). The KMO correlation for the survey instrument was 0.84, and the Barlett test of sphericity returned a chi-square value of 1753.15, and a p-value of < 0.001, confirming that a construct validation using EFA was appropriate for the study instrument.

The overall Cronbach's coefficient for the instrument was 0.88. Cronbach's alpha for each domain area were as follows: effective use of information domain, 0.88, and effective use of information technology, 0.82 (Table 4.4). All Cronbach's alpha was well above the recommended benchmark of at least 0.70 (Nunally, 1975), indicating that the resulting instrument was reliable.

**Table 4.3: Final Item Loading of Exploratory Factor Analysis (EFA)**

| Variable | Factor 1 | Factor 2 |
|---|---|---|
| Q1 | 0.6179 | |
| Q2 | 0.6791 | |
| Q3 | 0.5858 | |
| Q4 | 0.5766 | |
| Q5 | 0.8475 | |
| Q6 | 0.8729 | |
| Q7 | | 0.7144 |
| Q8 | | 0.6306 |
| Q9 | | 0.7355 |
| Q10 | | 0.7749 |

**Blanks represent factor loading <.4*

**Table 4.4- Survey Instrument Domains and Competencies**

| Domain | Cronbach's Alpha | Number of Items | Competency Item |
|---|---|---|---|
| *Effective Use of Information* | 0.88 | 6 | Collecting, summarizing, and interpreting information relevant to an issue |
| | | | Identifying appropriate sources of data and information to assess the health of a community |
| | | | Effectively running and presenting reports using information systems |
| | | | Using and interpreting clinical data from Electronic Health Records (EHRs) and other clinical sources |
| | | | Using and interpreting quantitative data |
| | | | Using and interpreting qualitative data |
| *Effective use of Information Technology* | 0.82 | 4 | Basic computer skills such as sending and receiving emails |
| | | | Using word processing, spreadsheet and presentation software such as Microsoft Word, Excel, PowerPoint and Access |
| | | | Using browser software to navigate the World Wide Web |
| | | | Using general-purpose online search engines to search the Web (e.g., Google, Yahoo) |
| | | | Describing at basic level technology employed to ensure computer systems' security |
| | Overall Cronbach's alpha: 0.88 | | *for each competency participants rated proficiency, relevance and frequency of use |

## Cross-cutting Informatics Competency Levels and Gaps

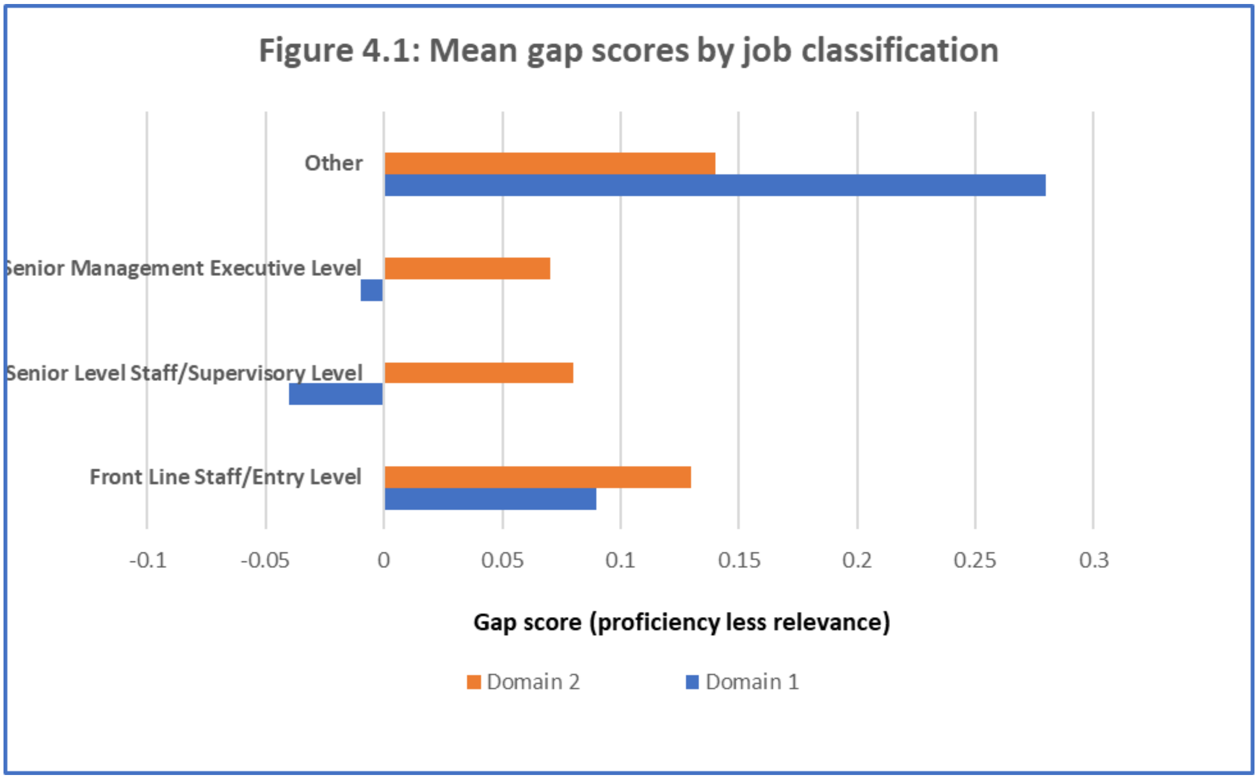
The mean proficiency and relevance scores for the resulting cross-cutting informatics competencies are presented by job classification in Table 4.5. In the domain "Effective Use of Information," all job levels reported, overall moderate to high levels of proficiency. Senior-level staff/supervisory level employees reported the highest proficiency levels with an average score of 3.68; the ‘other’ category had the lowest average score of 3.29. Proficiency levels for all items in this domain were above 3, except for “Using and interpreting clinical data from Electronic Health Records (EHRs) and other clinical sources”, where senior-level staff/supervisory level employees reported the lowest proficiency score of 2.96.

In the same domain for relevance of competencies to job roles, senior-level staff/supervisory level had the highest average score of 3.71, and the “other” category had the lowest mean score of 3.01. Consistently, relevance scores were lower than proficiency score in the “Effective Use of Information” domain. As with proficiency, the lowest mean score was recorded “Using and interpreting clinical data from Electronic Health Records (EHRs) and other clinical sources”, with senior-level staff/supervisory level employees and “other” employees reporting relevance scores of 2.59 and 2.73, respectively.

In the domain “Effective Use of Information Technology,” all job levels reporting high levels of proficiency, with mean scores above four on all items, except for one item. Notably, the “other” category of employees reported low to moderate proficiency in the following: “Using browser software to navigate the World Wide Web”. On average, senior management /executive level reported the highest level of proficiency in this domain (mean score of 4.82), whereas the “other” category had the lowest mean score of 4.22. In the same domain for relevance of competencies to job roles, senior management /executive level had the highest average score of 4.75 and the “other” category had the lowest mean score of 4.08.

Figure 4.1 is a presentation of the mean gap scores by job classification for each domain (i.e. Domain 1 = effective use of information and Domain 2 = effective use of information technology). With respect to Domain 2 (Effective Use of Information Technology), all job levels demonstrated adequate mean proficiencies relative to perceived relevance, indicating little need for additional training. With respect to domain 1 (Effective Use of Information), competency gaps were identified by Senior management executive level and senior-level staff /supervisory level employees as evidence by negative gap scores (Figure 4.1).

| Table 4.5: Cross-Cutting Informatics Competency Mean Scores on Proficiency (P) and Relevance (R) by Job Classification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Front Line Staff/ Entry Level** | | **Senior Level Staff/ Supervisory Level** | | **Senior Management / Executive Level** | | **Other** | |
| **Effective Use of Information** | **P** | **R** | **P** | **R** | **P** | **R** | **P** | **R** |
| Collecting, summarizing, and interpreting information relevant to an issue | 4.15 | 4.10 | 4.20 | 4.32 | 4.17 | 4.36 | 3.97 | 3.76 |
| Identifying appropriate sources of data and information to assess the health of a community | 3.71 | 3.75 | 3.56 | 3.66 | 3.59 | 3.57 | 3.26 | 3.05 |
| Effectively running and presenting reports using information systems | 3.43 | 3.40 | 3.67 | 3.66 | 3.59 | 3.71 | 3.32 | 3.15 |
| Using and interpreting clinical data from Electronic Health Records (EHRs) and other clinical sources | 3.52 | 3.31 | 3.36 | 3.33 | 2.96 | 2.59 | 3.00 | 2.73 |
| Using and interpreting quantitative data | 3.42 | 3.32 | 3.65 | 3.69 | 4.04 | 4.00 | 3.00 | 2.62 |
| Using and interpreting qualitative data | 3.46 | 3.26 | 3.56 | 3.59 | 3.72 | 3.87 | 3.18 | 2.76 |
| **Average Mean Score** | **3.61** | **3.52** | **3.67** | **3.71** | **3.68** | **3.68** | **3.29** | **3.01** |
| **Effective Use of Information Technology** | **P** | **R** | **P** | **R** | **P** | **R** | **P** | **R** |
| Basic computer skills such as sending and receiving emails | 4.74 | 4.70 | 4.86 | 4.83 | 4.96 | 4.96 | 4.85 | 4.78 |
| Using word processing, spreadsheet and presentation software such as Microsoft Word, Excel, PowerPoint and Access | 4.31 | 4.21 | 4.42 | 4.49 | 4.71 | 4.75 | 4.23 | 3.97 |
| Using browser software to navigate the World Wide Web | 4.38 | 4.25 | 4.69 | 4.53 | 4.79 | 4.63 | 3.27 | 2.98 |
| Using general-purpose online search engines to search the Web (e.g., Google, Yahoo) | 4.57 | 4.31 | 4.74 | 4.55 | 4.83 | 4.67 | 4.53 | 4.59 |
| **Average Mean Score** | **4.50** | **4.37** | **4.68** | **4.60** | **4.82** | **4.75** | **4.22** | **4.08** |




**Factors Associated with Informatics Competency – Results from Path Analysis**

Tables 4.6 and 4.7 present results from the path analysis, jointly assessing the relationship between employee and organizational characteristics on with IT use proficiency, and the relationship between IT use proficiency and information use proficiency.

*Factors Associated with IT use Proficiency*

Age was negatively associated with IT use proficiency (ß=-0.252; <0.01), thus supporting hypothesis H1. Previous informatics training was positively associated with IT use proficiency (ß= 0.276; <0.05), supporting hypothesis H2. Proficiency in IT usage did not vary across local health department and thus rejecting hypothesis H3. Associations were not observed for gender, education, job classification or race. Employees who were classified as senior management or supervisors had higher IT use proficiency levels compared to others (ß= 0.191; <0.05) (Table 4.6)

*Factors Associated with Information Use Proficiency*

IT use proficiency was positively associated with information use proficiency (ß= 0.567; <0.001), thus supporting hypothesis 4. A positive association was observed for previous informatic training (ß=0.450; <0.01). Compared to other LHDs, Fulton county LHD had higher informatic use proficiency levels (ß= 0.091; <0.05). There was no age, gender, race, education, or job classification effect on information use proficiency (Table 4.6).

*Assessment of Mediation*

Table 4.7 presents the direct and indirect path coefficient estimates for the information use proficiency model. The relationship between assessed employee factors with information use proficiency was mediated by proficiency in IT use. Specifically, the relationship between age and information use proficiency is mediated fully by IT use proficiency as indicated by the lack of a direct effect, the presence of a significant indirect effect (Table 4.7) and a negative association with IT use (Table 4.6), thus satisfying H5. The relationship between previous informatics training and information use proficiency was partially mediated by IT use proficiency (H6) as indicated by significant direct and indirect effects (Table 4.7) and a significant positive association with IT use proficiency (Table 4.6). The relationship between LHD and information use was not found to be mediated by IT use (H7) as indicated by the lack of an indirect effect (Table 4.7) and the lack of an association between LHD and IT use proficiency. Taken together, the results suggest that the relationship between the assessed employee characteristics and information use proficiency is mediated by IT use proficiency.

Table 4.6. Path Analysis

| | | | | | |
|---|---|---|---|---|---|
| ***Correlates of IT Use Proficiency*** | | | | | |
| | Parameter estimate | Standard error | P-value | 95% CI | |
| Age, 45 years and older (Ref: Under 45 years) | -0.252 | 0.081 | 0.002 | -0.411 | -0.094 |
| Previous Informatics Training (Ref: None) | 0.276 | 0.116 | 0.017 | 0.048 | 0.503 |
| LHD : Fulton (Ref: Other) | 0.007 | 0.031 | 0.831 | -0.054 | 0.067 |
| LHD: Clayton (Ref: Other) | -0.085 | 0.102 | 0.403 | -0.284 | 0.114 |
| Female (Ref: Male) | 0.037 | 0.109 | 0.732 | -0.176 | 0.251 |
| Black/African American (Ref: Other) | -0.020 | 0.095 | 0.831 | -0.206 | 0.166 |
| At least has Masters Degree (Ref: Other) | 0.070 | 0.087 | 0.421 | -0.100 | 0.240 |
| Senior Management or Supervisory Role (Ref: Other) | 0.191 | 0.085 | 0.024 | 0.025 | 0.358 |
| ***Correlates of information use proficiency*** | | | | | |
| | Parameter estimate | Standard error | P-value | 95% CI | |
| IT use proficiency | 0.567 | 0.081 | 0.000 | 0.408 | 0.727 |
| Age, 45 years and older (Ref: Under 45 years) | -0.149 | 0.113 | 0.185 | -0.370 | 0.072 |
| Previous Informatics Training (Ref: None) | 0.450 | 0.160 | 0.005 | 0.135 | 0.764 |
| LHD : Fulton (Ref: Other) | 0.091 | 0.043 | 0.032 | 0.008 | 0.174 |
| LHD: Clayton (Ref: Other) | -0.002 | 0.140 | 0.991 | -0.275 | 0.272 |
| Female (Ref: Male) | -0.199 | 0.149 | 0.182 | -0.491 | 0.093 |
| Black/African American (Ref: Other) | -0.144 | 0.130 | 0.269 | -0.399 | 0.111 |
| At least has Masters Degree (Ref: Other) | 0.027 | 0.119 | 0.818 | -0.206 | 0.261 |
| Senior Management or Supervisory Role (Ref: Other) | 0.048 | 0.117 | 0.681 | -0.182 | 0.278 |

Table 4.7. Direct, Indirect and Total Effects

| ***Factors Associated with Information Use Proficiency*** ***Path coefficients*** | | | |
|---|---|---|---|
| | Direct Effect | Indirect Effect | Total Effect |
| IT use proficiency | 0.567*** | No path | 0.567*** |
| Age, 45 years and older (Ref: Under 45 years) | -0.149 | -0.143** | -0.292* |
| Previous Informatics Training (Ref: None) | 0.450** | 0.156* | 0.606*** |
| LHD : Fulton (Ref: Other) | 0.091* | 0.004 | 0.094* |
| LHD: Clayton (Ref: Other) | -0.002 | -0.048 | -0.050 |
| Female (Ref: Male) | -0.199 | 0.021 | -0.178 |
| Black/African American (Ref: Other) | -0.144 | -0.011 | -0.155 |
| At least has Masters Degree (Ref: Other) | 0.027 | 0.040 | 0.066 |
| Senior Management or Supervisory Role (Ref: Other) | 0.048 | 0.109* | 0.157* |

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

# CHAPTER 5

# DISCUSSION AND CONCLUSIONS

## Introduction

The purpose of this study was to assess the informatics competency proficiency of the public health workforce in 3 Georgia health districts and identify existing gaps. The study also identified factors associated with PHI competency proficiency as well as the relationship between the PHI competency domains. The study validated a short 10-item instrument for assessing foundational or cross-cutting PHI competencies across the two domains of IT use and information use. The instrument demonstrated validity and reliability.

## Summary and Interpretation of Findings

The results from the competency assessment indicated relatively high levels of foundational informatics competency among public health professionals in the metro Atlanta area, especially in the IT use informatics competency domain. Using gap scores as a proxy for training need, the study did not identify a need for training in the informatics competency domain of IT use but identified a need for training in the competency domain of information use for employees at the Senior Management/Executive level, and Senior-level staff/Supervisory levels. This finding is not surprising considering the job classification level. Subordinates often perform the actual usage of information such as identifying, collecting, and summarizing data, running reports, and using clinical data from EHRs, while supervisors review the reports produced to form policies and strategize. Overall, the general lack of a need for training, particularly in the area of IT use, may be reflective of adequate training being currently provided at participating LHDs. It is also possible that the workforce developed expertise through usage or may have received training to make use of information technology and systems.

*Employee Factors and Informatics Competency*

Concerning the factors associated with PHI competency proficiency and the relationship between the competency domains, the findings were generally consistent with hypothesized expected outcomes and consistent with the literature review findings.

As postulated in hypothesis H1, age was negatively associated with IT use proficiency. Individuals, 45 years and older were less proficient, compared to those under 45 years, consistent with past research that has identified age-related disparities in computer and IT proficiency. For example, Moore, Rothpletz, and Preminger (2015) found in their study that a negative correlation exists between age and computer literacy, with older individuals having more inadequate computer skills. This may, in part, be facilitated by exposure to the technology, given evidence that younger individuals tend to use computer technology programs more often (Saare, Hussain, & Wong Seng Yue, 2019).

Previous informatics training made a significant difference in IT use proficiency (H2) with a positive association observed. Specifically, employees reporting previous informatics training displayed greater proficiency in IT use proficiency in comparison with those that had no prior experience. Previous informatics experience has been linked to an individual's confidence in the use of information and communication technologies (Suárez-Rodríguez, Almerich, Orellana, Díaz-García, 2018; Kleib et al., 2018). There is a famous saying that "practice makes perfect," therefore, the expectation is that an individual with previous informatics training will develop proficiency in IT use over time. This saying is reflective of evidence that suggests that an individual's experience with technology tools influence the usage of such technologies (El-Masri & Tarhini, 2017).

The findings indicated that the relationship between employee factors such as age and previous informatics training was mediated through proficiency in IT use. Therefore, suggesting that eliminating demographic-related differences in IT use (in particular age-related disparities) may improve the effective use of information for population health improvement. Also, providing informatics training as part of workforce development or continuing education process may help improve PHI competencies among public health professionals in the metro Atlanta region.

*Organizational Factors and Informatics Competency*

Organizational factors/characteristics (workplace dynamics) play a significant role in enhancing staff morale and reducing turnover in the face of dwindling financial resources (Boakye et al., 2019). Massoudi, Chester, and Shah (2016) found IT capacity to vary based on organizational factors such as governance structure and jurisdiction size. Given the varying size and service scope of the LHDs in this study, variations in informatics competency were expected. Interestingly, information use proficiency and not IT use proficiency was found to vary within LHDs, rejecting hypothesis H3. It is worthy to note that this study did not assess specific organizational factors and thus cannot provide an explanation for why Fulton County, for example, reported higher proficiency in information use. Additional research is, therefore, needed to characterize the specific organizational elements that are associated with informatics competency.

*Relationship Between Informatics Domains of IT Use and Information Use*

This study is one of the first studies to examine the inter-relationship among the informatics competency domains. The study identifies IT use proficiency to be an essential component to the effective utilization of information for population health management – also an important informatics function. An integral part of public health is to reduce health disparities, and there is evidence that PHI provides LHDs with the tools needed to address and eliminate these disparities (Shah et al., 2018). To achieve this, there is a need for effective integration and utilization of informatics tools to form policies, strategies, and create activities and programs targeted at reducing health disparities (information use). The findings suggest that improving IT use proficiency can facilitate the effective use of information.

For public health employees to make adequate use of information systems, it is important to know the IT tools' interoperation ability and operations (LaVenture et al., 2014; Shah et al., 2016). An essential part of public health is to improve population health outcomes, which requires the timely gathering of information from several sources to inform decisions. The use of HIEs and EHRs by LHDs is expected to improve these population health outcomes through the timely collection and exchange of pertinent and accurate data (Lovelace & Shah, 2016).

## Limitations and Strengths

One of the strengths of this study is the study population, as there is no record of such a study having been conducted in metro Atlanta. This study is first of such focusing on metro Atlanta health departments and first done in Georgia with a focus on individual health districts. The study received the backing of the district health directors of the health departments. The study provides the health department with baseline data, and the findings will assist the health departments in identifying informatics training needs and tailor training educations that would meet the requirements.

Secondly, the study added to the existing literature in PHI in a couple of ways, worth highlighting. First, it is one of the first studies (a) to validate a brief adapted instrument for the assessment of cross-cutting PHI competencies and (b) to assess the inter-relationships among the informatics competency domains of IT use and information use. The study thus extends the work of the ICPHP by providing LHDs with a short, validated tool (with only 10-items) to assess informatics competencies.

A few limitations of the study are worth mentioning. First, the study was a cross-sectional study; therefore, causality cannot be established. In addition, the study was conducted in three urban counties in one state; thus, the findings may not be generalizable beyond this population. Third, refining the survey instrument required an extensive process of improving the question to ensure staff at all levels could understand while preserving the essence of the item. However, as with all self-administered surveys, it is difficult to ascertain if all participants responded to the items with the same frame of reference. The potential for non-response bias is a possibility; that is, the lack of response by some employees may have influenced the result. Further, the survey instrument used for the study may have been subject to self-reporting bias as with other surveys of this nature. Lastly, the study may have omitted key variables. For example, the survey did not obtain specific organizational level information. Also, it did not ask the question about the ease of use, which is associated with technology proficiency based on reviewed literature (El-Masri, M., & Tarhini, A., 2017).

**Public Health Practice Implications and Recommendations**

There is a continual increase in the use of information technology, information systems, data mining, artificial intelligence, telemedicine, and EHRs. All these are reasons for public health to leverage the use of these systems to build its informatics capacity to enhance its healthcare service delivery and remain relevant in the delivery system. The findings for this study identify some implications for public health practice and research.

First, the findings suggest that although Atlanta metro public health professionals, although proficient in IT use, have an opportunity to improve their proficiency in collecting, analyzing, and leveraging information for population health improvement, particularly among senior executives or those with a management and supervisory role. This can be achieved through informatics training, suggesting an opportunity for informatics training either as part of public health (e.g., MPH curriculum) educational curriculum or through continuing education in the workplace.

LHDs, however, cannot improve what they do not assess. Thus, it is recommended that informatics competency assessment should be incorporated as a part of new hire orientation as individuals become a part of the workforce. This study provides LHDs with a brief assessment tool that can be used to assess employee technology readiness and proficiency with the use of information. The tool can be administered to staff on entry into the workforce to create a baseline informatics competency level, which can then be used for individual personal training, development, and evaluation tool.

**Conclusion and Next Steps**

In conclusion, the overall findings show that the current workforce of the metro Atlanta health departments generally have the knowledge, skills, and attitudes to use currently available information technology tools and systems to achieve organizational and individual goals in the workplace. Periodic assessment of staff informatics competencies will contribute to proactively identifying and addressing training needs, thus positioning employees for maximum productivity when using informatics technology and informatic systems to perform their job responsibilities. LHDs can use the short, validated tool used in this study for such assessments.

Further, several opportunities exist for future research, including assessing if geographic (rural-urban) disparities exist concerning PHI competency. Also, the three-county health departments studied served only one county each, and future studies can replicate this study in LHDs with a multi-county structure. It may also be worthwhile to design studies that shed more light on the specific organizational factors that influence workforce PHI competency.

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# APPENDIX A
# FINAL SURVEY QUESTIONS

Q1

Please select your Health Department

- ◌ Clayton County Health Department
- ◌ DeKalb County Health Department
- ◌ Fulton County Health Department

Q2

In what age group (in years) are you?

- ◌ 18-24
- ◌ 25-34
- ◌ 35-44
- ◌ 45-54
- ◌ 55+

Q3

Gender:

- ◌ Male
- ◌ Female
- ◌ Non Binary/Other

Q4

Please specify your race:

- ◌ Black/African American
- ◌ White
- ◌ Native American/ American Indian

- Asian /Pacific Islander
- Multiracial
- Other

-

Q5

What is the highest level of school you have completed or the highest degree you have received?

- Less than high school degree
- High school graduate (high school diploma or equivalent including GED)
- Some college but no degree
- Associate degree in college (2-year)
- Bachelor's degree in college (4-year)
- Master's degree
- Doctoral degree
- Professional degree (JD, MD)

Q6

In terms of your current occupation, how would you characterize yourself?

- Clerical Staff – Provide basic staff support for other staff members
- Front Line Staff/ Entry Level- Carry out the daily functions of the health department and not in management position
- Senior Level Staff/Supervisory Level- program management and supervisory roles
- Senior Management Executive Level – oversees major programs often more than one and have several people reporting to them
- Other, please specify:

- 

Q7

Using years and months, how long have you worked with the Board of Health?

Q8

In what field is your highest level of education?

Q9

Do you have any formal training in informatics?

- No
- Yes, please describe

- 

Q10

Do you have any certifications in informatics?

- No
- Yes, please list

- 

Q11

**Effective use of Information**

| PROFICIENCY: On a scale of 1 to 5 rate your proficiency on this skill. 1 = Not Proficient 5 = Very Proficient | | | | | RELEVANCE: On a scale of 1 to 5 rate importance of skill to the work you do. 1 = Not Important 5 = Very Important | | | | | USE FREQUENCY: On a scale of 1 to 5 rate how often you use this skill for work. 1 = Never 5 = Always | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |

| | PROFICIENCY: On a scale of 1 to 5 rate your proficiency on this skill. 1 = Not Proficient 5 = Very Proficient | | | | | RELEVANCE: On a scale of 1 to 5 rate importance of skill to the work you do. 1 = Not Important 5 = Very Important | | | | | USE FREQUENCY: On a scale of 1 to 5 rate how often you use this skill for work. 1 = Never 5 = Always | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **Collecting, summarizing, and interpreting information relevant to an issue** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Identifying appropriate sources of data and information to assess the health of a community** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Effectively running and presenting reports using information systems** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Using and interpreting clinical data from Electronic Health Records (EHRs) and other clinical sources** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Using and interpreting quantitative data** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Using and interpreting qualitative data** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Q12

**Effective use of Information Technology**

| | PROFICIENCY: On a scale of 1 to 5 rate your proficiency on this skill. 1 = Not Proficient 5 = Very Proficient | | | | | RELEVANCE: On a scale of 1 to 5 rate importance of skill to the work you do. 1 = Not Important 5 = Very Important | | | | | USE FREQUENCY: On a scale of 1 to 5 rate how often you use this skill for work. 1 = Never 5 = Always | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **Using the media, advanced technologies, and community networks to communicate** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Basic computer skills such as sending and receiving emails** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Using word processing, spreadsheet and presentation software such as Microsoft Word, Excel, PowerPoint and Access** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Utilizing modern information technology as a tool to promote public health** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Using browser software to navigate the World Wide Web** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Using general-purpose online search engines to search the Web (e.g., Google, Yahoo)** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Utilizing modern information technology tools to identify, locate, interpret and use online public health information and data** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Using statistical or other analytical software** | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

Q13

**Effective Management of Information Technology Projects**

| | PROFICIENCY: On a scale of 1 to 5 rate your proficiency on this skill. 1 = Not Proficient 5 = Very Proficient | | | | | RELEVANCE: On a scale of 1 to 5 rate importance of skill to the work you do. 1 = Not Important 5 = Very Important | | | | | USE FREQUENCY: On a scale of 1 to 5 rate how often you use this skill for work. 1 = Never 5 = Always | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **Describing at a basic level the internet and World Wide Web** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Naming the technologies currently available for delivering distance learning materials to learners** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Describing at basic level technology employed to ensure computer systems' security** | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

End of Survey Survey Termination Options.

# APPENDIX B
# PARTICIPANT INFORMED CONSENT LETTER

**Project # H20046**

Dear Employee,

My name is Olatanwa Adewale, a current doctoral candidate at Jiann Ping Hsu College of Public Health, Georgia Southern University and conducting an independent public health workforce informatics competency assessment, on behalf of your health department for my dissertation to complete my program. The title of my dissertation is Title: Assessing Public Health informatics competencies: A study of three health departments in metro Atlanta. Your input is invaluable for this vital study. Therefore, I am requesting that you complete the attached survey. The survey should take approximately 15 minutes to complete.

Your participation in this survey is entirely voluntary. You will not receive any financial or other compensation for your assistance. **Please note that your employer will not have access to your actual responses.** Your confidentiality will be assured as all data will be held in a secured file by the principal investigator at Georgia Southern University. **All responses will be reported in aggregate form, and no unique individual identifiers will be reported.** Thus, your **participation in this study will have no adverse impact on you or your relationship with your employer**. Your employer will not be aware of your participation as responses will be recorded on an anonymous link directly to the Georgia Southern University server. We also do not anticipate you experiencing any discomfort or risk as a result of your participation in this study. However, if you do, you may stop participating at any time you wish.

Participants have the right to ask questions, and the research team will do their best to answer them. Should you have any questions or concerns, please contact Olatanwa Adewale [00994@georgiasouthern.edu or 404-520-1638] or my research adviser Dr. Bettye Apenteng [bapenteng@georgiasouthern.edu or 912-478-2416]. This project has been reviewed and approved by the Georgia Southern University Institutional Review Board under tracking number **H20046** and Georgia Department of Public health Institutional Review Board under tracking number **190815**. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services Sponsored Programs at 912-478- 5465.

**Participants have to be 18years or older** to complete this survey and participate in the study. Your completion of the attached survey represents your consent to participate in this study.

Thank you for your participation in this initiative.

Sincerely yours,
Olatanwa Adewale MPH
(404) 520-1638,
00994@georgiasouthern.edu

APPENDIX C

Georgia Southern University
Office of Research Services & Sponsored Programs

**Institutional Review Board (IRB)**

Phone: 912-478-5465
Fax: 912-478-0719
IRB@GeorgiaSouthern.edu
Veazey Hall 3000
PO Box 8005
Statesboro, GA 30460

**To:** Adewale, Olatanwa; Apenteng, Bettye

**From:** Office of Research Services and Sponsored Programs
Administrative Support Office for Research Oversight Committees (IACUC/IBC/IRB)

**Approval Date:** 8/23/2019

**Subject:** Institutional Review Board Exemption Determination - Limited Review

After a review of your proposed research project numbered H20046, titled "Assessing Public Health Informatics competencies: A Study of three health departments in metro Atlanta," it appears that your research involves activities that do not require full approval by the Institutional Review Board (IRB) according to federal guidelines.

According to the Code of Federal Regulations Title 45 Part 46, your research protocol is determined to be exempt from full review under the following exemption category(s):

Exemption 2 Research involving only the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, if: Information obtained is recorded in such a manner that human participants cannot be identified, directly or through identifiers linked to them. Please visit our FAQ's for more information on anonymous survey platforms; Any disclosure of the human participant's responses outside the research could not reasonably place the participant at risk of criminal or civil liability or be damaging to the participant's financial standing, employ-ability or reputation; Survey or interview research does not involve children; The research project does not include any form of intervention.

Any alteration in the terms or conditions of your involvement may alter this approval. *Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that your research, as submitted, is exempt from IRB approval. You will be asked to notify the IRB upon project completion. If you alter the project, it is your responsibility to notify the IRB and acquire a new determination of exemption.*

Sincerely,

Eleanor Haynes

Eleanor Haynes
Research Integrity Officer

# APPENDIX D

DPH
Georgia Department of Public Health

Kathleen E. Toomey, M.D., M.P.H., Commissioner | Brian Kemp, Governor

2 Peachtree Street NW, 15th Floor
Atlanta, Georgia 30303-3142
dph.ga.gov

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August 16, 2019

Olatanwa Adewale
Student (Clayton County District Epidemiologist)
2228 Asquith Avenue
Marietta GA 30008

**Project:** **190815 - Assessing public health workforce informatics competencies: A study of three health departments in metro Atlanta**

**Project Status: Exempt**

Dear Researcher,

The DPH Institutional Review Board has determined that the above-referenced project is **exempt** from the requirement for IRB review and approval.

Reason:
EXEMPT CATEGORY #2:
Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
(ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
(iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review.

This exemption applies only to the protocol described in your application. Any modification to this protocol may change the status of this project and may require IRB review and approval except where necessary to eliminate apparent immediate hazards to human subjects.

If you have any questions regarding this letter or general procedures, please contact the DPH IRB at **DPH-irb@dph.ga.gov.** Please reference the project # in your communication.

Best wishes in your research endeavors,

Brian Kirtland, Ph.D.
Digitally signed by Brian Kirtland, Ph.D.
DN: cn=Brian Kirtland, Ph.D., o=Institutional Review Board, ou=GA Dept of Public Health, email=Brian.Kirtland@dph.ga.gov, c=US
Date: 2019.08.16 14:36:08 -04'00'