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Mobile Technology Deployment Strategies for Improving the Quality of Healthcare

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This is to certify that the doctoral study by

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Abstract

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Postmaster's Certificate in Nursing Informatics, Walden University, 2014

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Ineffective deployment of mobile technology jeopardizes healthcare quality, cost control, and access, resulting in healthcare organizations losing customers and revenue. A multiple case study was conducted to explore the strategies that chief information officers (CIOs) used for the effective deployment of mobile technology in healthcare organizations. The study population consisted of 3 healthcare CIOs and 2 healthcare information technology consultants who have experience in deploying mobile technology in a healthcare organization in the United States. The conceptual framework that grounded the study was Wallace and Iyer's health information technology value hierarchy. Data were collected using semistructured interviews and document reviews, followed by within-case and cross-case analyses for triangulation and data saturation. Key themes that emerged from data analysis included the application of disruptive technology in healthcare, ownership and management of mobile health equipment, and cybersecurity. The healthcare CIOs and consultants emphasized their concern about the lack of cybersecurity in mobile technology. CIOs were reluctant to deploy the bring-your-own-device strategy in their organizations. The implications of this study for positive social change include the potential for healthcare CIOs to emphasize the business practice of supporting healthcare providers in using secure mobile equipment deployment strategies to provide enhanced care, safety, peace of mind, convenience, and ease of access to patients while controlling costs.

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Dedication

I dedicate this bestowal to my late son, Joseph Min-Jae Song. My dear son, I know you are in heaven waiting to see me with a welcoming smile. You have watched me all along. Thank you, my dear.

Acknowledgments

First, I want to give all glory to God almighty. Without God's infinite mercy and wisdom, I would not have been able to make it this far. I also would like to express my sincere gratitude to the committee chair Dr. Krista Laursen, for your encouragement, research insight and expertise, wisdom, patience, and attention to detail. I am forever grateful for all you taught me.

I also want to express my gratitude to the committee member Dr. Jorge Gaytan, thank you for your valuable advice on many occasions and encouragement that motivated me to achieve a higher level of excellence. I also thank Dr. Alex Lazo for his time and service as the second committee member while I was completing my study. To Dr. Matthew Knight, the university research reviewer, thank you for your suggestions and insightful feedback in the early stages of my study. I would also like to acknowledge the program manager Dr. Susan Davis, Dr. Jan K. Garfield, Dr. Yvonne Doll, and Dr. Fred M. Walker who oversaw the program and ensured my study to meet the requirements of the university. To my cohort, including Dr. Camilla Henry, I thank you all colleagues very much for your ideas and support. I should not forget to thank my friend and ex-boss, Dr. John Hudson II for his encouragement. To all editors who contributed a great deal to this study, thank you very much. I could not finish this work without your help.

To my dear lifetime partner Helen and my precious daughter Elizabeth, words cannot convey the depth of my appreciation. I love you and thank you for all your support and understanding for the last 30 years. You have been my rock and made my career what it is now by putting up with my details and work schedule.

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Section 1: Foundation of the Study

The U.S. healthcare delivery system is undergoing a rapid transformation as a result of the governmental public policy efforts in the United States, such as enactment of the Affordable Care Act and the Health Information Technology for Economic and Clinical Health (HITECH) Act (Turakhia, Desai, & Harrington, 2016). The U.S. federal government has promoted healthcare organizations (HCOs) to implement health information technology (HIT; Turakhia et al., 2016). The Centers for Medicare and Medicaid Services (CMS) began to reimburse HCOs and healthcare providers based on the value or performance, not on diagnoses or severity of illness, with the Hospital Value-Based Purchasing Program, starting in 2011, to comply with the Affordable Care Act (Figueroa, Tsugawa, Zheng, Orav, & Jha, 2016).

Government funding for performance and technology advancement in healthcare promotes tele-health, electronic health records (EHRs), patient-centered care, evidence-based medicine, safer patient care, and keen awareness of cybersecurity. One area in discussion is mobile technology. The stakeholders in healthcare have begun to discuss mobile technology for healthcare, also known as *mobile health* or *m-health*, as crucial in raising expectation for the benefits in healthcare (Silva, Rodrigues, de la Torre Díez, López-Coronado, & Saleem, 2015). Silva et al. (2015) predicted healthcare services would become more affordable with the introduction of mobile technology. M-Health solutions enable social networking to promote healthy behaviors and awareness among patients involved in the network groups and communities (Silva et al., 2015).

Background of the Problem

Even though m-health is advantageous in healthcare, a proliferation of mobile equipment such as laptops, notebooks, tablets, and smartphones can lead to security complications. To address mobile equipment security concerns, the information technology (IT) researchers developed several mobile technology deployment strategies. Gajar, Ghosh, and Rai (2013) introduced the following framework for the deployment strategies: here-is-your-own-device (HYOD), choose-your-own-device (CYOD), on-your-own-device (OYOD), and bring-your-own-device (BYOD). BYOD is popular in enterprise settings (Singh & Pandey, 2016). However, chief information officers (CIOs) are highly concerned about the security vulnerability of BYOD (Keyes, 2014). Another anticipated mobile technology deployment strategy on the horizon is corporate-owned, personally enabled (COPE) devices. These devices are preconfigured company-owned devices for personal use (C. K. Kao et al., 2017). Attracted by the benefits of BYOD in cost savings and improved productivity when compared to other strategies, many healthcare CIOs may be willing to implement the BYOD strategy (Keyes, 2014).

Problem Statement

Ineffective deployment of mobile technology jeopardizes healthcare quality, cost, and access, resulting in HCOs losing customers and revenue (Jin & Chen, 2015). Cook County hospitals in Illinois lost roughly $165 million in revenue over the past 3 years because of ineffective use of information systems and mobile technology (Illinois Cook County Government, 2018). The general business problem was that HCOs were losing customers and revenue due to ineffective deployment of mobile technology. The specific

business problem was that some CIOs lack strategies to deploy mobile technology effectively.

Purpose Statement

The purpose of this qualitative multiple case study was to explore the strategies healthcare CIOs use to deploy mobile technology effectively. The targeted population consisted of five healthcare CIOs and HIT consultants in the United States who had successful experience in deploying mobile technology. The implications for social change include the potential for CIOs to deploy mobile technology effectively for the benefit of healthcare providers, staff members, and patients. The benefits of using mobile technology are as follows: (a) information and time management, (b) health record maintenance and access, (c) communications and consulting, and (d) reference and information gathering (Rothman et al., 2017). With the identification of strategies for deploying mobile technology effectively—which benefits healthcare providers, staff members, and patients—healthcare CIOs can provide an additional mode of communication that supports enhanced care, safety, peace of mind, convenience, and ease of access.

Nature of the Study

I conducted a qualitative research study. Healthcare providers and staff members use evidence-based practice to capture business phenomena and support daily operations (Dowling, Lloyd, & Suchet-Pearson, 2016). Researchers conducting quantitative studies gather data and analyze variables to test hypotheses and examine phenomena to validate business theories (McCusker & Gunaydin, 2015). In contrast, researchers conducting

qualitative studies of business phenomena make observations and explore solutions to problems (Thorne, Stephens, & Truant, 2016). The mixed-method approach includes both qualitative and quantitative methods (McCusker & Gunaydin, 2015). Because the purpose of this study was to explore and propose business solutions for m-health, the qualitative method was the most appropriate.

Lewis (2015) identified the following five qualitative research designs: case studies, narrative study, grounded theory, ethnography, and phenomenology. I chose the case study design. A case study is a qualitative study in which the investigator explores in-depth social behavior in a contemporary bounded system or multiple bounded systems (Yazan, 2015). A case study design was appropriate for my study because the purpose of the study was to explore the best strategies for CIOs to deploy mobile technology in the contemporary, multibound, healthcare system.

A narrative study includes the study of a phenomenon by sourcing the required information from documentary sources or narratives (Mear, Lukman, & Aljadani, 2016), which was not the focus of this study. Researchers conducting a grounded theory study move beyond description to generate or discover a theory, a unified explanation for a process, or an action (Ivey, 2017). The goal of this study was not to build a fundamental theory to support the explanation of a phenomenon, and, consequently, the grounded theory design was not the most appropriate design. Ethnography is a family of methods involving direct and sustained social contact with agents, and the generation of a rich depiction of the encounter to represent the human experience (Marion, Eddleston, Friar, & Deeds, 2015). I did not engage in sustained contact with agents to develop a depiction

of the encounter. Hence, an ethnographic design was not appropriate for this study. Researchers use a phenomenological design to describe and capture individual human experiences and to explore phenomena through the explanation and interpretation of participants' experiences (Künzler□Heule, Beckmann, Mahrer□Imhof, Semela, & Händler□Schuster, 2016). I did not intend to explore the lived experiences of study participants. Therefore, a phenomenological design was not appropriate for this study.

Research Question

What strategies do healthcare CIOs use to deploy mobile technology effectively?

Interview Questions

1. What strategies do you use to deploy mobile technology effectively?
2. Why do you use these strategies?
3. What strategies were unsuccessful for deploying mobile technology effectively?
4. What barriers have you encountered during and following your use of these strategies to deploy mobile technology effectively?
5. How have you overcome these barriers?
6. What additional observations would you like to share about strategies to deploy mobile technology effectively?

Conceptual Framework

I used the HIT value hierarchy as the conceptual framework for this study. Wallace and Iyer (2017) developed the HIT value hierarchy in modifying Maslow's needs hierarchy for application to the study of the small healthcare providers' practices.

According to Wallace and Iyer, organizations must satisfy lower-stage needs before they can achieve the next stage of maturity. Within the HIT value hierarchy, HCOs mature sequentially in the stage from (a) infrastructure and connectivity needs, (b) stability and security needs, (c) integrated information, and (d) interorganizational integration, to the highest stage of (e) paradigm shifting (Wallace & Iyer, 2017). I used the HIT value hierarchy as a lens to explore how HCOs may deploy mobile technology in an effective manner to meet connectivity, security, and information delivery needs (lower level needs in the HIT value hierarchy) and, ultimately, to achieve a paradigm shift in the provision of care.

Operational Definitions

Blockchain: Blockchain is a digital database containing information, such as records of financial transactions, that can be simultaneously used and shared within a large decentralized, publicly accessible network (Cachin, 2016).

Bring-your-own-device (BYOD): BYOD is one of the mobile technology deployment strategies for employers. HCOs can allow the healthcare providers and staff to bring their mobile equipment at work to use it to provide care. BYOD is popular in enterprise settings (Singh & Pandey, 2016). However, HCOs are highly concerned about the security vulnerability of BYOD (Keyes, 2014).

Disruptive technology: Disruptive technology is a technology that drives an entirely new market of services and replaces the mainstream technology (Yamagata-Lynch, Cowan, & Luetkehans, 2015).

Ecological momentary assessment: Ecological momentary assessment allows for

a reduction of recall bias and the static nature of questionnaires and clinical interviews through a dynamic assessment of subjective and objective data in the subject's natural environments. (Vogel, Mohnke, & Walter, 2018).

E-prescribing: E-prescribing is a prescriber's ability to electronically send an accurate, error-free and understandable prescription directly to a pharmacy from the point-of-care, an important element in improving the quality of patient care (Centers for Medicare & Medicaid Services, 2014). CMS requires the healthcare providers to use e-prescribing to get reimbursement from the Medical Part D program (Powers, Gabriel, Encinosa, Mostashari, & Bynum, 2015).

Hyperledger: The Hyperledger project is a collaborative effort to create an enterprise-grade, open-source distributed ledger framework and code base (Cachin, 2016). Hyperledger is an open-source community hosted by the Linux Foundation to help to advance technology and thought leadership (M. Gupta, 2018).

Internet of things (IoT): IoT, also called the Internet of Everything or the Industrial Internet, is a new technology paradigm envisioned as a global network of machines and devices capable of interacting with each other (I. Lee & Lee, 2015). IoT will transform the real-world objects into intelligent virtual objects (Madakam, Ramaswamy, & Tripathi, 2015). IoT is recognized as one of the most important areas of future technology and is gaining vast attention from a wide range of industries (I. Lee & Lee, 2015).

*Mobile health (*also known as *mHealth* or *m-health):* M-Health is healthcare using mobile technology. M-Health enables healthcare providers to deliver healthcare anytime

and anywhere, surpassing geographical, temporal, and even organizational barriers, utilizing mobile technology (Silva et al., 2015).

MUMPS (Massachusetts General Hospital Utility Multi-Programming System; M): MUMPS or *M* is a general-purpose computer programming language designed by Massachussett General Hospital in 1966 (Kuzmak, Demosthenes, & Maa, 2018). Its differentiating feature from other programing languages is its *built-in* database, enabling high-level access to disk storage using simple symbolic program variables and subscripted arrays; similar to the variables used by most languages to access main memory (Inoue & Zhou, 2016).

Wireless body area network (WBAN): A WBAN is the network of many small low-power, intelligent, invasive/noninvasive, micro- and nano-technology sensor nodes, through which users could monitor the real-time parameters of patients' physiology remotely (He, Zeadally, & Wu, 2015).

Assumptions, Limitations, and Delimitations

Assumptions

I assumed that certain conditions inherently exist in my study. Assumptions are facts assumed to be true but unverified (Attfield & Huang, 2004). First, I assumed that the participants with one of the titles of chief technology executives had the relevant expertise to answer the interview questions. Second, I assumed that participants provided truthful and honest disclosures of their titles and job descriptions and accurate interview responses. Third, I assumed the participants understood the success criteria of their

mobile technology deployment projects and objectively evaluated the success of the projects at closing.

Limitations

Limitations of a research study are the conditions and influences that the researcher cannot control (Brutus, Aguinis, & Wassmer, 2013). Readers should accept the findings and conclusions in a qualitative study with caution because generalization may be limited (Simon & Goes, 2013). I could not remove bias in my study because I depended on my view to interpret the collected data. This was a qualitative, multiple case study. I did not test the results statistically. My ability to solicit participants might also have had resulted in inadequate sampling.

The local, state, and federal laws, regulations, policies, cultural, and customary procedures limited the collection of enough data in this study. The U.S. federal government imposes a substantial penalty on HCOs, healthcare providers, and staff members who infringe the privacy of their patients by revealing protected health information (PHI) to the public either intentionally or accidentally (Hui Yang & Garibaldi, 2015). Therefore, study participants may not have revealed the violations that they had not reported to the authority. Even though I am a U.S. citizen who has the right to access public information from the U.S. federal, state, and local governments, under the Freedom of Information Act of 1966, HCOs also have obligations to protect the organizations, the organizations members, and patients' privacy (Hui Yang & Garibaldi, 2015). To comply with the healthcare laws, regulations, and policies of the local, state,

and federal governments pertaining to the privacy of information, I could not collect comprehensive and unbiased information.

Delimitations

Study delimitations are constraints that researchers impose on the scope of the research study (Simon & Goes, 2013). First, I limited the region of the study to the United States. Second, I focused my study only on the healthcare industry. Third, I interviewed only health technology executive officers and consultants as a primary data source for this study.

Significance of the Study

Contribution to Business Practice

The CIOs who understand and deploy mobile technology successfully contribute to business practice. Ensuring patient safety, information security, and protection of privacy are the priorities for healthcare CIOs (Zafar, Ko, & Osei-Bryson, 2016). Healthcare CIOs support healthcare operations, enabling healthcare personnel to overcome geographical, temporal, and organizational barriers to effective healthcare delivery (Silva et al., 2015). Healthcare CIOs must be careful in deploying new technologies. Despite the evidence that the use of m-health is beneficial (Kalem & Turhan, 2015; Nerminathan, Harrison, Phelps, & Scott, 2017), some CIOs are unsure what strategies to use to deploy mobile technology systems at an institutional level (Ehrler, Blondon, Baillon-Bigotte, & Lovis, 2017). The CIOs who understand successful mobile technology deployment strategies ensure that their organization effectively

integrates innovative technology to enhance the quality of care. The findings of this study may facilitate the success of healthcare CIOs' business practice.

Implications for Positive Social Change

The CIOs who successfully deploy mobile technology to their organization bring social changes to their organization. The iron triangle—the triangle of cost, quality, and access to healthcare—is difficult to manage (Myers & Twigg, 2017). HCOs should use disruptive technology such as smartphones, radio frequency identification (RFID), and tele-health systems to resolve the issue of the healthcare iron triangle (Cheng, Huang, Ramlogan, & Li, 2017). With disruptive technology, HCOs can enable their providers to offer healthcare service that is more affordable, of higher quality, and more accessible to patients (Myers & Twigg, 2017). With the identification of the most effective mobile technology deploying strategy, healthcare CIOs can provide the additional mode of communication that supports enhanced care, safety, peace of mind, convenience, and ease of access. Where the results of this study are implemented, positive social change to HCOs will result.

A Review of the Professional and Academic Literature

I used various academic databases and a search engine to gather data. The primary purpose of this review was to present the conceptual framework to assert the focus of this study, providing a critical analysis and synthesis of the literature on potential themes and phenomena, identifying gaps in research, and confirming the appropriateness of the method of the study. I present the conceptual framework of the study first. Then I review

(a) Wallace and Iyer's (2017) HIT value hierarchy and Maslow's needs hierarchy,

(b) the iron triangle of healthcare,

(c) the concepts of security, privacy, and trust (SPT),

(d) a discussion of cybersecurity,

(e) the literature on m-health applications in depth,

(f) the literature on BYOD and discuss m-health to synthesize the themes and phenomena I identified in the purpose statement, and lastly,

(g) the gaps in research for mobile technology deployment strategies in healthcare.

To search the literature, I used the following databases: EBSCO Discovery Service, Walden University Library's Thoreau, Ulrich'sWeb Global Serials Directory, and Crossref. I also used the search engine, Google Scholar. The keywords were as follows: *access*, *cost*, *employer-employee relationship*, *health*, *healthcare*, *job satisfaction*, *Maslow's needs hierarchy*, *quality*, , and *work performance*. I also searched the literature with the keywords of *privacy*, *security*, *disruptive technology*, *mobile*, *mobile health*, *m-health*, *mHealth*, and *BYOD.* Additional keywords I used were *CIO*, *chief information security officer (CISO)*, *electronic health record*, *EHR*, *tele-health*, *privacy*, and *Health Insurance Portability and Accountability Act* (*HIPAA*). In addition, I added the keywords of *cybersecurity*, *laws*, *regulations*, *ethics*, and others related to the mobile technology in the search. I also used the keywords *infrastructure*, *stability*, *integrated information*, *competitive differenctiation*, and *paradigm shifting*. I used the keywords to search the literature but also used them as the codes for data analysis.

Most of the literature I reviewed were from academic and professional sources. I

reviewed a total of 116 references, out of which 99 (85.3%) were peer-reviewed, six (5.2%) were government reports or similar documents, and four (3.4%) were reports from academic or professional organizations. I did not include any seminal works in the literature review. Ninety-nine articles (85.3%) were within 5 years of my anticipated study completion, dated 2015 to 2019.

Wallace and Iyer's HIT Value Hierarchy

The purpose of this qualitative multiple case study was to explore the strategies healthcare CIOs use to deploy mobile technology effectively. Wallace and Iyer's (2017) HIT value hierarchy was the framework of this study. Wallace and Iyer developed the framework in 2017, modifying Maslow's needs hierarchy to serve as a maturity model for small healthcare practices. Researchers frequently use Maslow's needs hierarchy in studies of the fields of psychology, behavioral science, nursing, and healthcare (Harrigan & Commons, 2015). Wallace and Iyer modified Maslow's needs hierarchy and studied organizational maturity, relating the maturity stages to HIT values for small practices. I applied Wallace and Iyer's HIT value hierarchy to this study to explore the effective mobile technology deployment strategy for HCOs.

The focus of Wallace and Iyer's (2017) HIT value hierarchy was the needs of HCOs to motivate to grow in the HIT field. In contrast, the focus of Maslow's needs hierarchy was the needs of people to be motivated to do more. A few researchers developed the conceptual frameworks for maturity of organizations. Arif et al. (2017) identified three levels of organizational maturity in knowledge sharing (KS): (a) identification of the variable in the organization's KS practices; (b) occasional use of

technology to increase KS activities; and (c) demonstration of the importance of the variables in affecting KS as being fundamentally ingrained in the organization's vision, mission, strategy, and operations. Schumacher, Erol, and Sihn (2016) defined nine dimensions and assigned 62 items for assessing the industrial maturity of organizations. The dimensions include products, customers, operations, technology, strategy, leadership, governance, culture and people (Schumacher et al., 2016). Wallace and Iyer studied the relationship of HIT value and maturity of HCOs.

According to Wallace and Iyer (2017), HCOs satisfy the lower-stage needs before they can achieve the next stage of maturity in the order of (a) infrastructure and connectivity needs, (b) stability and security needs, (c) integrated information, (d) interorganizational integration, and (e) paradigm shifting, respectively. Mature HCOs can satisfy higher needs. Each stage in the HIT value hierarchy parallels each level of Maslow's needs hierarchy (see Figure 1).

Infrastructure and connectivity. According to Wallace and Iyer (2017), infrastructure and connectivity needs, equivalent to the physiological needs in Maslow's needs hierarchy, is the first level of maturity of organization. The IT team of an HCO supports the phycological needs of healthcare providers, staff members, and patients, in the form of infrastructure and connectivity needs (Wallace & Iyer, 2017). Wakabayashi (2016) agreed with Wallace and Iyer that infrastructure and connectivity are the key to IT evolution. Organizations in the stage of infrastructure and connectivity needs are reactive, acquiring basic infrastructure with fewer standards and little to no IT policies only to install needed equipment and provide fixes when equipment goes down (Wallace & Iyer,

2017). Without the strong IT support of the infrastructure and connectivity, healthcare providers and staff members cannot work efficiently (Wakabayashi, 2016). IT infrastructure and connectivity are the fundamental needs of HCOs.

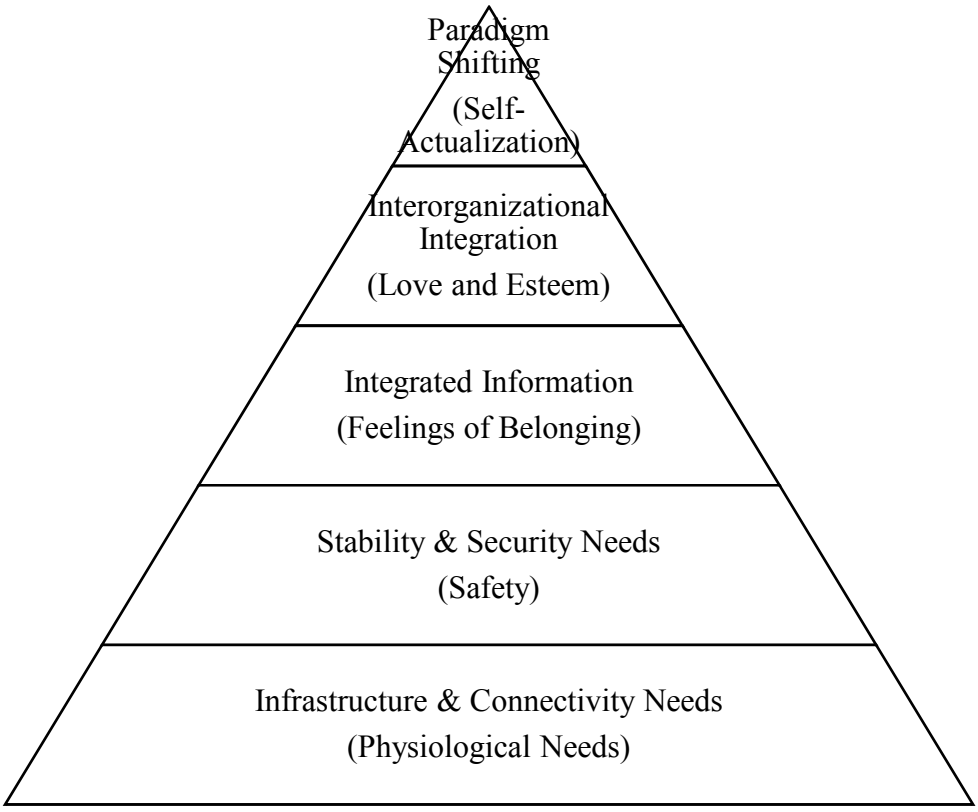

Figure 1. Levels of the HIT value hierarchy, with corresponding levels of Maslow's needs hierarchy shown in parentheses. Adapted from "Healthcare IT Value Hierarchy Framework for the Small Physician Practices Context," by S. Wallace, and L. Iyer, 2017, *Journal of the Midwest Association for Information Systems, 2017,* p. 96. Copyright 2017 by Steven A. Wallace and Lakshim S. Iyer. Modified with permission.

The IT teams provide wireless network supports in addition to the wired network that is the main infrastructure. Although the IT infrastructure installed in an HCO is traditionally a wired network, healthcare providers, staff members, and patients now ask for nontraditional infrastructure such as wireless and Bluetooth networks (T. Wu, Wu, Redoute, & Yuce, 2017). Because innovation in infrastructures means replacing or

modifying existing components of an infrastructure without changing the constituting architecture (S. Li, Da Xu, & Zhao, 2015), most HCOs utilize the wired infrastructure as the backbone and the wireless and other communication conduits to complement the main infrastructure, preserving the original IT and communication architecture. Hence, the future HCO infrastructures will consist of the wired backbone to the heterogeneously connected IoT and mobile devices.

In the stage of infrastructure and connectivity needs, most HCOs convert paper charts to EHR. Patients, families, and friends may bring their mobile devices to the hospital to make calls, read books, and surf the Internet. Some patients are using mobile phones to stay in touch with providers (McInnes et al., 2015). McInnes et al. (2015) reported that the participants in their study felt mobile-phone calls or text messages could be used to remind patients of appointments, prescription refills, medication taking, and returning for laboratory results. The healthcare providers carry a smartphone for the clinical use (Nerminathan et al., 2017). The healthcare providers and staff members communicate with mobile devices while making a round as well in the office (Thomairy, Mummaneni, Alsalamah, Moussa, & Coustasse, 2015). Supporting the infrastructure with the mix of wireless connectivity becomes the norm of healthcare IT teams in this stage.

Stability and security. According to Wallace and Iyer (2017), stability and security, equivalent to safety in Maslow's needs hierarchy, is the next level of growth. With various kinds of m-health applications (also known as apps), the app developers collect and offer critical, sensitive, and private health information, a practice by which the developers weaken information security and privacy (Dehling, Gao, Schneider, &

Sunyaev, 2015). CIOs and CISOs fulfill the tasks of cybersecurity in this stage (Jalali & Kaiser, 2018). Maintaining IT infrastructure, connectivity, stability, and security become a priority.

HCOs need to consider stability and security needs seriously. IT standards and policies begin the formation of IT optimization in this stage of maturity (Wallace & Iyer, 2017). For user acceptance and trust, HCOs need to devise and employ appropriate security measures and processes (Dehling et al., 2015). In this stage, the IT team controls access to both the IT systems and the information about the systems (Enck et al., 2014). The importance of security becomes apparent in this stage.

Integrated information. After meeting stability and security needs, HCOs grow to meet the higher needs. In the Maslow's needs hierarchy, the higher needs above safety are social needs such as the feelings of belonging (Harrigan & Commons, 2015). The HIT equivalent of the social needs is integrated information (Wallace & Iyer, 2017), the needs of communication. Satisfying the need of communication for healthcare providers and staff members becomes imperative in providing quality care and ease of access and reducing costs.

Use of the cloud becomes popular in the integrated information stage. Mobile cloud computing (MCC) is the combination of cloud computing, mobile computing, and wireless networks to bring rich computational resources to mobile users, network operators, and cloud computing application developers (Abolfazli, Sanaei, Sanaei, Shojafar, & Gani, 2016). The IT team initiates MCC utilized internally in this stage (Jo, Maksymyuk, Strykhalyuk, & Cho, 2015). The IT team implements intraorganizational

information systems crossing departmental and functional boundaries (Wallace & Iyer, 2017). In this stage, patients can freely obtain the health information needed and communicate to their healthcare providers.

Interorganizational integration. The next stage in Wallace and Iyer's HIT value hierarchy is interorganizational integration, equivalent to love and esteem in Maslow's needs hierarchy. Work efficiency, effective communication, and sharing resources become important in this stage (Robbins, 2018). Healthcare CIOs need to concentrate on strategic management for the development of competitive advantage based on technology (Sakas, Vlachos, & Nasiopoulos, 2014). HCOs need to use unique IT solutions to differentiate themselves from their competitors to try to create a competitive advantage (Wallace & Iyer, 2017). Utilizing mobile technology in supporting patient care facilitates the organization to have a leading edge (Sakas et al., 2014). Interorganizational integration becomes instrumental for this stage.

Interorganizational integration is the response to the demands for improved effectiveness and quality. HCOs have turned to integrating their health and social services to address specific problems pertaining to quality, cost, access, and continuity of service for people living with complex health, social, and economic needs (Breton et al., 2017). To meet the demands, three development trends of decentralization, specialization, and professionalization contributed to Scandinavian interorganizational healthcare (Ahgren, 2014). The integrated model fosters collaboration between partner organizations. Development of interorganizational management structures and communication platforms, provision of adequate resourcing, and increased engagement

of primary care may engage high level organizational integration aimed at improved care coordination for patients with medical complexity (Kingsnorth, Lacombe□Duncan, Keilty, Bruce□Barrett, & Cohen, 2015).

Paradigm shifting. HCOs provide not only basic services but also the higher level of technology need—paradigm shifting. In this stage, the IT team seeks paradigm shifts in technology, such as disruptive technology, tele-health, and m-health (Wallace & Iyer, 2017). The HCOs that utilize mobile technology to healthcare are changing the way to do their business.

The use of disruptive technology in healthcare and tele-health is paradigm shifting. Throughout the history of medicine, healthcare providers have relied on disruptive innovations and technologies to improve the quality of care delivered, patient outcomes, and patient satisfaction (Rothman et al., 2017). The shift in the system design paradigm from open, small, and single loop to closed, large, and multiple loops is taking place in healthcare (Pang, Yang, Khedri, & Zhang, 2018). Mobile technology in health care is quickly becoming the next disruptive technology to come (Rothman et al., 2017). The stakeholders in healthcare currently discuss big data, automated medical production, healthcare robotics, human-robot symbiosis, and use of artificial intelligence (Pang et al., 2018). HCOs in the highest stage of maturity accept the paradigm shifting of using advanced technology and innovation to healthcare. Related to m-health, a few trends of paradigm shifting in healthcare are the use of disruptive technology, tele-health, and patient-centered care.

Disruptive technology. Disruptive technology is paradigm shifting. Shifts in

technological paradigms simultaneously disrupt HCOs and create opportunities for the organizations to grow (Ho & Lee, 2015). Currently, the long-standing curative paradigm in healthcare is facing a crisis due to an aging population, a significant increase in chronic diseases, and the development of more expensive diagnostic tools and therapies (Moerenhout, Devisch, & Cornelis, 2018). The goal of disruptive technology is not to bring chaos but to provide value to markets (Thompson, 2016). Disruptive technology can be the solution for the healthcare crisis.

The surge in computing power and mobile connectivity have fashioned a foundation for m-health that can transform the mode and quality of clinical research and healthcare on a global scale (Steinhubl, Muse, & Topol, 2015). As elaborated in the failure of Eastman Kodak, implementation of disruptive technology seems to have a distinctive effect on the survival of an organization (Melvin, 2018).

The smartphone linked wearable sensors, point-of-need diagnostic devices, and medical-grade imaging, all built around real-time data streams and supported by automated clinical decision support tools unimpeded by geographical boundaries will enable care and enhance our understanding of physiological variability (Steinhubl et al., 2015). The implementation of mobile technology in healthcare is quickly becoming the next surge of the disruptive technology in healthcare (Steinhubl et al., 2015). Without the prompt implementation of disruptive technology, any HCOs will have an issue of survival in the full maturity, not even able to sustain the business.

Tele-health. Tele-health is the provision of healthcare remotely by means of a variety of telecommunication tools, including telephones, smartphones, and mobile

wireless devices, with or without a video connection (Dorsey & Topol, 2016). Tele-health includes not just delivery of healthcare services at a distance but patient and health professional education, public health, and public administration (Daniel & Sulmasy, 2015). According to Dorsey and Topol (2016), three trends are currently shaping tele-health as following: (a) the transformation of the application of tele-health from increasing access to healthcare to providing convenience and eventually reducing cost, (b) the expansion of tele-health from addressing acute conditions to also addressing episodic and chronic conditions, and (c) the migration of tele-health from hospitals and satellite clinics to the home and mobile devices.

Patient-centered care. Mature HCOs in paradigm shifting promote patients' self-actualization with patient-centered care (Tai-Seale, Sullivan, Cheney, Thomas, & Frosch, 2016). The National Committee for Quality Assurance (NCQA, 2017) promotes a set of priorities for strong patient engagement strategies. Patient-centered care is a trend within modern healthcare (Inzucchi et al., 2015). HCOs are using technology and innovation to change how they conduct business (Wallace & Iyer, 2017) and focus on the delivery of patient-centric care. Patient-centered care is the centric theme of the business strategy of the HCOs in the stage of paradigm shifting (O'Hare, Rodriguez, & Bowling, 2015). With patient-centered care, HCOs put patients and their families at the center of all quality improvement practices.

Three tenets of patient-centered care are communication, partnership, and health promotion (Constand, MacDermid, Dal Bello-Haas, & Law, 2014). Primary care physicians can improve outcomes for patients in all areas of health management (Diaz et

al., 2016) through the use of communication, partnership, and health promotion. Primary care providers can select the patient-centered care model from the evidence-based studies that best suits their patient's needs and be confident that the care plan will satisfy the three core elements of patient-centered care provision (Constand et al., 2014). HCOs improve communication, partner relationship, and health promotion through technology and innovation (Cheng et al., 2017). Patient-centered care promotes patients' self-actualization (Tai-Seale et al., 2016). Patient-centered care is the centric theme of the business strategy of the HCOs in this stage (O'Hare et al., 2015).

Iron Triangle of Healthcare

Healthcare organizations provide patient-centered care through the management of the iron triangle of healthcare—quality, cost, and access. HCOs experience difficulties in improving quality while lowering cost and easing access at the same time (Liu, Love, Smith, Matthews, & Sing, 2016). Cheng et al. (2017) suggested HCOs should consider using disruptive technology to improve the three elements of the iron triangle simultaneously. HCOs must strive to improve quality of care while lowering cost and easing access. With m-health, HCOs can meet all requirements from stakeholders.

Quality improvement. Healthcare providers and staff members should continuously examine and improve their work processes. The Institute of Medicine issued a report, *To err is human: Building a safer health system* (Mitchell, Schuster, Smith, Pronovost, & Wu, 2015). In the report, the Institute of Medicine recognized quality and patient safety as the sentinel issues in healthcare delivery. HCOs must continuously improve the quality of care for patient safety. The concept of continuous quality

improvement is a participative, systematic approach to planning and implementing a continuous organizational improvement process (L. R. Burns et al., 2012). With continuous quality improvement, HCOs create a safe environment in the provision of care.

Quality consists of three major elements—structure, process, and outcomes. Structure pertains to having resources needed to provide adequate care (L. R. Burns et al., 2012). A process is how healthcare providers provide interventions and how staff members work, step by step (Larrucea, O'Connor, Colomo-Palacios, & Laporte, 2016). Outcomes are the result or consequence of interventions or efforts (Zinman et al., 2015). With structure, HCOs provide the process of care and obtain clinical outcomes. Quality improvement is, therefore, the improvement in three dimensions of structure, process, and outcomes. For proper quality improvement, HCOs must consider all three dimensions.

A structure provides necessary resources in a business. Communication networks within HCOs, for example, facilitate effective communication (Song & Eveland, 2015). The IT infrastructure is another example of structure. A wireless network is typically complementary to the previously wired information and community network. Nevertheless, a wireless network is essential in providing m-health, such as tele-health, wireless telecommunication, the smart suits, wearable devices, and supply chain management (Silva et al., 2015). HCOs can improve quality of healthcare and satisfy patients' needs by providing information, knowledge, and entertainment through the organizational structure and communication infrastructure. HCOs improve the quality of

service by improving the organizational structure and communication infrastructure.

Another element of quality is process. A process is how healthcare providers and administers work step by step (L. R. Burns et al., 2012). Process improvement can result in better outcomes. Healthcare providers and staff members streamline clinical workflow to increase the value of care (J. C. Lee, Shiue, & Chen, 2016). With mobile technology, IT teams help healthcare providers and staff members improve quality (Silva et al., 2015). IT teams facilitate the efficient communication among healthcare providers, staff members, and patients.

Improvement of outcomes is another focal point of quality improvement. In a systematic review of the randomized controlled trials, remote patient monitoring showed early promise in improving outcomes for patients with selected conditions, including obstructive pulmonary disease, Parkinson's disease, hypertension, and low back pain (Noah et al., 2018). In a systematic review, Free, Phillips, Watson, et al. (2013) analyzed the controlled trials of m-health interventions delivered to healthcare consumers. According to Free, Phillips, Watson, et al., the healthcare providers using mobile technology had better outcomes and improved prognoses. With mobile technology, HCOs can improve quality, reduce costs, and improve access.

Cost reduction, revenue generation, and revenue enhancement. Cost is another concern in healthcare. With disruptive technology, HCOs can reduce cost, improve quality, and ease access to healthcare (Myers & Twigg, 2017). The American Hospital Association (AHA, 2017) noted the causes of rising healthcare cost were the advancement of medicine, aging population, and rising burden of chronic disease. AHA

also accused the advancement of technology as another source of rising cost. On the other hand, Atasoy, Chen, and Ganju (2017) showed that although EHR adoption increases the costs of the adopting hospital, it has significant spillover effects by reducing the costs of neighboring hospitals. In contrast to other advanced technology, m-health tends to be both disruptive in the healthcare market and able to lower cost.

Tele-health is one of the frequently cited examples of disruptive technology in healthcare. Healthcare providers can reduce cost with tele-health (Dorsey & Topol, 2016). With the current implementation of the pay-for-performance (value-based) payment system in the U.S., the third-party payors are willing to pay for tele-health (Clough & McClellan, 2016). A dermatologist can assess the skin condition of a patient remotely with the video camera in the patient's smartphone. With a creative use of mobile health information and sensing technology, healthcare providers can reduce healthcare cost and improve a patient's well-being (Kumar et al., 2013). Healthcare providers can provide immediate care and reduce travel time and cost with tele-health. M-Health enables HCOs to reduce healthcare cost.

Healthcare CIOs need to understand the marketing effects of m-health on customer satisfaction. A quarter of all nonprofit HCOs in the U.S. operates with negative margins (Mindel & Mathiassen, 2015). To increase revenue, some healthcare providers offer phone and online consultations as alternatives to traditional office visits (Lund & Marinova, 2014). Mindel and Mathiassen (2015) acknowledged the potential role of mobile technology in HCO's administrative activities in revenue cycle management to sustain the healthcare business. HCOs should offer m-health to strengthen the strategic

position to sustain their business.

To increase revenue, HCOs need to work closely with the stakeholders in the community and incorporate successful and socially desirable business models that can lead to profit. Mangone et al. (2016) found that collaboration among stakeholders was imperative for increasing revenues using m-health. A new paradigm of the healthcare workforce planning model which integrated changing circumstances, in terms of demography, epidemiology, productivity, application of new technology into service, workforce planning, change management, and collaboration with all stakeholders, controls for supply-led pressures on expenditure (Birch, Murphy, MacKenzie, & Cumming, 2015). With the stakeholder collaboration, HCOs can raise the capital necessary to build infrastructure, lower expenditures, and build a reputation.

Improving access. Access is the last area of discussion on improvement of healthcare with mobile technology. Mobile technologies have the potential to bridge systemic gaps needed to improve access to and use of health services, particularly among underserved populations (Agarwal et al., 2016). Migrant Chinese populations in the Western countries have a high prevalence of chronic hepatitis B due to poor access to healthcare and a late diagnosis (Vedio, Liu, Lee, & Salway, 2017). Access is one of the three elements of care. Continuous quality improvement means to have the continuous improvement of access.

Mobile health technology can improve access. According to De Almeida Costa et al. (2017), the Brazilian government provided a virtual clinic system and mobile communication devices to residents of Amazona. With the project, the government

minimized social and financial impacts and avoided unnecessary travel and procedures (De Almeida Costa et al., 2017). In another systematic review of m-health outcome studies, Free, Phillips, Galli, et al. (2013) examined the improvement of the healthcare delivery processes. Free, Phillips, Galli, et al. found that 11 of 25 outcomes showed significant benefits. Free, Phillips, Galli, et al. noted significant improvement in the communication between nurse and surgeon with mobile phones and a significant reduction of incorrect diagnoses with mobile technology. One of the access issues HCOs can solve with mobile technology is to overcome physical difficulties imposed by patients' conditions or the environment. With m-health, healthcare providers and patients can communicate remotely.

Healthcare systems are in challenging financial climate in many countries. For such a challenging environment, a needs-based approach is more appropriate (Birch et al., 2015). Brazil made rapid progress toward universal coverage of its population through its national health system (Macinko & Harris, 2015). The Brazilian national health system has decentralized management, and the municipalities handle most primary care services as well as some hospitals and other facilities (Macinko & Harris, 2015). All publicly financed health services and most common medications are universally accessible and free of charge at the point of service for all citizens—even 26% of the population enrolled in private health plans (Macinko & Harris, 2015). According to Macinko and Harris (2015), the important innovation implemented in the Brazilian system was the development, adaptation, and rapid scaling up of a community-based approach to provide primary healthcare. Utilization of mobile technology proactively in

responding to the needs of patients before illness further deteriorates the patients' condition would reduce the needs of emergency or specialty care (Macinko & Harris, 2015). The supply-demand equilibrium approach, such as emphasizing specialty care, does not work in healthcare (Birch et al., 2015). With a needs-based approach, HCOs align their services based on patient-centered care.

Job Satisfaction, Work Performance, and Employee Relationship

Healthcare CIOs and IT teams also serve the healthcare providers and staff members for job satisfaction and improve clinical and work performance. Population changes impact staffing of HCOs (Kroezen et al., 2015). Manley, Martin, Jackson, and Wright (2016) explained how workforce recruitment might decrease because of increased patient cases. Recruiting more care providers might be the solution. However, costs may increase in response to the aggressive recruitment. As an alternative strategy, HCOs can solve the dilemma with mobile technology (De Almeida Costa et al., 2017). Mobile technology can supplement the lack of human resources (Free, Phillips, Galli, et al. 2013). With tele-health, healthcare providers can reduce the time and cost.

Healthcare organizations need to encourage healthcare providers and staff members for performance improvement. With BYOD, HCOs can empower healthcare providers and staff members to give the freedom of choices (Fluck, Adebayo, & Abdulhamid, 2017). According to Nerminathan et al. (2017), 90% of physicians surveyed reported using mobile devices to enhance their work efficiency. From the viewpoint of healthcare CIOs, the patient-centered care is equivalent to the customer-centered care. HCOs need to facilitate comfortable, convenient, and empowering work environment to

healthcare providers and staff members. CIOs can facilitate the work environment by allowing BYOD at work. The organizational success depends on performance and productivity of healthcare providers and staff members (Dobrzykowski, McFadden, & Vonderembse, 2016). Providing flexible work hours and the wealth of resources with telecommuting, tele-health, and BYOD to support clinical performance and job satisfaction are imperative to sustain the business of HCOs.

Chief information officers need to consider the corporate culture and stakeholder relationship before implementing new technology. Some staff members and patients may raise questions related to ownership, responsibilities, vulnerability of mobile equipment as pilferable items, cybersecurity, privacy, or consequences on employment (Al Ameen, Liu, & Kwak, 2012). Concerns on sleep quality, academic or work performance, anxiety, satisfaction with life, a cell phone use while walking or driving have increased (P. C. Kao, Higginson, Seymour, Kamerdze, & Higginson, 2015; Trivedi, Haynie, Bible, Liu, & Simons-Morton, 2017). To support business staff members, the Society for Human Resource Management (SHRM, 2018) issued a template version of a cell phone use policy at work (see Appendix A). By implementing the policy, HCOs protect the safety, privacy, and information security of healthcare providers, staff members, and patients, as well as the reputation of the organization, business ownership, and properties. CIOs and CISOs can adopt the SHRM's template to develop the m-health use policy.

With the evidence-based policy and procedure establishment, CIOs can succeed in a deployment of mobile devices. C. K. Kao et al. (2017) recommended HCOs to create and maintain best practices for the use of mobile devices by (a) defining the structure of a

mobile technology governance, (b) determining the right mobile technology deployment strategy, (c) promoting a mobile device etiquette, (d) providing the standard protocols handling PHI and information security, and (e) developing a reviewing process and regularly reviewing m-health apps in the mobile devices. Thus, CIOs need to consider all circumstances and carefully implement the policy and apply the right mobile technology deployment strategy. HCOs must protect the privacy of healthcare providers, staff members, and patients, as well as the reputation of the organization, business ownership, and properties.

Security, Privacy, and Trust

Security, privacy, and trust (SPT) in healthcare are an issue of growing importance. Security is a concept similar to the safety of a system as a whole (Al Ameen et al., 2012; Wallace & Iyer, 2017). Both patients and HCOs are concerned about security because a third party may take advantage of confidential data (Rahimi, Ren, Liu, Vasilakos, & Venkatasubramanian, 2014). Some patients may refuse to take the full advantage of mobile technology because they do not believe mobile devices are safe due to a concern about misuse of data or loss of privacy (Al Ameen et al., 2012). If a security breach occurs because of mobile device use, the HCO are reponsible for negligence. The growing issue of security further shed light on the importance of the role of CISOs.

Protecting privacy of patients is the priority in healthcare. In contrast, Maslow did not place privacy in the need hierarchy (Harrigan & Commons, 2015). Rather, Maslow posited that one of the characteristics of self-actualizing people is the capacity for detachment and need for privacy (Harrigan & Commons, 2015). In other words, privacy

is an element of self-actualization. Therefore, protecting privacy is one of the themes of patient-centered care.

Privacy is a critical issue in the cloud environment. Many HCOs implemented the healthcare cloud model (Griebel et al., 2015). The confidential patient information resides on the cloud not in the local computers anymore (Rahimi et al., 2014). The cloud model complicates the security problem even more as HCOs introduce new dimensions into the problem scope related to the model architecture and multitendency, elastic, and layer-dependency stack (Almorsy, Grundy, & Müller, 2016). The MCC environment is even more vulnerable to cyberattacks due to weakness in the security of the combined cloud and mobile technology environment (A. J. Burns & Johnson, 2015). The responsibilities of healthcare CIOs and CISOs have increased to protect patients' privacy in the cloud computing environment.

Many analysts are actively exploring and examining the technical solutions to overcome SPT issues for healthcare. Sicari, Rizzardi, Grieco, and Coen-Porisini (2015) proposed a fuzzy approach with a trust-based access control (FTBAC) framework. The FTBAC framework consists of three layers: the device layer, request layer, and access control layer. The device layer includes all IoT devices and communication among these devices (Sicari et al., 2015). The request layer is responsible for collecting experience, knowledge, and recommendation information and calculating fuzzy trust value (Sicari et al., 2015). The access control layer executes decision making processes and maps to calculate a fuzzy trust value to the access permissions with the principle of least privilege (Sicari et al., 2015). The FTBAC framework is one of the solutions to overcome SPT

issues for healthcare.

The fuzzy approach is the utilization of the fuzzy schema. The fuzzy schema is a mathematical logic that attempts to work out problems by assigning the prediction values to an imprecise range of data. Fuzzy logic detects misbehaving nodes by giving a certificate to the only trusted node (Arulkumaran & Gnanamurthy, 2017). The simulation results show that the FTBAC framework guarantees flexibility and scalability, and the framework is energy efficient (Sicari et al., 2015). With the FTBAC framework, cybersecurity engineers can develop a firewall for mobile technology, IoT, wearable devices, and other disruptive technologies in healthcare settings, based on the level of confidence on trust of users (Sicari et al., 2015). The real issue is that, even though the technology is available, the acceptance of the technology takes time.

SPT, Healthcare Regulations, and Cybersecurity

App developers must protect collected information to be stored in the safe storage and not allow unauthorized access. According to Wallace and Iyer's (2017) HIT value hierarchy, information security, which is a safety issue, is a priority for healthcare providers, staff members, and patients (Rahimi et al., 2014; Wallace & Iyer, 2017). All stakeholders—lawmakers, government health agencies, policy developers, app developers, HCOs, healthcare providers, staff members, IT industry, educators, marketing professionals, and consumers must work together for the common goal to protect health information security (Kruse et al., 2017). HCOs alone cannot resolve the SPT issue.

One of the roles of CIOs and CISOs is to implement cybersecurity policies and

procedures to protect the organization. To understand the responsibility of healthcare CIOs for cybersecurity, I review the healthcare cybersecurity laws and regulations. I only review the U.S. and Europe legal systems. The U.S. and European systems are leading the global legal communities.

The U.S legal system is prominent in the protection of SPT. The Privacy Act of 1974 includes requirements for the collection, maintenance, use, and dissemination of information about individuals maintained in systems of records by federal agencies (Fuller, 2017). The Privacy Act of 1974 prohibits the disclosure of a personal record of the federal governments without written consent (Nissim et al., 2018).

U.S. Department of Health and Human Services (HHS) regulates HCOs with HIPAA. HIPAA is a law regarding healthcare patients' privacy and PHI (Iyengar, Kundu, & Pallis, 2018). HHS exercises its authority with HIPAA and imposes a significant penalty on HCOs, healthcare providers, staff members, and business associates who violate privacy of patients (Hui Yang & Garibaldi, 2015). HIPAA consists of many rules, including the rules related to privacy and information security, such as Privacy Rule, Security Rule, and Breach and Notification Rule (Anderson, Baskerville, & Kaul, 2017). The U.S. Congress also extended the enforcement scope of HIPAA with the enactment of the HITECH Act, which includes mandatory breach notification requirements and more costly penalties in certain situations (Samora, Blazar, Lifchez, Bal, & Drolet, 2018). The HITECH Act addresses privacy and security concerns associated with the electronic transmission of health information through several provisions that strengthen the civil and criminal enforcement of the HIPAA rules (Turakhia et al., 2016). Researchers would

not be able to get the participants' personal information if the patient participant does not agree to disclose the information.

CIOs collaborate with CISOs in developing privacy and information security policies and procedures based on HIPAA and state laws to protect patients' privacy. Before developing policies and procedures, healthcare executives need to identify privacy and security risks (Hall & McGraw, 2014). By focusing on compliance with HIPAA and state laws to establish policies, CIOs brings the community together, identifying threats (Anderson et al., 2017). Beyond the civil rights enforcement of HHS, several government agencies, including the Food and Drug Administration, Federal Communication Commission, and Federal Trade Commission, are responsible to regulate the wireless communication (Samora et al., 2018). CIOs change the society while protecting patients.

The European Union also takes actions along with the United States. The Data Protection Directive 95/46/EC of 1995 is the EU law regarding security and privacy in healthcare (Martínez-Pérez et al., 2015). In the context of the EU data privacy framework, consent is an instrument for patients to control their data (Mittal & Sharma, 2017). In addition, the EU lawmakers enacted Directive 9/46 EEC in 2015, which allows transfers of personal data between the EU member states and third-party countries for processing only where the receiving state authorities guarantee an adequate level of protection (Horsley, 2016). While some regulation of electronic PHI does occur globally, regulation of mobile PHI is still rare.

Security, privacy, and trust in many aspects are not solely technical issues. Individual users that interact with the modern technology must assume the equal

partnership to build a holistic system that provides foolproof SPT mechanisms (Akram, Chen, Lopez, Sauveron, & Yang, 2018). According to Akram et al. (2018), an emerging trend in information security is to develop technical solutions that involve and empower the users. This trend has the potential to solve not only the present challenges but also the future challenges posed by emerging technology, such as IoT, autonomous systems (transports, cars, drones, etc.), and artificial intelligence. Healthcare providers, staff members, and patients should learn how to use the security instruments properly. CIOs and IT teams must continuously upgrade their knowledge and skills in cybersecurity. Collaborating with healthcare information management and cybersecurity professional organizations would be helpful in developing information and knowledge in cybersecurity.

Lawmakers have expanded cybersecurity laws and regulations in response to increased cyberattacks. Government officials, healthcare providers, and staff members need to invest more time and funding to ensure the protection of PHI from unauthorized access (Kruse, Frederick, Jacobson, & Monticone, 2017). Kruse et al. (2017) agreed that the healthcare industry still had been lagging in cybersecurity. A few researchers have reviewed the current privacy and security laws for m-health (Martínez-Pérez, de La Torre-Díez, & López-Coronado, 2015). To improve the public perception of m-health to increase credibility, privacy, and confidentiality, researchers, legal experts, and policymakers must establish policies and procedures to collect and handle m-health user data appropriately.

Cybersecurity plays an essential role in success of m-health. CIOs must have the

technical knowledge in cybersecurity and coordinate with the CISO and IT team to implement security policies. One of the defense mechanisms CIOs can use for cybersecurity is the situational awareness model. Situational awareness is a multifaceted and well-studied phenomenon (Lowe, Ireland, Ross, & Ker, 2016). The situational awareness theory is a variation of the systems theory (Endsley, 2015). Healthcare CIOs may use the situational awareness model for cybersecurity.

The situational awareness model consists of four constructs: situational understanding, situational assessment, mental models, and sensemaking. Situational understanding is the product of application of analysis and judgment to the system and environment, which determines the relationship of the current factors and forms logical conclusions concerning threats to the system or mission accomplishment, opportunities for mission accomplishment, or gaps in information (Endsley, 2015). With situational assessment, HCOs build a mental model through sensemaking to achieve the optimum level of situation awareness. A situational assessment should result from a multitude of information sources (Graafland, Schraagen, Boermeester, Bemelman, & Schijven, 2015). Mental model is a set of well-defined, highly organized yet dynamic knowledge structures developed over time from experience (Endsley, 2015). Sensemaking is the responses and recovery efforts before, during, and after the cyberattack as the results of situational understanding and situational assessment (Takahashi, Tandoc, & Carmichael, 2015). CIOs utilize the concepts and framework of situation awareness to prevent, defend, and recover from cyberattacks.

The major challenge in cybersecurity is that most attacks have already occurred

before the CISO acts. Hence, CIOs and CISOs need a tool to monitor the security state of the infrastructure continuously and prepare for a disaster recovery. Such instruments are continuous monitoring and risk scoring (Weintraub, 2016). CIOs, CISOs, IT teams, and other staff members responsible for cybersecurity must continuously monitor the situation with a reliable risk scoring instrument as well as educate the staff members on defensive routines and alert them against any cyberattacks (No & Vasarhelyi, 2017). Proactively monitoring the situation is important. Situational awareness is the primary cybersecurity measure.

Healthcare organizations must be proactive in cybersecurity. Researchers and cybersecurity professionals proposed many technology solutions. Georgescu and Smeureanu (2017) examined several characteristics of how hacking communities communicate and collaborate online and how much the hackers could obtain the information by analyzing different types of the Internet text communication channels. Georgescu and Smeureanu found semantic web technology can be a proactive solution. Romero-Mariona et al. (2016) developed the technology matching tool to assist users in determining appropriate, best-fit technologies for securing networking by empowering the users to define priorities for specific product feature sets as dictated by the specific environment to be protected. Akram et al. (2018) proposed user-centered cybersecurity solutions. One of such a technical solutions Akram et al. presented was the personal data server overlay, which stores secure electronic personal health and academic records on inexpensive but portable devices. With the personal data server overlay, HCOs store data in a set of secure portable tokens that are under the control of individual users. Belyaev,

Sun, Ray, and Ray (2018; also cited in Akram et al., 2018) suggested putting all essential personal health record stored in a smart chip, in the form of a smart card, which can be carried by the individual. Healthcare providers access the record through the information highway when needed as care provided, from the smart card with the portable token.

Privacy, open access to health records, and freedom to access information are in a major conflict for HCOs. The issue of open access for m-health is convoluted due to the inherent modularity of mobile technology. According to HIPAA and the EU Data Protection Directive 95/46/EC of 1995, HCOs must protect patients' privacy (Martínez-Pérez et al., 2015). HCOs cannot publish PHI without the consent of the patient except some research uses. Even in research, researchers must not identify or publish personally identifiable information (PII) in the research report without the consent of the participant (Rho, Jang, Chung, & Choi, 2015). In contrast, HIPAA also permits patients to see and get copies of their health information or share it with a third party, such as a family member, other doctors, or even to a mobile app as needed (U.S. Department of Health & Human Services, 2018a). In other words, HHS advocates open access as well as privacy.

Another challenge for cybersecurity in m-health is the ownership of data. App developers have catalyzed the issue by enabling government officials, healthcare providers, and staff members to access data collected by mobile apps (Olff, 2015). Big data, artificial intelligence, and other developments with the increasing connectivity of traditionally isolated devices also caused significant changes in the virtual environment (Romero-Mariona et al., 2016). App developers usually do not respond appropriately to secure users' PHI and often release insecure apps (Martínez-Pérez et al., 2015). No

regulatory systems currently exist to keep privacy from selling app-generated data to third parties (Treskes, van der Velde, Barendse, & Bruining, 2016). Hence, how to regulate mobile apps and equipment is a unique challenge for drug regulatory authorities, including Food and Drug Administration and European Medical Association (Terry & Wiley, 2016). Martínez-Pérez et al. (2015) recommended the security measurements for privacy (see Table 1). HCOs should protect the infrastructure by implementing the security and privacy recommendations for m-health.

Table 1

Security and Privacy Recommendations for M-Health Applications

Property	Minimum Requirements	Recommended Requirements
Access control	The access control to the PHI must be patient-centered. The HCO allows or forbids access to the users for information at any moment.	The HCO creates role-based access, giving reading possibilities to some roles and adding limitations to others.
Security and Confidentiality	The HCO uses AES to encrypt PHI. The cryptographic key must have at least 128 bits. This method offers better encryption than other techniques.	The HCO uses a key of 192 or 256 bits.

(table continues)

Property	Minimum Requirements	Recommended Requirements
Authentication	The HCO authenticates the users with a unique ID and a password only known by the user and links ID to a PKI, preferably RSA and the symmetric key for encryption.	The users must use a complex password with at least seven characters and the combination of letters and numbers, including one capitalized letter and a special character, employing multifactor authentication to complement the ID/password identification when possible, and using an item the user possesses (smart key) or a physical feature, such as a fingerprint or face recognition.
Data Transfer	The HCO uses TLS with 128-bit encryption methods. It is also possible to use VPNs.	The HCO uses TLS with 256-bit encryption methods. It is also very recommendable to show an icon in the app notifying the transfer of data.
WBANs Communication	Cryptographic methods in securing the WBSNs for authentication and key distribution. The HCO can identify and authenticate mobile device (smartphone) by its IMEI) or its Subscriber Identity Module (SIM) card number.	the user's biometric patterns to encrypt and decrypt the symmetric key, which can facilitate the connection of the WBSNs to the mobile device.

(table continues)

Property	Minimum Requirements	Recommended Requirements
Data Retention	The HCO should include the retention policy in the privacy policy to inform patients. The HCO keeps data only if the necessary for the initial purpose.	When the user completes the process, the user must erase PHI, and notify the patients. The HCO should provide a mechanism to let the patients check if the user deleted the PHI.
Integrity	At least, the HCO must use the symmetric key-based authentication code, such as AES.	The HCO uses a public key-based digital signature. Under no circumstances, the HCO uses watermarking methods with medical images since they can deteriorate the quality and even provoke bad diagnoses.
Breach Notification	In case of a PHI breach, the app should alarm the HCO and the competent authority, and the HCO must notify the affected user as soon as possible (1–3 days). The HCO must help the user to relieve the consequences the breach may have caused.	The HCO must compensate the affected user to restore the damages done. In cases of breaches affecting a significant number of users, the HCO must notify the media to inform about the problem.

(table continues)

Property	Minimum Requirements	Recommended Requirements
Informing Patients	Before the collection and use of PHI, the HCO should use the display in the app notifying a privacy policy to the patients about the identity of the agent that will use the data, purpose of the collection of the information, privacy protection methods used, rights the patients have, and contact information. If the users accept the policy, they give their consent for data collection. It must include a section for minors, requiring the consent of a legal tutor.	The policy should be easy to understand, concise and clear, since users are not fond of reading large legal documents in an app. It is highly recommended to leave the policy accessible to users at any moment in the app.

Note. AES = Advanced Encryption Standard. PKI = public key infrastructure. IMEI = International Mobile Equipment Identity. RSA = Rivest, Shamir and Adleman System. SIM = Subscriber Identity Module. TLS = Transport Layer Security. VPN = Virtual Private Network. Adapted from "Privacy and Security in Mobile Health Apps: A Review and Recommendations," by B. Martínez-Pérez, I. de La Torre-Díez, & M. López-Coronado, 2015, *Journal of Medical Systems, 39*(181), p. 6. Copyright 2014 by Springer Science & Business Media. Modified with permission.

To support business staff members, the Society for Human Resource Management (2018) issued a template version of a cell phone use policy at work (see Appendix A). By implementing the policy, HCOs protect the safety, privacy, and information security of healthcare providers, staff members, and patients, as well as the reputation of the organization, business ownership, and properties. CIOs and CISOs can adopt the template provided by Society for Human Resource Management to develop the m-health use policy.

With the evidence-based policy and procedure establishment, CIOs can succeed in a deployment of mobile devices. C. K. Kao et al. (2017) recommended HCOs to create

and maintain best practices for the use of mobile devices by (a) defining the structure of a mobile technology governance, (b) determining the right mobile technology deployment strategy, (c) promoting a mobile device etiquette, (d) providing the standard protocols handling PHI and information security, and (e) developing a reviewing process and regularly reviewing m-health apps in the mobile devices. Thus, CIOs need to consider all circumstances and carefully implement the policy and apply the right mobile technology deployment strategy. HCOs must protect the privacy of healthcare providers, staff members, and patients, as well as the reputation of the organization, business ownership, and properties.

M-Health Apps

Mobile health technology is disruptive in the healthcare market. Disruptive technology is a marketing strategy in which businesses use inexpensive technology to penetrate markets (Yamagata-Lynch et al., 2015). Examples of disruptive technology include smartphones, inexpensive digital or video cameras, tablets, and RFIDs. With disruptive technology, healthcare providers can improve access to healthcare, improve quality, and reduce cost (Millan, Yunda, & Valencia, 2017). Tele-health itself is disruptive technology (Millan et al., 2017). Mobile technology is a crucial part of the disruptive technology for healthcare.

Healthcare organizations empower patients by allowing the patients to use mobile devices to access the Internet for health information (Hollis et al., 2015). Patients, their family members, and friends can use the Internet through a wireless connection in the patient room and waiting room, necessitating HCOs to adapt to the cultural changes

(Dwivedi, Shareef, Simintiras, Lal, & Weerakkody, 2016). IT teams provide Internet access through a wireless connection to patients and families so that they can use smartphones, tablets, and electronic books. When IT teams meet all needs of patients, families, and friends, HCOs can sustain their business.

Mobile EHRs. EHRs can be mobile. Recently, many HCOs introduced mobile EHRs (mEHR), especially in many Asian countries. The number of users and the amount of access to the mEHR system of a medical center in South Korea significantly increased (Y. Lee et al., 2017). Many HCOs in Taiwan and other countries use an mEHR system (M. Wu et al., 2015). The mEHR significantly improved documentation compliance in standard data entry format, abbreviation, content correction/revision, patient care needs, and care goals (M. Wu et al., 2015). The number of HCOs using mEHR is globally increasing.

Many researchers investigate mEHR. Z. Cai, Yan, Li, Huang, and Gao (2017) proposed a flexible EHR sharing scheme supporting offline encryption of EHR and outsourced decryption of EHR ciphertexts in MCC. The performance comparisons indicated that the mEHR sharing scheme was suitable for the m-health cloud (Z. Cai et al., 2017). Crowson, Kahmke, Ryan, and Scher (2016) conducted a prospective cohort study. The purpose of the study was to examine the utility of electronic tablets and their capacity (a) to increase hospital floor productivity and efficiency, (b) improve patient care information safety, and (c) enhance resident education and resource utilization, on a busy surgical otolaryngology inpatient service. The residents felt that they could transfer more detailed information faster and document easily in the medical record through a

tablet (Crowson et al., 2016). Mobile technology provides convenience to healthcare providers. Healthcare providers can access data immediately at bedside and provide safe patient care.

Tele-health. With tele-health, HCOs resolve the issues of the iron triangle by connecting healthcare providers and patients in virtual proximity. Mobile technology is one of the primary components of tele-health in addition to telephone service (Yuen et al., 2015). As more than 80% of the U.S. physicians have smartphone access at work (Johnston et al., 2015), mobile devices can be a valuable tool for tele-health.

With mobile phone-based interventions, healthcare providers can provide high-quality healthcare to hard-to-reach underserved populations (Price et al., 2013). In a survey of Hispanic migrant farm workers, 81% of the participants who owned cell phones capable of sending and receiving health-related messages were receptive to using m-health technology and felt the use of mobile phones would be helpful in enhancing medication adherence, self-monitoring health conditions, and receiving quicker medication changes from their doctors (Price et al., 2013). Especially, video and photo telecommunication are valuable for tele-health. Panayides, Antoniou, and Constantinides (2015) posited that m-health medical video communication systems could deliver responsive, reliable, and high-diagnostic quality. Using tele-health with mobile technology, HCO can improve quality, reduce cost, and provide more opportunities to patients.

Secure messaging. The use of a secure messaging system (SMS) in healthcare is flourishing in the United States. CMS, state governments, and health insurance

companies (third-party payors) in the United States has not reimbursed the costs of tele-health, SMS, or e-mail until recently (U.S. Department of Health & Human Services, 2018b). The third-party payors have been reluctant to pay for tele-health services except in a case where the patient comes to the remote office to communicate with the healthcare provider in the main office (U.S. Department of Health & Hman Services, 2018b). Currently, the U.S. federal government revised the regulations and policies, changing the payment systems according to the demand of the requirements of modern health technology.

The U.S. government recently modified the traditional diagnosis-related group (DRG)-based payment scheme to the value-based payment scheme (Figueroa et al., 2016). As a result, the third-party payors in the United States now pay for tele-health, phone calls, and SMS (U.S. Department of Health & Human Services, 2018b). With the national initiative, the use of SMS in healthcare is flourishing in the United States.

Wireless monitoring and surveillance. Some HCOs implemented the idea of *smart city* to take advantage of technology. In smart suites of the smart city, automated events occur based on patients' and nurses' location, preferences, and patterns (Hossain, Muhammad, & Alamri, 2017). Nursing tasks take less time or are no longer necessary due to utilization of smart technology seamlessly integrated into nurses' routines. HCOs use wearable technology, wireless monitoring, and surveillance technology for deployment of smart suites. With wearable technology, the smart city residents can interact with healthcare providers and staff members in *sustainable health centers* (P. K. Gupta, Maharaj, & Malekian, 2017). The sustainable health center is a part of the smart

city with equipment to perform various physical activities and keep the records updated for every physical activity of each citizen within the local database server (P. K. Gupta et al., 2017). The smart city is an ideal city for the healthcare providers and staff members who utilize wireless technology measuring objective data with m-health technology.

Healthcare organizations utilize WBANs for the communication among wearable, and bodily embedded devices, desktop and laptop computers, servers, and the mobile devices of healthcare providers, staff members, and patients. With wearable and bodily embedded devices, healthcare providers can identify the granular changes in the signs and symptoms of patients such as heart rate and galvanic skin response correlated with pain (Johnson, Gollarahalli, Abrams, Jonassaint, & Shah, 2017). Healthcare providers' assessment in a psychometric measurement such as a pain scale can be subjective. With m-health, healthcare providers can obtain objective data.

The smart suites, smart cities, WBANs, and mobile apps are some of the examples of the mobile technology used to improve healthcare quality and access and reduce costs. WBANs provide connectivity between the wearable device in the body and the monitoring server so that the healthcare provider can obtain objective assessment information (Lu, Gong, Liu, Wu, & Peng, 2018). With WBANs, the communication between sensors (or actuators) within, on, or in the immediate proximity of a human body and the measuring devices is simple, speedy, accurate, and reliable (Lu et al., 2018). Johnson et al. (2017) used the Technology Recordings to Understand Pain (TRUE Pain) mobile app and a wearable device for ecological momentary assessment to record symptoms and objective patient data during treatment in a clinical trial. Johnson et al.

concluded that the readings by the wearable devices were closer to the true state of pain compared to the pain scores recorded by nurses.

BYOD

Bring-your-own device is the most prevailing mobile deployment strategy studied. Gajar et al. (2013) introduced a technical framework for the mobile technology deployment strategies that consists of HYOD, CYOD, OYOD, and BYOD. Among the strategies, BYOD is the most predominant mobile technology deployment strategies studied (Vorakulpipat, Sirapaisan, Rattanalerdnusorn, & Savangsuk, 2017). Many researchers are interested in a study of BYOD.

Another strategy is HYOD. Another name for this strategy is to use what-you-are-told (UWYT; Vorakulpipat et al., 2017) to have. With the HYOD or UWYT strategy, HCOs provide mobile devices to healthcare providers, staff members, and patients (Gajar et al., 2013). The HCO owns, controls, and maintains the devices. HYOD has been prevailing strategy in healthcare (Vorakulpipat et al., 2017). HYOD and BYOD are in contrast (see Table 2).

With CYOD, HCOs provide a number of devices while healthcare providers, staff members, and patients can choose a device among them. With the CYOD strategy, the users have authority to install some specific apps and software (Gajar et al., 2013). The HCO owns and controls the device while the HCO and the users maintain the devices together (C. K. Kao et al., 2017). The HCO has the ownership of the CYOD, but healthcare providers, staff members, and patients configure the devices as they want. The HCO would not be able to save costs but provide freedom of a choice and convenience to

users. In contrast, BYOD is financially beneficial to the HCO. The CYOD strategy is the most recent arrival in the enterprise settings.

Table 2

Differences Between HYOD and BYOD

	HYOD (HCOs' devices)	BYOD (users' devices)
Information security governance	(a) Standardized devices (b) Tightly coupled (c) Focus on organizational control (d) Fully controllable	(a) Diverse devices (b) Loosely coupled (c) Focus on flexibility and agility (d) Partially controllable, require user awareness
Operations	(a) Full centralized management (b) Standard hardware (c) Standard software (d) Acceptable use policy	(a) User responsible for their own devices (b) Hardware of their choice (c) Standard and user's software (d) Acceptable use policy and BYOD policy
Personnel	(a) Lesser level of user technical competency (b) Central support (c) Lower cost of personal training	(a) Higher level of user technical competency (b) Central support and self-service (c) Higher cost of personal training
Application	(a) Standard and corporate applications (b) Controllable and cybersecurity vulnerability	(a) Standard, corporate, and user's applications (b) Harder to control cybersecurity, sandboxed, or container management (c) Focus on open standards
System	(a) Centralized control of access to applications, systems, and information	(a) Centralized control of infrastructure, distributed control of application and information

(table continues)

	HYOD (HCOs' devices)	BYOD (users' devices)
Information and data flow	(a) Centrally provisioned and secure information	(a) Centrally provisioned, distributed security
	(b) Easier to comply with rules and adult	(b) Hard to comply with rules and audit
	(c) Easier to implement access and adult control for cybersecurity	(c) Hard to implement access control for cybersecurity
		(d) Remote information wiping control for cybersecurity is required

Note. Adapted from "A Policy-Based Framework for Preserving Confidentiality in BYOD Environments: A Review of Information Security Perspectives," by C. Vorakulpipat, S. Sirapaisan, E. Rattanalerdnusorn, V. & Savangsuk, 2017, *Security and Communication Networks*, *2017*(2057260), p. 3. Copyright 2017 by Charlee Vorakulpipat et al. From the open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With BYOD, healthcare providers, staff members, or patients buy their device, or the HCO provides some financial assistance to the users to buy the device from the consumer market (Gajar et al., 2013). The users retain ownership, have full control, and can install whatever apps or software the users desire under the condition that the users comply with the HCO's mobile technology use policies (Gajar et al., 2013). The HCO provides some support for configuration of the devices (Vorakulpipat et al., 2017). Because the BYOD strategy benefits employers, employees, schools, teachers, and students, BYOD prevails in the enterprise and education settings.

With OYOD, healthcare providers, staff, and patients can bring their devices, but the HCO does not provide the support. The users do not need to comply to the HCO's policies for the use of the device (Gajar et al., 2013). The healthcare providers and staff

members may store PII on the device. With OYOD strategy, HCOs cannot regulate the transmission of PII to the device. This strategy is the violation against HIPAA (Hui Yang & Garibaldi, 2015) and other healthcare regulations. Besides, the OYOD strategy is vulnerable to cyberattacks.

The bring-your-own device strategy is widespread. The research is more active for enterprises and education then healthcare. BYOD is the most active research topics among mobile technology deployment strategies due to its benefits (Gajar et al., 2013; Keyes, 2014; Singh & Pandey, 2016). I found 22,300 results in a Google Scholar search with a keyword of *BYOD* and 10,600 results, together with a keyword *education*. Among nine search results in the first page, two (22.2%) were for education and one (11.1%) for enterprises but none for healthcare. I also used EBSCO Discovery Service for a search by subject. With *Health Sciences* as the subject and *BYOD* as the keyword, I found 312 results. In the first page of 20 study results, 10 reports were for education (50%), one for technology (5%), four for cybersecurity (20%), four for healthcare (20%), and one for enterprises (5%).

The search results of EBSCO Discovery Service were a little better than the Google Scholar, but the results with the topic in education were still prevailing in healthcare. In the search with CiteSeer, the scientific literature digital library and search engine that has focused primarily on the literature in computer and information science (Pennsylvania State University, 2016), I obtained 669 articles with the keyword *BYOD*. Among first 10 articles, five articles were for enterprises (50%), three articles for education (30%), and two articles for cybersecurity (20%) but, again, none for healthcare.

I found a gap in research for BYOD in healthcare during the search. To provide safe and convenient BYOD services to healthcare providers, staff members, and patients, I advocate more active studies for BYOD in healthcare.

Manually managing BYOD can be quite a labor-intensive endeavor for an IT team to ensure that individual devices are connected safely to the organization's IT infrastructure. Some HCOs might need to manage several hundreds of BYOD if not thousands. Fortunately, a technical solution exists. HCOs usually manage multiple mobile devices. The examples are hand-held blood glucose meters and bar-code medicine-administration hand-held devices. However, HCOs use the HYOD not BYOD strategy for the devices (*Y* means the group of users not individual users in this case). Managing BYOD would be more complicated than managing HYOD. Keyes (2014) presented a few management concepts for BYOD as following: configuration management (CM), content management, and resource management. CM, content management, and resource management are the major components of the enterprise information management (EIM) framework for BYOD.

Configuration management ensures that each device is configured correctly in the network. With CM, HCOs provide the means to manage technology-related processes in a structured, orderly, and productive manner, which should be the fundamental focus of HIT (Keyes, 2014). HCOs can gain several benefits from a CM system. Employees use CM to (a) organize tasks and activities that maintain the integrity of BYOD framework (i.e., devices, software, network); (b) help manage assets; (c) track modifications; (d) correct device/software configurations of software; (e) help ensure any changes made to

be the accurate baseline or version; (f) help limit legal liability by recording everything—including memos, decisions, meeting minutes, and so on, providing a paper trail; (g) trace responsibility for the source; (h) provide consistent conformance to organizational requirements and mandates; (i) enhance compliance with standards being applied; (j) provide an environment in which meaningful measures can be gathered and used; (k) provide data for easily generated reports; (l) quickly audit; (m) produce circumstance/conditions retaining information relative to the production process; (n) provide communication channels between groups; (o) foster an ability to improve without being punitive (Keyes, 2014).

The content management system automates the management of the contents provided to and from mobile devices. With content management, HCOs can address four elements of EIM: correspondence, workflow, document, and records management (Keyes, 2014). The content management system in EIM consists of several subsystems: content management, document management, records management, digital asset management, brand management, library management, digital imaging, learning imaging, geographic information, mobile content management (MCM), and mobile device management (MDM) subsystems (Keyes, 2014). MCM and MDM subsystems automatically task the major parts of cybersecurity. CM, MCM and MDM systems work synergistically in a wireless network.

Mobile content management is a new class of mobile security solution that focuses on securing content. An MCM server may reside in the private cloud network (Keyes, 2014). To protect contents stored on or transmitted to or from mobile devices,

HCOs need to secure the software contents with an MCM subsystem (Ouko, 2017).

An MCM subsystem shields the confidential data from unauthorized access and malware (Ouko, 2017). Ouko (2017) recommended the MCM subsystem to be in the private rather than public cloud. With the MCM subsystem, the IT and security teams can ensure distribution and storage of PHI and PII adhered to industry regulations and policies (Ouko, 2017).

In summary, the best practices for protecting confidential data on mobile devices are (a) to choose a solution that protects all confidential files on all devices, (b) to centralize access control and monitoring, (c) to connect MCM to SharePoint and other important services, (d) to increase trust and control with the private clouds, and (e) to block risky services (Ouko, 2017). MCM is one of the proven solutions for mobile technology. The MCM is the central monitoring system to act as a firewall to protect PHI and PII and ensure encrypted transmission of the private contents.

The major task of MDM is securing mobile devices. The MDM automatically tasks the organization's provision of mobile devices and maintains access control lists of the devices permitted to access the network (Ouko, 2017). Under the purview of the MDM, the staff members will have complete rights over nearly every aspect of every mobile devices (Zahadat, Blessner, Blackburn, & Olson, 2015). With the MDM solution, HCOs manage the mobile devices effectively, efficiently and automatically, securing PHI and PII in the devices, so protecting the patients' privacy.

Resource management is another essential part of the BYOD scheme. With resource management, HCOs provide a common view of the data including definitions,

stewardship, distribution, and currency and ensure operational integrity (Keyes, 2014). Resource management encompasses the full range of processes and technology to register, approve, configuration-control, and manage BYOD devices (Zahadat et al., 2015). Resource management can securely store and transmit organizational data to the BYOD that may not be particularly trustworthy, when the device becomes secure (Keyes, 2014). Resource management includes activities formally to approve users and devices into the BYOD program, register devices, install required software, configuration, and applications to meet organizational requirements, and manage the relationship between the organization, the user, and the device throughout the BYOD lifecycle (Zahadat et al., 2015). Resource management also processes the data coming from BYOD, IoT, WBANs and other mobile equipment (Zahadat et al., 2015). Configuration management, content management, and resource management systems are the significant parts of the BYOD scheme in the healthcare infrastructure.

Virtualization techniques are useful in deploying BYODs. Organizations adopt virtualization in server and desktop environments to provide fault tolerance, resource management, and energy efficiency (Shuja, Gani, & Madani, 2016). Along with 5G-speed cellular networks, MCC technology is paving the way for the computing-intensive applications involving multidimensional massive data processing assisted by the cloud (Chen, Zhang, Li, Mao, & Leung, 2015). Virtualization enables parallel execution of multiple operating systems (OS) while sharing the hardware resources (Shuja et al., 2016). The MCC paradigm is a promising solution provides a uniform platform for cloud-based resource sharing and augmentation for mobile computing (W. Li, Zhao, Lu,

& Chen, 2015). Enterprises did not previously deemed virtualization as a feasible technology for mobile and embedded devices due to their limited processing and memory resource (Shuja et al., 2016). Conversely, more enterprises are now advocating BYOD applications that enable coexistence of heterogeneous OS on a single mobile device (Shuja et al., 2016). The trend is the result of developing more powerful central processing units (CPUs). Moreover, embedded devices require virtualization for logical isolation to keep the secured OS from the general-purpose OS on a single device (Shuja et al., 2016). Virtualization is necessary to manage resources for HCOs to enable BYOD, security, and logical isolation of use cases.

CIOs often worry security vulnerability of BYOD. To alleviate the risk, the healthcare CIOs may deploy HYOD, an easy solution, which is the most secure even though HYOD is the costliest. HCOs rarely adopt the BYOD strategy except for patients and their friends and families, not for the providers and staff members. My Google Scholar search with keywords *BYOD*, *health*, and *healthcare* resulted in only 2,200 results, equivalent to the 10% result of the search only with *BYOD*. Another mobile technology deployment strategy is CYOD, which is to use preconfigured HCO-owned devices for personal use (C. K. Kao et al., 2017). A deployment of CYOD is also rare in healthcare. I found the works on CYOD reported in a few symposiums but not in the peer-reviewed journals.

Gaps in Research for Mobile Technology Deployment Strategies in Healthcare

Researchers have been actively investigating m-health. I found clear evidence of benefits of using mobile equipment in health. M-Health provides a convenient and

efficient work environment for healthcare providers and staff members to meet patients' needs. However, I could not find any feasibility studies on mobile technology deployment strategies in healthcare. In a literature review, Moyer (2013) concluded that peer-reviewed studies were still emerging about BYOD mobile device in healthcare. C. K. Kao et al. (2017) recommended BYOD in healthcare but fell short in proving the feasibility of the models in the healthcare settings. Even though Keyes (2014) presented technical information on BYOD in healthcare extensively in a book, Keyes failed to provide the clear evidence of the feasibility of BYOD in healthcare. The peer-reviewed feasibility studies of any mobile technology deployment strategies for healthcare are rare.

I found an industrial feasibility studies on m-health. The World Health Organization (WHO, 2011) recommended strategies and policies that integrate electronic health and m-health interoperability into healthcare. The WHO researchers found the widespread usage of m-health globally. However, WHO did not provide a comparative analysis of the different strategies of the mobile technology deployed in the report. It is not a peer-reviewed document.

Researchers of the Health Information Management and Systems Society (HIMSS, 2016) surveyed the U.S. healthcare staff members regarding their use of mobile technology, including apps for patient education and engagement, mobile-optimized patient portals, patient-generated mobile health data, consumer devices, clinical grade medical devices, SMS texting, and tele-health. Most respondents (81%) indicated their organization used at least one of the technologies included in the research (Health Information Management and Systems Society, 2016). Sixty-seven percent reported

deploying multiple solutions across their organization (Health Information Management and Systems Society, 2016). However, no scholars formally reviewed the results of the study. Attracted by the benefit of BYOD in cost savings and improved productivity, some healthcare CIOs were willing to accept the strategy. I conducted this feasibility study for m-health.

The perceptual security vulnerability of BYOD is still lingering in the mind of healthcare CIOs. Yeager (2016) posited that accessing radiology images and other clinical information on personal mobile devices such as smartphones and tablets had been considered taboo among most HCOs for many years, but Yeager agreed that the resistance had begun to soften in recent years. The healthcare industry is progressively accepting m-health, if not prevailing (HIMSS, 2016). I conducted a qualitative multiple case study. This study will benefit HCOs to move forward rapidly advancing the technology while reducing costs, improving quality of care, and easing access. By exploring the current strategies healthcare CIOs use to deploy mobile technology, I was able to assess the state of m-health in the industry. In addition, this study will provide the opportunity for a further investigation of quantitative and mixed-method analyses.

Summary and Transition

I presented the findings of the literature review and explored the current knowledgebase regarding m-health. In the search, I found active research activities in m-health. The healthcare industry lagged in utilizing the disruptive technology of mobile technology and taking advantage of the benefits. I did not find the clear evidence of the use of BYOD in healthcare. I filled the gap with this study by exploring the mobile

technology deployment strategies available, which would maximize the benefits to the healthcare industry.

In Section 2, I described the role of the researcher, participants, research method and design, population and sampling, research ethics, data collection instruments and technique, data organization techniques, data analysis, reliability, and validity for the research project. In Section 3, I present the study findings, application of the study to the professional practice, implications for social changes, recommendations for action, recommendations for the future research, reflection, and conclusion.

Section 2: The Project

In this section, I present the detailed plan of my research study and describe how I conducted it. The first section is the purpose statement. I then present my role as a researcher, discuss the participants, and detail the research method and design. I also present the population and sampling, research ethics, data collection instruments and techniques, data organization, and data analysis techniques and discuss how I obtained reliable and valid study findings.

Purpose Statement

The purpose of this qualitative multiple case study was to explore the strategies healthcare CIOs use to deploy mobile technology effectively. The study population consisted of five healthcare CIOs and HIT consultants in the United States with successful experience in deploying mobile technology. The implications for social change include the potential for CIOs to deploy mobile technology effectively for the benefit of healthcare providers, staff members, and patients. The benefits of using mobile technology are as follows: (a) information and time management, (b) health record maintenance and access, (c) communications and consulting, and (d) reference and information gathering (Rothman et al., 2017). With the identification of strategies for deploying mobile technology effectively—which benefits healthcare providers, staff members, and patients —healthcare CIOs can provide an additional mode of communication that supports enhanced care, safety, peace of mind, convenience, and ease of access.

Role of the Researcher

In conducting a qualitative study, researchers play a unique role in the data collection process by serving as the research instrument (Houghton, Casey, Shaw, & Murphy, 2013). The researcher can affect the study results with the researcher's perspective of the cultural world (Moon, 2015). I conducted semistructured interviews to collect data and then analyzed the data and collected documents. I was the personal lens for this study. I could not separate myself from this study.

I affected the study findings positively and negatively. The researcher's work experience and knowledge not only enrich the content of the study but also validate the accuracy of findings (Berger, 2015). Having experience as a field medic, health insurance agent, nurse's aide, health data analyst, and registered professional nurse, I have nuanced knowledge of healthcare. I also have experience in business administration, supply management, computer network management, radio communication, and communication security. I enriched the study with this knowledge of healthcare, business administration, and technology.

I took full advantage of my experience in this study. Nevertheless, the benefits of the researcher's experience and knowledge are possible only if the researcher addresses the high-stakes issues of data confidentiality, data use and ownership, and release of findings up front, to the mutual satisfaction of the stakeholders (Nelson, London, & Strobel, 2015), to reduce bias in a study. Coordination with the review committee and the approval process of the study were imperative for the success of this study.

I strived to be a balanced observer while conducting the study, alleviating bias.

Researchers should adhere to ethical standards (Harriss, MacSween, & Atkinson, 2017). In 1974, the U.S. Congress enacted the National Research Act, which is based on *The Belmont Report* (Adashi, Walters, & Menikoff, 2018), to require researchers to get voluntary informed consent from all persons taking part in studies done or funded by the Department of Health, Education, and Welfare (Centers for Disease Control & Prevention [CDC], 2017), after the media news broke out about the U.S. Public Health Service syphillis study at the Tuskegee Institute and the historic $10 million out-of-court settlement reached between the the participants and families and the U.S. goverrnment (CDC, 2015; CDC, 2017).

I abided by the U.S. National Research Act. I submitted the training certificate to the Walden University Institutional Review Board for approval. I designed my study to be credible and dependable so that other researchers could duplicate the study and find the similar results.

I abided by the principles and guidelines of *The Belmont Report*. *The Belmont Report* is a statement of basic ethical principles and guidelines that assists in resolving the ethical problems surrounding the conduct of research with human subjects (Adashi et al., 2018). In the United States, the agencies which evaluate systems that collect PII must determine that the privacy of the identifiable persons is adequately protected (Posey, Raja, Crossler, & Burns, 2017). Researchers have an ethical duty to protect study participants from harm, safeguard their confidentiality, and obtain their informed consent before they participate in the study (Harriss et al., 2017). Before the beginning of a study involving human subjects, the researcher must submit the study proposal to the

institutional review board (IRB), an administrative body established to protect the rights and welfare of human research subjects (Happo, Halkoaho, Lehto, & Keränen, 2017).

The main purpose of interviews in a qualitative study was to seek perceptions of reality from the participants' narratives of their experiences and feelings and to produce in-depth descriptions of the phenomenon (Yüksel & Yildirim, 2015). In the interviews, I used the various tools and techniques to achieve rigor of study. Even if all safeguards were in place, I might still have had bias toward a certain mobile technology deployment strategy. A researcher may not be able to observe phenomena wholly objectively because the researcher looks through a personal lens shaped by the researcher's experiences (Tsohou et al., 2015). The researchers may also actively engage the participants when needed in the qualitative study (Høffding & Martiny, 2016), increasing the risk of bias. Hence, the credibility of the qualitative study heavily depends on the procedures implemented and self-awareness of the researcher (Houghton et al., 2013). Because I was the one who tested the credibility and dependability of the study for the data collected before others confirmed the accuracy of the data collected and analyzed, I had to ensure to mitigate bias.

To minimize bias, researchers can use the technique of bracketing in a qualitative study (Overgaard, 2015). I balanced myself between bracketing and active engagement during the interviews to obtain the optimum level of interaction. In addition to bracketing, I further mitigated bias with member checking, reaching data saturation, enabling sensemaking, and carefully reviewing and revising interview questions and data collection protocols.

Member checking is a review of the interpretation of the data by the interviewee to ensure the information is what the interviewee meant to impart and is an important component of validation in qualitative studies (Fusch & Ness, 2015). Member checking is an essential process to alleviate bias in a qualitative study. I adopted the member checking protocol of Birt, Scott, Cavers, Campbell, and Walter (2016), to reduce bias (see Appendices H and I).

Participants

The targeted population consisted of at five healthcare CIOs and HIT consultants in the United States, with successful experience in deploying mobile technology in their organization. I interviewed the healthcare CIOs as the primary data source. The CIOs were the experts in IT and cybersecurity. The title of the CIOs were chief innovation officer (CIO), CISO, chief technology officer (CTO), chief medical informatics officer (CMIO), chief nursing informatics officer (CNIO), pharmaceutical chief informatics officer (Pharm. CIO), chief digital officer (CDO), and so on. For the purposes of this study, I referred to these business executives and consultant as CIOs. The professional focus of CIOs is the strategies and communication aspects of the digital transformation (Horlacher & Hess, 2016).

I did not interview any personal friends. Brewis (2014) advised to avoid bias by not interviewing personal friends or employees where the researcher works. Greene and Sullivan (2015) noted that a researcher's position and experiences may influence what information the interviewee would share, how the thoughts and ideas of interviewees would relate to the researcher, and the analyses and conclusions the researcher would

draw from the phenomenon. I might have the preference for a certain mobile technology deployment strategy through my work experience, and, therefore, I might have tried to influence the interviewees with my relationship to interfere unconsciously. In addition, the interviewees who had known me might not have given me the full detail or correct information with the assumption that I already had the information. Thus, I avoided interviewing any personal friends.

To build a relationship with participants, I divided the relationship creation into three phases: initial access, building trust and securing access, and breakthrough. The initial phase was achieved through networking. The initial phase was a challenge. Establishing contacts and gaining permission to conduct a qualitative study with elite participants can be time-consuming and stressful (Lancaster, 2017; Monahan & Fisher, 2015). To maximize recruitment success, researchers need to ensure that recruitment is inclusive of all who fit within sampling parameters (Ellard-Gray, Jeffrey, Choubak, & Crann, 2015). While I used my personal and professional network to recruit the participants, I carefully monitored the participants' qualifications.

I expanded my personal and professional networks in its maximum capacity to increase the number of prospective participants. Networking is one of the assets for chief executives to expand their influence (Avellaneda, 2016). Because leaders generally are sociable (W. Sun, Mollaoglu, Miller, & Manata, 2015), networking was the effective recruiting tool for my study. Many healthcare chief executives join and lead professional associations, such as HIMSS, and social network services (SNS), such as LinkedIn, FaceBook, Instagram, and Twitter. I am a member of HIMSS and have many chief

executives in my LinkedIn, FaceBook, Instagram, and Twitter networks. Most members are close enough but not too intimate with me to be my study participants. I asked some HIMSS members to refer healthcare CIOs in the United States. I also asked my LinkedIn members to refer their network members to join me.

Monahan and Fisher (2015) recommended the following strategies in the initial phase: (a) attending industry or government conferences, (b) finding the names and making phone calls, (c) communicating legitimacy, (d) reducing perception of threat, (e) coordinating coincidence and making barely announced visits, (f) mobilizing indirect access, (g) filing freedom of information requests, (h) triangulating the Internet data, and (i) initiating and following up on multiple leads simultaneously. For the initial access, Blix and Wettergren (2015) discussed that feeling of uncertainty and how growing familiarity with the field resulted in a self-confident performance by the researcher, including a sense of competence and a perception of trustworthiness. Weiner, Puniello, Siracusa and Crowley (2017) suggested researchers could use social media to recruit a low incidence, hard-to-reach population. In considering the socio-financial status of the interviewees, I used referrals as the major recruiting tool. I used networking to build a relationship with participants in the initial phase and to gain a sense of competence and trust.

Snowball sampling is a chain-referred method from the participants to recruit participants (Valerio et al., 2016). Researchers can use snowball sampling to recruit participants (Valerio et al., 2016). I used the snowball technique to expand my network. I have more than 1,500 network members in the personal network of professionals in the

United States and overseas, including healthcare, human resources, information technology, military, academic, accounting, art, and music professionals. I also asked the interviewees to provide two names of other health care CIOs they know of in the United States.

The next step is to build trust and secure access. Blix and Wettergren (2015) proposed that researchers would use the emotion work in the process of gaining, securing, and maintaining access to participants. The concern for transparency is particularly important in gaining access to HCOs (Høyland, Hollund, & Olsen, 2015). Establishing the long-term relationship between researchers and participants ensures two-way communication and keeps the focus on the production of useful knowledge (Meadow et al., 2015). I have been networking throughout my career. My honesty and networking skills helped me find business leaders quickly and break through the protection layer. I used the personal and professional networks to support my effort to build relationships in the second phase of the researcher-prospective participant relationship. I often sent a message or e-mail to my network members. I congratulated the anniversary of their work and birthday. I took time to build the relationship with the recruits.

The third phase of recruiting is a break-through. Høyland et al. (2015) emphasized detailed and permanent documentation of the access process. The relationship between a reseracher and a participant should be based on mutual respect and a position of equality as human beings, but the fallacy exists that the interviewer and the person interviewed work together in a relationship of complete equality (Holloway & Galvin, 2016). First, I

sent the message through LinkedIn, asking for participation and their phone number and e-mail address (see Appendix K). Next, I sent the letter of invitation to the prospective study by e-mail (see Appendix B) with a consent form. I also collected the contact information from LinkedIn. With the preparations, I easily broke through the processes. I eventually called, asking for an interview or thanking for participation if the interviewee already agreed to participate.

The participant CIOs were knowledgeable and had a background to answer the overarching question of this study. Peak (2016) interviewed a vice president/CIO of a company and explored the contemporary role of CIOs. According to Peak, CIOs and IT consultants (a) build a global infrastructure and capacity, (b) focus on connectivity, (c) connect the internal systems to run seamlessly together, (d) connect people to the broader world of web-based technology and services, (e) and invest in advanced analytics and data-driven insights. The role of a CIO is to oversee IT, project management, cybersecurity, and innovation (Skalik, 2016). The healthcare CIOs in the interviews had known about the IT infrastructure deployed in HCOs and had been involved in making decisions with the deployment of the wireless network. The interviewees' knowledge, expertise, judgment, insights, wisdom on mobile technology, and integrity were the focus of this case study. I relied on the interviewees' experience and judgment in deciding if the strategy implemented in the organization had been successful.

At the beginning of the study, I profiled 1,537 members in my LinkedIn network. I found 11 healthcare CIOs in my LinkedIn network before the first wave of profiling and sending a message. While recruiting the participants, I continually expanded the LinkedIn

network. At the end of the recruiting phase, my LinkedIn network expanded from 1,537 to 1,747 members. I primarily used the snowball technique to expand the network. In addition, I obtained the HIMSS member directory to search the healthcare CIOs in the region and I identified 450 HIMSS members in Washington. At the first undertaking of recruitment, I could not secure any participants. Thus, I decided to expand the pool of the prospective participant to include HIT consultants and expanded the area from the northwestern to the entire United States. The IRB approved the changes.

Research Method and Design

Because the purpose of this study was to explore the effective mobile technology deployment strategy for healthcare with interviews and other data collection instruments for business phenomena rather than statistically examine the strategies, a qualitative multiple case study was the most appropriate. In a qualitative study, researchers gain deep insights into the success factors and consequences of business analyses, utilizing a multitheory perspective (Parks & Thambusamy, 2017). In a multiple case study, researchers explore business phenomena of the contemporary or multiple bounded systems through detailed, in-depth data collection involving multiple sources of information (Yazan, 2015).

Research Method

Researchers have the following choices of modalities in research: qualitative, quantitative, and mixed methods. A research problem guides the choice of research method and design for the study. I employed a qualitative research method to explore the effective mobile technology deployment strategy for healthcare. Researchers conducting

quantitative study examine variables to verify a single theory (L. Cai, Dai, He, Zhao, & Liu, 2015). Researchers conducting a qualitative studies of business phenomena make observations and explore solutions to a business problem (Thorne et al., 2016). The mixed-method approach includes both qualitative and quantitative study methods (McCusker & Gunaydin, 2015). Business phenomena usually function under multi-conceptual systems, which are too complicated to be analyzed by quantitative techniques (Thorne et al., 2016). Therefore, a quantitative approach is not appropriate for my study.

I conducted interviews using open-ended questions and analyze the data based on multiple frameworks. Researchers conducting qualitative studies of business phenomena make observations and explore solutions to a problem (Thorne et al., 2016). Researchers conducting qualitative study can observe the phenomena in a multitheory perspective (Kurnia, Karnali, & Rahim, 2015). In addition to the main conceptual framework of Wallace and Iyer's (2017) HIT value hierarchy, I used a few interrelated technical and methodological frameworks for this study. I developed an understanding of the phenomena with the conceptual and technical frameworks in the in-depth literature review. I also developed the study protocols based on methodological frameworks. Because the purpose of this study was to explore and propose business solutions for m-health, I explored multiple theories to search the business solution. Quantitative and mixed-method approaches were not appropriate because I was not examining a single theory.

Research Design

I conducted a multiple case study. Lewis (2015) identified the following five

qualitative research designs: case studies, narrative studies, grounded theory, ethnography, and phenomenology. Some researchers designate narrative study as a discourse analysis (Lewis, 2015). Among five research designs, I selected a case study. The case study design is a tool for researchers to study complex business phenomena (Baxter & Jack, 2008). I wanted to observe the business phenomena closely to explore the solution to deploy mobile technology.

My study was not a narrative study. A researcher conducting a narrative study studies a phenomenon by obtaining the required information from the documentary sources or narratives (Mear et al., 2016). A narrative study helps researchers who are exploring the participants' explicit perspectives construct a story based on the narratives the researcher collects from interviews (Peden-McAlpine, Liaschenko, Traudt, & Gilmore-Szott, 2015). In contrast, the purpose of my study was not to record the facts or perspectives through participants' narratives. I am exploring business phenomena to find the best business strategy for HCOs.

My study was not a grounded theory study. Researchers conducting a grounded theory study move beyond a description to generate or discover a theory, a unified theoretical explanation for a process or an action (Ivey, 2017). The grounded theory study is a naturalistic inquiry that entails identifying themes and patterns and involves rigorous coding for analysis and interpretation of qualitative data (Cho & Lee, 2014). The goal of this study was not to build a fundamental theory to support the explanation of a phenomenon, as in a grounded theory study. The scope of the population in grounded theory studies tends to be broader than a case study, and a much more intensive analysis

of the data usually follows (Cook, Holmboe, Sorensen, Berger, & Wilkinson, 2015). The goal of this study was to find the business strategy for HCOs by interviewing a few healthcare CIOs who successfully deployed mobile technology, not to build a theory.

In an ethnographic study, the researcher is interested in exploring the shared patterns of behavior, beliefs, and language of the entire culture-sharing group, as well as a description of senses and sociality of observation and in-depth interviews, photographing, and audio and video recording, along with research participants (Marion et al., 2015). I did not intend to detail the experience of culture and life, as in an ethnographic study. I wanted the detailed experience of healthcare CIOs who successfully deployed mobile technology in their organization. In the traditional ethnography, the researcher observes and participates but does not actively seek to change the situation (Baskerville & Myers, 2015). I was searching for a business solution and advocating the change of situations to promote benefits for healthcare providers, staff members, and patients. Therefore, I actively sought to change the situation that was unsafe for patients and engaged to promote the benefits of m-health, in addition to active observation.

My study was not phenomenological. Researchers conducting a phenomenological study identify the original and unchanging meanings of the issue under study (Chan, Fung, & Chien, 2013). Phenomenologists explores human consciousness or self-awareness (Sohn, Thomas, Greenberg, & Pollio, 2017). The objective of this study was not exploring human consciousness or self-awareness. In a phenomenological study, a detailed phenomenological analysis of personal accounts, followed by presenting and discussing the generic experiential themes, is typically paired

with the researcher's personal interpretation (Künzler□Heule et al., 2016). In contrast, I was exploring a phenomenon in a real-life setting to solve a business problem, not analyzing personal accounts. Hence, I avoided inserting my personal interpretation of data that interviewees presented. Todd et al. (2016) conducted a phenomenological study, exploring the lived experience of patients, caretakers, and healthcare professionals. Conversely, I was not interested in exploring the lived experience. I was searching for a business solution, not a personal life.

A case study was appropriate for my study. A case study is a qualitative study in which the investigator explores in-depth social behavior, contemporary bounded system, or multiple bounded systems over time through detailed, in-depth data collection involving multiple sources of information (Yazan, 2015). A qualitative case study is valuable for health science research in developing theories, evaluating programs, and developing clinical interventions (Baxter & Jack, 2008). A case study design was appropriate for this study because I was evaluating different strategies for healthcare CIOs to deploy mobile technology.

A case study was versatile for my study purpose. The case study research has a level of flexibility and wide diversity in the study design not readily offered by other qualitative approaches such as grounded theory or phenomenology (Yin, 2018). Even though some qualitative researchers argued that case study research is anecdotal and unscientific, the consensus among researchers is that case study research is one of the most powerful research designs to explain real-life and causal links, with which the researcher can appreciate the subjective richness of individuals recounting their

experiences (Cronin, 2014). With a case study design, I could explore the business solutions in detail for the current healthcare systems interacting with multiple phenomena and observe the business processes in action.

One of the benefits of the case study in exploring the solution for a business problem is that researchers can apply a variety of data collection techniques (Yin, 2018). One of the techniques I used was data saturation. With data saturation, researchers generalize the study results. Failure to reach data saturation affects the quality of study and hinders contend validity (Fusch & Ness, 2015). Data saturation is dependent on (a) the aim of the study, (b) sample specificity, (c) use of established theory, (d) quality of dialogue, and (e) analysis strategy (Malterud, Siersma, & Guassora, 2016). A researcher meets the requirement of data saturation when the researcher gathers enough information to replicate the study when the researcher attains the ability to obtain additional new information, when further coding is no longer feasible, and when other researchers can replicate the study (Fusch & Ness, 2015). To meet the requirements, I conducted a multiple case study, interviewing five CIOs and HIT consultants and analyzing academic, organizational, and government documents and news media articles. I selected a conceptual framework to support data analysis. I used an interview framework, recorded interviews, and used computer software to analyze the data to meet the requirements of dialogue quality, with a focused analysis. In addition, I analyzed the additional documents for triangulation and data saturation.

Population and Sampling

The population of this study is five healthcare CIOs and HIT consultants in the

United States. I used the purposeful sampling and census sampling methods—the nonprobability techniques. Researchers often use nonprobability sampling techniques in the qualitative or mixed-method study approach (Etikan, Musa, & Alkassim, 2016).

Purposeful sampling involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Palinkas et al., 2015). Census sampling is a sampling method to invite all members of the population of a study (Asadollahi et al., 2015). I interviewed the healthcare CIOs and HIT consultants who agree to participate in the study. While using the sampling methods, I ensured the prospective interviewees were with the knowledge and experience in deploying mobile technology in a healthcare setting.

I also used a census sampling method for participant organizations. Census sampling is a sampling method to invite all members of the population of a study (Asadollahi et al., 2015). In a practical consideration, census sampling is appropriate for case studies (Cleary, Horsfall, & Hayter, 2014). I decide to study at least five cases. For demographic homogeneity of the samples to avoid Type I and Type II errors and generalization of the findings, selecting the right number of samples or cases is imperative (Palinkas et al., 2015). In a multiple case study, researchers conduct sampling from multiple cases (Gentles, Charles, Ploeg, & McKibbon, 2015). I had five cases to ensure data saturation. I could not find any new information in the fifth interview.

Even though the nonprobability techniques mentioned above have the strength for this study, the techniques are not without weaknesses. The purposeful or convenient sampling techniques may introduce bias. With snowballing, the sampling method that I

used for the purpose of recruiting participants, researchers diversify the pool of the prospective participants (Valerio et al., 2016). However, diversification usually delays data saturation (Palinkas et al., 2015). Census sampling is only possible with a small sample of participants (Cleary et al., 2014). A census sampling was possible because I had a small sample size.

To decide the proper number of participants and minimize the weakness, I considered data saturation. Guest, Bunce, and Johnson (2006) reported in their literature review that the researchers had reached data saturation within the first twelve interviews but found the basic elements for metathemes as early as six interviews. According to Guest et al., the methodologists recommended the varied number of interviews: from the optimum number of 36 interviews for ethnographic studies to 15 as the smallest acceptable sample size in qualitative research; approximately 30 to 50 for ethnographies, between five and 25 for a phenomenological study, 20 to 30 for a grounded theory study; six to 8 interviews for a homogeneous sample; and 12 to 20 when looking for disconfirming evidence or trying to achieve maximum variation. None of these recommendations were with the rationale. Guest et al. did not suggest the sample size for case studies. Case study researchers explore a varied number of cases from one to many cases, determined by the experience of the researcher (Yin, 2018). I determined the number of participants with the guidance with the review committee and program manager who had several decades of combined experience in research. In addition, I considered my convenience and time to conduct interviews. For data saturation, I collected and analyzed the data until no new themes emerged.

Ethical Research

I began soliciting participants by searching my social networks and sending invitation messages to potential participants to introduce myself to explain the purpose of this study. Lancaster (2017) suggested to send a letter to obtain consent from participants. Upon generating interest from potential participants, I sent the consent form by e-mail. Regmi et al. (2017) developed a consent form. The consent form consists of (a) contact information, (b) sponsoring institution, (c) study purpose, (d) anticipated risks, (e) voluntary nature of the study, and (f) freedom to withdraw from the study at any time. Researchers need to understand how the public comprehends the consent elements (Rothwell et al., 2017). I did not collect data until the prospective interviewee stated that the interviewee fully understood the elements and completed the consent form.

The participants and the participant organizations had some risks and benefits in the study. The psychological and physical risks were minimal. However, the legal, relationship, economical, and professional risks were substantial. The information I collected in the interview could have resulted in the disclosure of the violation of laws or workplace policies, disagreement with leadership decisions, poor work performance, or other information that could damage the participant's position, professional reputation, promotability, or employability. The disclosure of the participant organization's violation of laws, the local policies, poor performance, or anything else could have damaged the organization's reputation or marketability. The time commitment to this study was approximately 60 to 120 minutes after normal work hours. More importantly, however, the study benefited the participants and participant organizations indirectly with the

contribution to the knowledgebase related to mobile technology deployment strategies used in the healthcare industry. The participants will also gain the knowledge from this study when they read the copy of the results of this study.

I obtained consent from all prospective interviewees before I proceeded to collect data. The participants need to know each element of the consent form (Rothwell et al., 2017). The first step of an interview was to contact potential study participants in person, via e-mail, or by phone. The personal introduction and detailed explanation of the purpose of the study were the next, followed by the presentation of the consent form to the willing participants. I followed up with the participants to clarify any questions about the study before I scheduled to conduct the interview. I retrieved the signed consent form indicating the voluntary agreement to participate in the study before the interview. CIOs are in the high socio-financial status (Skalik, 2016). I, therefore, informed the interviewees that they would not receive compensation. I reiterated at the beginning of an interview that the participant can withdraw their participation at any time. If the interviewee wanted to be withdrawn from the study, I would have immediately stopped, thanked the person, and left the premises. I did not have any prospective participants opt out during the interview. I asked for the permission to record the interview before starting an interview.

I did my best to conduct this study ethically. Failure to recruit enough participants can jeopardize the quality of research and threaten efforts to accumulate knowledge and exercise evidence-based practice for business management (Armstrong, Price, & Geddes, 2015). The failure may lengthen the period of my study. Despite this, I agree with

Armstrong et al. (2015) in designing recruitment materials conservatively because of ethical concerns regarding the risk of coercion and offense posed by recruitment materials. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research recommended three fundamental principles for ethical treatment of subjects or participants remain highly influential, respect for persons, beneficence, and justice (Paxton & Griffiths, 2017). To obtain permission to use intellectual property, I corresponded with the authors of the literature I referenced (see Appendix J).

The Belmont Report is the base of the conceptual framework of the NIH extramural research training program. From 1976, the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research held monthly deliberations in Smithsonian Institution's Belmont Conference Center over a period of nearly four years (Adashi et al., 2018). The Commission summarized the basic ethical principles identified and reported in *the Belmont Report* (Adashi et al., 2018). *The Belmont Report* is a statement of the basic ethical principles and guidelines that should assist in resolving the ethical problems related to the research with human subjects (Adashi et al., 2018). Researchers have an ethical duty to protect study participants from harm, safeguard their confidentiality and obtain their informed consent before they participate in the study (Vos, van Delden, van Diest, & Bredenoord, 2017). According to *The Belmont Report*, researchers must treat their study participants with justice, respect, and beneficence.

The National Institutes of Health provides training to researchers conducting the studies involving human subjects. I completed the extramural research training program

offered by the NIH Health Office and received the certification. I prepared various instruments, protocols (see Appendices C and D), and a data organization plan to ensure the ethical protection of participants is adequate.

I backed up the collected data on a password-protected encrypted external hard drive powered from my laptop computer and limited the use of paper to the minimal for the security of data. Data security in the cloud is more complicated than is in the traditional information systems (Y. Sun, Zhang, Xiong, & Zhu, 2014). Hence, I disabled the auto-backup to the cloud and manually backed up the data. I am keeping the logs, transcripts, recorder, research journal, external hard drive, paper copies of the note that I did not convert to an electronic file in a locked cabinet that only I can access. I will keep them in the cabinet for 5 years. Researchers conducting a study involving human subjects must submit the study proposal for a review, to an IRB, an administrative body established in the research organization to protect the rights and welfare of human research subjects (Happo et al., 2017). The Walden University IRB approval number for this study is 12-12-18-0453212.

To ensure privacy and confidentiality, I treat the PII of the participants as confidential. As a student and doctoral degree candidate at Walden University, government employee, licensed registered professional nurse, and professional healthcare information management specialist, I am responsible for the protection of personal information for my clients. Researchers protect confidentiality as the participant discloses to the researcher information of which the participant regards as confidential or secret and the researcher undertakes (implicitly or explicitly) not to reveal this information to

anyone who does not already possess it (Harriss et al., 2017). Both user awareness and security notices have a positive statistical effect on information disclosure (Benson, Saridakis, & Tennakoon, 2015). To avoid the use of PII, I referred to the interviewees by an identification number, P1, P2, P3, P4, and P5 for the primary interviewees, and HCO 1, HCO 2, HCO 3, HCO 4, and HCO 5 for the participant organizations. I considered organizations as human entities and, therefore, respected organizations' privacy and avoided the use of organizations' identifiable information.

Data Collection Instruments

I used the variety of data collection instruments and processes for triangulation. The instruments I used include semistructured interviews with healthcare CIOs and the document review of the company and government documents and news media articles. In a case study, researchers use a variety of data collection instruments. Researchers conducting a case study may use different approaches: an exploratory, descriptive, or explanatory method (Yin, 2018). Case studies provide the opportunities to adopt and match different forms of data, enabling a more in-depth understanding of a phenomenon, which is particularly important in the field of healthcare management, where the managerial processes are otherwise difficult to investigate (Runfola, Perna, Baraldi, & Gregori, 2017). I was able to obtain the knowledge from the interviewees with their experience, meeting the purpose of this study to solve the business problem for HCOs. The document review was helpful in achieving data saturation.

I prepared six interview questions for semistructured interviews (see Appendix D). With semistructured interviews, researchers ensure that all participants are asked

relevant questions and allow participants the opportunity to talk about issues that are important to them. (Tonkin-Crine et al., 2015). Semistructured interviews are in-depth conversations between the researcher and interviewee (Gilbart et al., 2015), which have an overall purpose prompted by the research aims but are strongly guided by the interviewee's perceptions, opinions, and experiences (Cridland, Jones, Caputi, & Magee, 2015). I actively engaged the interviewee while ensuring I serve as a balanced judge.

The interview format can be face-to-face, telephone, or video conference, as mutually agreed. In a face-to-face interview, the participant can provide more in-depth information than other types of interviews (Cridland et al., 2015). The process of creating an interview matrix helps display whether any gaps exist between the actual questions and the questions that would have been asked, assessed, adjusted, or added in interview questions (Castillo-Montoya, 2016). The interview protocol I prepared includes an interview matrix (see Appendix D). The semistructured-interview approach helped me understand the strategy the health technology executive interviewees used in implementing mobile technology for their organization.

I conducted a document review to validate the findings with triangulation. Researchers conducting qualitative studies often use a document review for triangulation (Moore, Prentice, & McQuestion, 2015; Siegner, Hagerman, & Kozak, 2018). Even though a document review would not generate insightful responses as much as interviews (Blix & Wettergren, 2015), a document review is a convenient data collection method for researchers because most documents are readily available in the Internet, through the library databases, in the news media, and from the participant organizations.

Data Collection Technique

I sought reliability and validity in my study with the triangulation technique. To establish external validity of study results, researchers test the interview data with the data from other sources and multiple cases, a technique called triangulation (Eid & Elbanna, 2018). In triangulation, researchers use more than two sets of data for validation purposes (Hussein, 2015). I collected data from variety of sources, interviewing healthcare CIOs and reviewing the standard operating procedures, user and technological manuals, implementation guidelines, patient brochures, government documents, local and national newspapers, and academic and professional reports.

I used semistructured interviews with healthcare CIOs as the primary data source. Castillo-Montoya (2016) developed a model for the qualitative study interviews. An interview protocol underpins the interview process and influences subsequent research stages (Cridland et al., 2015). I carefully adopted Castillo-Montoya's model in the interview protocol. I recorded all interviews, in addition to taking notes on nonverbal expressions and key comments. I manually transcribed interviews if the interviewee refused to be recorded. I used the interview protocol and ensured the participants answered one question at a time and in order to maintain a neutral position when I asked questions or took notes. While detailed answers are essential, keeping track of time and remaining in control of the interview process help avoid redundancy and enhance efficiency (Oates, 2015). The use of the case study protocol, and interview protocol help me remain in control of the interview process. For member checking, I e-mailed the results of analysis to the interviewee so that the interviewee could review my analysis for

any disagreements with their knowledge and experience.

At the beginning of each interview, I reiterated the participants' rights, including the right to withdraw at any time. The participants need to understand the consent elements before providing data (Rothwell et al., 2017). The number of questions in the actual interview may be flexible, reflecting the context of the interview conversation. With semistructured interviews, researchers provide some structure but work flexibly (Tonkin-Crine et al., 2015). I did not use the script in the interview protocol verbatim but as a guide to have a conversational interview. I followed the guideline in the interview protocol to determine how much variation I needed in each interview. After an interview, I reviewed the conversation, interview questions, and interview protocol and revise the interview script as necessary for the next interviews. Researchers need to mitigate bias in data collection with member checking (Amankwaa, 2016; Marshall & Rossman, 2016). I conducted follow-up interviews with all participants. I utilized an activity checklist for a close reading of interview protocol and a think-aloud activity before the next interview (see Appendix E).

Face-to-face interviews have advantages for a qualitative study. In a face-to-face interview, the interviewer can establish rapport with participants to make them feel more comfortable and at ease, which can generate more insightful responses (Blix & Wettergren, 2015). The interviewer has more opportunity to ask follow-up questions, probe for additional information, and circle back to key questions later in the interview to generate a rich understanding of attitudes, perceptions, and motivations (Castillo-Montoya, 2016). The interviewer can monitor changes to tone, word choice, and body

language to get a deeper understanding (Oates, 2015). In addition, the sampling of a face-to-face interview is in a higher quality compared to other qualitative data collection methods such as a focus group which may pose the potential distractions or peer pressure dynamics that can sometimes emerge (Sackett & Lawson, 2016). With a face-to-face interview, researchers need a fewer participants to glean useful and relevant insights. In other words, the interviewee in a face-to-face in-depth interview provides higher information power compared to other data collection instruments (Malterud et al., 2016). Because the in-depth interviews were insightful, I was able to identify highly valuable findings very quickly.

Nonetheless, face-to-face interviews are not without disadvantages. In-depth interviews are quite time consuming, as researchers must transcribe, organize, analyze, and report interviews (Castillo-Montoya, 2016; Lancaster, 2017; Monahan & Fisher, 2015). According to Castillo-Montoya (2016), the entire process can be undermined if the interviewer is not highly skilled and experienced. Recruiting interviewees also takes the time and resources of the researcher (Lancaster, 2017; Monahan & Fisher, 2015). For a face-to-face in-depth interview, researchers must carefully choose participants to alleviate bias (Brewis, 2014).

One of the data collection techniques is a pilot study. A pilot study is not a full-blown study (Czerwonka et al., 2015). A pilot study is a subset of a feasibility study (Eldridge et al., 2016). Researchers with a well-conducted pilot study with clear aims and objectives within a formal framework can ensure methodological rigor and lead to high-quality research and scientific valid work that is publishable and beneficial to patients

and healthcare delivery (Doody & Doody, 2015).

A pilot study can be a quantitative, qualitative, or mixed-method study (Aarons, Ehrhart, Farahnak, & Hurlburt, 2015). With a pilot study, researchers can develop and enhance the skills necessary before commencing a larger-scale study (Doody & Doody, 2015). By conducting a pilot study, researchers can obtain preliminary data, evaluate their data-analysis method, and clarify the financial and human resources required (Doody & Doody, 2015).

A pilot study could be an independent study without the accompanying larger-scale study (Blanc, 2018), but my study was in a much larger scale than a pilot study. Because I was a lone researcher for this study, I did not have enough resources to conduct a pilot study and the accompanying larger-scale study. Even though pilot studies played a vital role in health research (Doody & Doody, 2015), I did not conduct a pilot study in addition to the proposed qualitative multiple case study due to the limit in the time, financial and human resources, and scope of the study.

To minimize bias in collecting data from the participants, I did not provide the operational definitions of the study to the participants. I allowed participants to interpret the meaning of *a strategy* in her or his own way. In doing so, I was able to collect the information based on the participants' experiences and learning environment, which was not influenced by my opinion.

In addition, I reviewed the variety of documents. I collected the organizational documents from the participants HCOs. I obtained the participant HCOs' policies and procedures for the use of mobile technology and equipment. I also reviewed the local

media reports and government reports. A researcher may conduct a retrospective observational study of all available reported data breaches from the publicly available federal, state, and local government regulatory database and media reports (Ronquillo, Winterholler, Cwikla, Szymanski, & Levy, 2018). The existence of well-prepared policies and procedures reflects the quality of the service they provide (Padgett, Gossett, Mayer, Chien, & Turner, 2017). Most HCOs publish their policies and procedures in their intranet (Gehring et al., 2017). I obtained the permission to access the policies and procedures of interest from the CIO interviewees. I also visited the local library for the media reports and browsed the Internet.

I mitigated bias with member checking. Member checking is a process in which the researcher provides interviewees with the opportunity to review and confirm the analysis and results of data collected from the interview (Fusch & Ness, 2015). Vos et al. (2017) suggested that a researcher inform interviewees in the consent form that the researcher might follow up with additional questions and for member checking. Birt et al. (2016) proposed the synthesized member checking (SMC) framework for member checking. I followed the steps in SMC flowchart for member checking (see Appendix G).

Data Organization Technique

I maintained the audit trail and created the case study database which contains information on my primary and secondary data sources. Yin (2018) suggested in conducting a case study that the researchers would use a research log to record the date of the interview, interviewee's initials, personal identification (ID), organization ID, data type (i.e., transcription, reflection, audio, video, etc.) and source (i.e., interview, survey,

document, etc.). Amankwaa (2016) suggested that researchers keep a reflective journal and abide by the trustworthiness protocol (see Appendix F). In addition to the log and journal, I maintained the electronic privacy table to identify the interviewees' and participant HCOs' ID numbers.

I used a password to access the table so that only I could view the table. I stored PII in the privacy table for guarding the information. I stored the table in a locked cabinet. Because the use of smartphone can reveal the location of the interviewee (Bader, Mooney, & Rundle, 2016), I did not use a smartphone to record the interviews. I destroyed the interview recordings immediately after transcribing them. I am keeping the external hard drive and all documents related to this study in a locked cabinet that only I can access. After 5 years, I will destroy the data and documents.

Data Analysis

I had a structured approach in analysis. I utilized multiple triangulation. With multiple triangulation, researchers apply multiple methodological techniques, theories, data types, data sources, investigators, and philosophies (Joslin & Müller, 2016). Joslin and Müller (2016) presented the five levels of the hierarchical structure of triangulation, data triangulation, investigator triangulation, methodological triangulation, theory triangulation, philosophical triangulation. Hussein (2015) offered six approaches, methodological triangulation, investigator triangulation, theoretical triangulation, analysis triangulation, data triangulation, and multiple triangulation.

I first conducted the within-case analysis. I used the theoretical, analysis, and data triangulations in the within-case analysis. With theoretical triangulation, researchers use

multiple theories in the same study to support or refute findings since different theories help researchers to see the problem at hand using multiple lenses (Modell, 2015). With analysis triangulation or data analysis triangulation, researchers use more than two methods of analyzing the same set of data for validation purposes (Hussein, 2015). With data triangulation or data sources triangulation, researchers use multiple data sources in the same study for validation purposes (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). I analyzed the same phenomena with different data collection instruments—the primary data from interviews and the secondary data from the additional documents.

Next, I compared the data from at least five different cases in a cross-case analysis. In other words, I used the within-case and then cross-case analysis. I did not use investigator triangulation or philosophical triangulation. With investigator triangulation, more than two researchers analyze data (Carter et al., 2014). I could not use investigator triangulation because I am a lone researcher. Researchers may use both qualitative and quantitative analysis methods in a mixed-method study, which is called as philosophical triangulation (Hussein, 2015). I did not conduct philosophical triangulation because this study is not a mixed-method approach.

Lastly, I reviewed the organizational and government documents, media articles, Internet reports, and other literature for triangulation. Paré, Trudel, Jaana, and Kitsiou (2015) categorized literature reviews in nine types as narrative reviews, descriptive reviews, scoping reviews, qualitative systematic reviews, meta-analysis, realist reviews, umbrella reviews, theoretical reviews, and critical reviews. Haibo Yang and Tate (2012)

classified literature reviews in four types as narrative reviews, descriptive reviews, vote-counting, and meta-analysis, respectively in the qualitative-quantitative continuum from a qualitative to quantitative analysis. According to Haibo Yang and Tate, a narrative review would be too subjective, and a vote-counting and meta-analysis may not be appropriate for a qualitative study. According to Paré et al., a scoping review, qualitative systematic review, realist review, umbrella review, theoretical review, and critical review are broad and deep in the scope. A descriptive review is appropriate for my study. I used the descriptive review method for this study.

To automate and organize the process and work effectively and efficiently, researchers use qualitative data analysis software (Woolf & Silver, 2018). Researchers can streamline and organize the work with the use of the analysis techniques and computer software (Zamawe, 2015). With the minimum of five cases in my study, I conducted multiple tasks. First, I analyzed the primary data from at least five interviews of each case. Second, I analyzed the additional documents from each case. Next, I compared the primary data with the secondary data for triangulation (within-case analysis). I also compared the results of five cases (cross-case analysis). Lastly, I compared the results of the cross-case analysis to the secondary data that I will collected from the review of the national and global documents. When I reached the data saturation, I stopped gathering any more data. I reached the data saturation in the fifth case. Even though the task of analysis was lengthy, I did not need to use the software.

Coding is the fundamental analysis technique for my study. Coding means categorizing data into the form or symbol of a code (Jha, Lin, & Savoia, 2015). A code is

a word or short phrase that evokes an attribute of an item of data (Woolf & Silver, 2018). Broad coding is roughly categorizing the priori themes based on the research question or themes found within the data (Houghton, Murphy, Shaw, & Casey, 2015). With broad coding, researchers code data in a general accounting scheme that is not specific to content but point to the general domains in which the researcher can develop codes inductively (Houghton et al., 2015). For example, Jha et al. (2015) coded 2,597 Facebook posts into 19 broad categories. Explanation building, or pattern coding is creating a more meaningful analysis with explanatory, inferential codes (Houghton et al., 2015). I coded the data collected based on my research question, conceptual framework, and technological models.

A variety of analytical techniques for a case study exists, as following: broad coding, pattern coding, memos, distilling, ordering, testing executive summary statements, developing propositions, pattern matching, explanation building, time-series analysis, cross-case synthesis, etc. (Houghton et al., 2015). Pattern matching, explanation building, time-series analysis, program logic models, and cross-case synthesis are the traditional techniques for case studies (Yin, 2018). By distilling and ordering, researchers use memos to tie different pieces of data together into a recognizable group of concepts (Houghton et al., 2015). Houghton et al. (2015) also developed the additional techniques based on the logical and sequential process of data analysis of Morse (1994). These analytical processes consist of comprehending, synthesizing, theorizing, and recontextualizing. I approached the analysis process in the hierarchical order.

Pattern matching is the comparison of patterns in the data collected from two or

more sources to determine if they match or not. Researchers analyzing the data from multiple sources can reconcile the findings in case study analysis through pattern-matching technique (Almutairi, Gardner, & McCarthy, 2014). Sarker et al. (2015) found three patterns of the IoT-based business ecosystem of data collected in six cases. I used pattern matching for comparison of data with the primary and secondary sources in the within-case analysis and comparison of data from the cases in the cross-case analysis.

Because the purpose of my study was to explore the most efficient mobile technology deployment strategy for healthcare, the major task of the data analysis of my study was exploration (see Table 3). The overall purpose of exploring was to consider the inherent nature of data. The rule of the thumb in the five-level QDA method (Woolf & Silver, 2018) was to organize the units of analysis not more than two at a time. If a researcher has more than two units of analysis, the researcher should develop the analytical strategy to organize and streamline the task, as shown in Table 3. I had two units of analysis—interview transcripts and potential strategies. The task of analysis was straightforward.

Table 3

Examples of Exploring: Examining the Content and Structure of the Data

Analytic task	Units	Discussion of the rule of thumb
Read interview transcripts to identify potential concepts for coding	• Interview transcripts • Potential concepts	Two units jump out of the analytic task and conform to the rule of thumb. *Interview transcripts* are units of data, and *potential concepts* are units of meaning. Now that these have been identified as units, the types of unit are no longer relevant for continuing the translation process.

Search newspaper articles for the use of evocative terms	• Newspaper articles • Evocative terms	Two units jump out of the analytic task and conform to the rule of thumb. *Newspaper articles* are units of data, and *evocative terms* are units of meaning. Now that these have been identified as units, the types of unit are no longer relevant for continuing the translation process.
	• Videos of math lessons • Types of interactions • Students • Teachers	The analytic task has four units, twice as many as the rule of thumb suggests. We could split the analytic task into two separate tasks—*watch videos of math lessons to identify types of interaction*, which contains the first two units, and *identify types of interaction between students and teachers*, which contains the last three. To bring this second task down to two units, we could think of students and teachers as instances of a single unit—participants. Judging the wisdom if doing this comes with experience, depending on what we anticipate may come later. If students and teachers are expected to be analyzed in similar ways in future analytic tasks, considering them as instances of the single unit *participants* should be nonissue.

(table continues)

Analytic task	Units	Discussion of the rule of thumb
Watch videos of math lessons to identify types of interactions between students and teachers		However, if students and teachers are independent elements in other research questions or subquestions, then translating them as a single unit may not be the best way to go. Splitting the task may simplify transaction, but it comes at a cost. It means identifying *types of interaction* first without regard to *students* and *teachers* and then going back to identify each type in relation to *students* and *teachers*. This is both cumbersome and implies easy separation of types of interaction from the people who are interacting. It may be best to think of these two dimensions at the same time as not worry about the slightly more involved translation. Thinking in this way might give you another idea. If it is nonissue to think of students and teachers as instances of one unit—participants—then the original analytic task has only three units, not four. Maybe that is the best solution.
Review field notes to summarize athletes' body language with same- and opposite gender coaches	• Field notes • Athletes • Body language	This analytic task has three units. *Field notes* are a unit of data because this is the form in which the data are store; thus, it needs to be a unit for translation. The question is whether *athletes* and their *body language* are really two ways of expressing the same unit. This depends on context—the objectives, methodology, and analytic plan. If the study is about self-identity in professional athletics, then athletes are the main entity of interest and would be a unit of analysis. Body

(table continues)

Analytic task	Units	Discussion of the rule of thumb
		language would be another unit, a unit of meaning. However, if the study is about the meaning of different types of body language in professional athletics, then, the unit *body language* would be the main unit of analysis, and this analytic task might have only two units—*field notes* and *body language*—and the analytic task might be better expressed as *review field notes to summarize participants' body language*. Whether *athletes* would become a unit of a later analytic task is unknown at this point.

Note. Adapted from "Qualitative analysis using ATLAS.ti: The five level QDA method," by N. H. Woolf, & C. Silver, Appendix 4, p. 187. Copyright 2018 by Routledge, 711 Third Avenue, New York 10017. Modified with permission.

I had a few guiding frameworks for the analysis of the primary data. The primary conceptual theory for the analysis is Wallace and Iyer's (2017) HIT value hierarchy. HCOs must satisfy the lower tiered needs before they can strive to achieve the next level of maturity, in the order of infrastructure and connectivity needs, stability and security needs, integrated information, interorganizational integration, and paradigm shifting (Wallace & Iyer, 2017). The second guiding framework was the healthcare iron triangle. HCOs must balance between three aspects of healthcare: quality, cost, and access (L. R. Burns et al., 2012). Lastly, I relied on the model of Gajar et al. (2013) to categorize the mobile technology deployment strategies. I explored the mobile technology deployment strategies to compare what the CIOs have learned in their job.

I used the modified integrative literature review framework developed by Christmals and Gross (2017) for the document review. The original framework was

formidable, lengthy, and well-structured. For this study, I used the abbreviated version of the framework.

During the sorting process, researchers maintain a list of themes, so they can easily see which themes are available (Nevedal, Kratz, & Tate, 2016). I used the following codes: belonging, BYOD, connectivity, cybersecurity, CYOD, esteem, healthcare provider, HYOD, infrastructure, integrated information, interorganizational integration, love, m-health, mobile technology, mobile technology deployment strategy, OYOD, paradigm shifting, patient-centered care, performance, physiological needs, privacy, relationship, safety, satisfaction, security, self-actualization, staff members, stability, trust, and patients.

I used the analytical planning worksheet. Having a standard worksheet for analysis is useful for demonstrating the integrity and quality of research, for providing an audit trail, and for offering an opportunity to review the detail of earlier steps of analysis (Woolf & Silver, 2018). The analytical planning worksheet helped me organize analysis and established the audit trail (see Appendix L).

Reliability and Validity

Rigor of study means the results of the study are true and truthful. In addition to authenticity added later (Lincoln & Guba, 1985), Morse (1994) proposed the following four criteria to assess rigor of qualitative research: dependability, credibility, confirmability, and transferability. Dependability refers to how reliable the data are (Fusch & Ness, 2015). Credibility refers to whether the findings are accurate and trustworthy from the perspectives of the researcher, participants, and readers (Munn,

Porritt, Lockwood, Aromataris, & Pearson, 2014). Transferability refers to speculations on the possible applicability of the findings to other situations under similar but not identical conditions (Cope, 2014). Confirmability is a criterion for assessing the accuracy and reasonableness of the findings obtained from the data and observation of the participants (Houghton et al., 2013). Authenticity refers to the ability and extent to which the researcher expresses the feelings and emotions of the participant's experiences in a faithful manner (Cope, 2014). Establishing reliability and validity in a qualitative study is imperative for the rigor of study.

I strove to conduct a reliable qualitative multiple case study and obtain valid study results. Reliability refers to consistency within the employed analytical procedures, and validity refers to the integrity and application of the methods undertaken and the precision in which the findings accurately reflect the data (Noble & Smith, 2015). Validity is trustworthiness, and reliability is the degree to which an account is believed to be generalizable (Morse, 2015). I identified internal and external threats to the study and mechanisms to strengthen reliability. For validity, I observed the controls, protocols, and strategies I proposed in the study proposal, to alleviate the threats to the rigor of the study and ensure the integrity of the study results.

Reliability

I looked for consistency in my study results. Reliability refers to how researchers demonstrate the study dependability (Fusch & Ness, 2015). Dependability was critical during the study design phase. Qualitative researchers include the mechanisms for ensuring dependability in the design of studies to ensure the integrity of collected data

and findings (Cope, 2014; Marshall & Rossman, 2016). Some mechanisms to strengthen dependability of research are an audit trail, member checking, transcript review, pilot test, expert validation of the interview questions, and implementing a variety of protocols (Amankwaa, 2016; Marshall & Rossman, 2016). To achieve study reliability, I prepared case study, interview, and trustworthiness protocols (see Appendices C, D, and F). In addition, I prepared the activity check list for interviews (see Appendix E), flow chart and example of member checking (see Appendices G and H), and strategies to reduce bias (see Appendix I).

I used member checking to ensure study dependability. Member checking is a process in which the researcher provides interviewees with the opportunity to review and confirm the analysis and results of data collected from the interview (Fusch & Ness, 2015). Vos et al. (2017) suggested that a researcher inform interviewees, in advance, in the consent form that the researcher may follow up with additional questions and for member checking. I was particularly interested in following the Synthesized Member Checking (SMC) framework proposed by Birt et al. (2016) for member checking. I followed the flowchart of the five-step tool of the member checking process undertaken in SMC (see Appendices G and H).

Another triangulation technique for interviews is a transcription review that the interviewee reviews the transcript of the interview. However, Birt et al. (2016) posited that member checking is more reliable than a transcription review. To be efficient, I did not conduct the transcript review.

I did not conduct a pilot test. Instead, I conducted an expert validation of the

interview questions. An expert validation of the interview questions is the additional technique for reliability. Santiago-Delefosse, Gavin, Bruchez, Roux, and Stephen (2016) emphasized the importance of the expert review in their study. Santiago-Delefosse et al. used the guidance of a Delphi study of a group of 16 international experts in the health and qualitative research fields with more than 10 years of practice for the methodology of their healthcare qualitative study. Epstein, Osborne, Elsworth, Beaton, and Guillemin (2015) reported their experimental study showed the expert committee that had added value. My review committee reviewed and approved the prospectus and proposal of this study, which included the purpose of the study, problem statement, research question, interview questions, conceptual framework, and significance of the study. My doctoral study committee and the IRB also approved the proposal of this study.

I left an audit trail for reliable study results. For the study results to be dependable, a study must be duplicable (Cope, 2014). I recorded all steps and procedures while conducting my study. In addition, I documented a research journal. With an audit trail, other researchers can assess the dependability of a study by duplicating the study (Kalakech, 2016). I left the audit trail so that other researcher can duplicate my study to confirm the study results.

Lastly, I prepared various protocols to ensure reliability in my study. Researchers who apply stringent procedures during the conduct of qualitative research can gain more reliable study information (Sanjari, Bahramnezhad, Fomani, Shoghi, & Cheraghi, 2014). Researchers use protocols to ensure planning and documentation of procedures and guard against arbitrary decision-making during the research conduct (Shamseer et al., 2015).

The readers also use protocols to assess the presence of selective reporting against completed reviews, and, when the researcher made the study results publicly available, the action reduces duplication of efforts and potentially prompt collaboration (Shamseer et al., 2015). I prepared a case study protocol (see Appendix C), an interview protocol (see Appendix D), a trustworthiness protocol (see Appendix F), and member checking instruments (see Appendices G and H). Following the protocols and using the instruments, I could conduct the standardized research study and obtained trustworthy and reliable information.

Validity

I strove to have the valid results of the study. Some scholars criticized the qualitative case study methodology that case studies are subjective, anecdotal, subject to researcher bias, and lacking generalizability by producing a quantity of detailed information about a single, and unique phenomenon or setting (Cope, 2014; Noble & Smith, 2015). Therefore, researchers conducting qualitative research must ensure validity of the study. Validity in qualitative research means appropriateness of the tools, processes, and data. (Leung, 2015). Validity appertains how researchers will address credibility, transferability, confirmability, and authenticity for true values (Cope, 2014; Noble & Smith, 2015).

One aspect of validity is credibility. Failure to reach data saturation has a negative impact on the credibility (Fusch & Ness, 2015). Techniques for achieving credibility are triangulation, bracketing, and other strategies to reduce bias (Hussein, 2015). Member checking, a verification of research findings with participants, is also the tool for

credibility (Fusch & Ness, 2015). For research procedures, data, and results to be credible, researchers must reduce bias. Noble and Smith (2015) advised some strategies to reduce bias (see Appendix I). I used the techniques to mitigate bias.

For the transferability, researchers must provide sufficient information on the interviewees and the research context while keeping the interviewee's confidentiality. The criterion of transferability depends on the aim of the qualitative study and is only relevant if the intent of the research is to generalize about the subject or phenomenon (Cope, 2014), which is closely related to the scope of the study and boundaries of the results (O'Brien, Harris, Beckman, Reed, & Cook, 2014). I am studying a phenomenon in a few cases, exploring the effective mobile technology deployment strategy in healthcare. Therefore, I am concerned with the transferability of my study, which has only a few cases that are hard to generalize.

Another aspect of validity is confirmability. A researcher demonstrates confirmability by describing how the researcher establishes conclusions and interpretations and exemplifying the findings the researcher derives directly from the data (Cope, 2014). The techniques which researchers can utilize in qualitative studies for confirmability are prolonged engagement in the field, peer debriefing, negative case analysis, reflexivity, thick description, member checking, and complexity of analysis (Hays, Wood, Dahl, & Kirk□Jenkins, 2016).

Prolonged engagement in analysis involves simultaneous or close sequencing of data collection and analysis to allow for immediate analysis of information from a data source and use of that analysis to guide the collection of additional information from the

same or other data sources (Hays et al., 2016). Peer debriefing is the briefing of the data collection and analysis processes to the scholarly colleagues to ensure validity of the study results. I conducted the peer debriefing in the Walden University doctorate completion courses. Negative case analysis is the refinement of a developing theme by actively attempting to disconfirm findings for a sample (Hays et al., 2016). I conducted member checking right after I completed the within-case analyses. I also used the peer debriefing as the opportunity for negative analysis. I presented the reflexivity, thick description, and complexity of analysis in the presentation of the findings in the final section.

I reported the study results with authenticity. To achieve study authenticity, researchers must report the feelings and emotions of the participants' experiences faithfully to grasp the essence of the experience through the participant quotes (Cope, 2014). In qualitative research, researchers need to determine not only the existence and accessibility of the research design and its various data collection strategies but also its authenticity and usefulness (Brooks & Normore, 2015). The authenticity standards for rigor in qualitative research includes responsiveness, reflexivity, purposeful sampling, rich description, triangulation, transparency, and transferability (Cook, Kuper, Hatala, & Ginsburg, 2016). First, I analyzed the primary and secondary data in depth. I searched the interview data deeply and widely for a true meaning. Second, I reported the study results as a first person to provided rich descriptions. I often cited direct quotations from the primary data. These activities enhanced the authentication of my study.

I collected data from narrow and focused samples. According to Etikan et al.

(2016), a researcher can achieve a balance between increasing inference quality/trustworthiness (internal validity) and generalizability/transferability (external validity), by having a narrow and focused purposeful sampling. The essence of purposeful sampling is to select information-rich cases for the most effective use of limited resources (Duan, Bhaumik, Palinkas, & Hoagwood, 2015). The convergence of multiple triangulation with the use of a homogenous but purposeful sampling helped the validity of my study.

Lastly, I ensured data saturation to further demonstrate study validity. Data saturation is to continue purposeful, iterative data collection and analysis until additional observations do not suggest new themes (Cook, Kuper, et al., 2016). A direct link exists between triangulation and data saturation (Fusch & Ness, 2015). Triangulation is a method to achieve data saturation. In practice, the sufficient rather than complete saturation is the goal (Cook, Kuper, et al., 2016). I used a variety of triangulation techniques during the data collection and analysis phases. I collected the interview data from the academic, health industry, and government documents for data saturation.

I ensured validity in my study. To meet the goal, I used a variety of techniques to meet credibility, confirmability, transferability, and authenticity—preparing the prospectus; conducting the literature review based on the conceptual frameworks; presenting the ethical research training certificate; presenting my personal, academic, and professional background and experience; conducting member-checking, triangulation of data with the use of secondary data sources and multiple cases, and data saturation by interviewing CIOs and HIT consultants until I did not find new data; and utilizing the

data collection frameworks and protocols. In the final section of this report, I presented the descriptive study results with direct quotes from interviews. I also left an audit trail.

Summary and Transition

The purpose of this qualitative multiple case study was to explore the strategies healthcare CIOs use to deploy mobile technology effectively. The study population consisted of five healthcare CIOs and HIT consultants in the United States who deployed mobile technology in their organization that benefited the healthcare providers, staff members, and patients. Section 3 consists of the report of findings, recommendations, reflections, and conclusion.

Section 3: Application to Professional Practice and Implications for Change

Introduction

In Section 3, I present the results obtained from the study. The BYOD strategy is popular in sales, marketing, and education settings because the strategy provides the affordable alternative to the traditional mobile device deployment strategy. The strategy can reduce the cost for employers because the equipment is owned by the employees. I conducted this qualitative, multiple case study to explore the strategies healthcare CIOs used in deploying mobile technology effectively and reducing costs. A highly effective company needs to use resources in an efficient way. According to Wallace and Iyer's (2017) HIT value hierarchy, organizations must satisfy lower-stage needs before they can achieve the next stage of maturity. Mature HCOs provide not only basic services but also the highest stage of technology need—paradigm shifting. In this stage, the IT team seeks a paradigm shift in technology, such as disruptive technology, tele-health, m-health (Wallace & Iyer, 2017), and blockchain (M. Gupta, 2018). Using the mobile technology in healthcare became the paradigm of the old days. The new paradigm in the HIT is to utilize blockchain, the Hyperledger system, in cybersecurity. I did not find any evidences of paradigm shifting in the interviews with three healthcare CIOs. In contrast, two HIT consultants I interviewed experienced paradigm shifting in the HCO they served. Not all HCOs in the United States arrived at the highest mature level.

HCOs need to continuously change the way they conduct business. With paradigm shifting, mature HCOs enable their social network to promote healthy behaviors and awareness among patients involved in the network and communities (Silva

et al., 2015). In my investigation of the HIT maturity of the HCOs in the United States regarding the use of mobile technology, I found that most HCOs in the United States were in the stage of interorganizational integration, falling short of the stage of paradigm shifting. In contrast, the IT industry and HIT consultants were leading the U.S. healthcare industry for paradigm shifting.

Presentation of the Findings

The overarching research question for this study was as follows: What strategies do healthcare CIOs use to deploy mobile technology effectively? I conducted this study to help HIT leaders develop more sustainable strategies to implement mobile technology successfully, thereby benefitting from the process and systems efficiency that IT brings to a business. Based on in-depth interviews and ancillary documents, the study consisted of identifying strategies healthcare leaders use to implement mobile technology successfully. I used a purposive, convenient sample of five HIT leaders in the United States who had successfully implemented mobile technology. The participants consisted of three CIOs and two HIT consultants.

I conducted five semistructured interviews. Participant P1 was a senior vice president and CIO of an integrated health network (IHN) located in the capital of a state. Participant P2, a certified professional in healthcare information and management systems, was a HIT consultant covering Wyoming and Montana, who specialized in EHR. She was a nurse informatics specialist. Participant P3 was a CISO. He was working in a midsize government HCO in the northcentral United States. P3 managed cybersecurity for his organization in a large city in the rural area of the northcentral

United States, providing technical support for the executive group and educating the staff for cybersecurity. Participant P4 was an HIT consultant for several HCOs in a metropolitan area in the Houston metropolitan area. He had been in the industry for more than a decade. P5 was a CNIO of a large HCO in the Minneapolis metropolitan area. She managed several projects, including a mobile technology deployment. She recently presented her experience at a HIMSS conference.

The interviews were semistructured to ensure that the critical issues of interest were covered with each participant while allowing flexibility to probe the details and enabling participants to contribute any other relevant information. I asked questions aimed at determining the strategies healthcare leaders used in implementing mobile technology. I had planned to interview at least five HIT leaders in the United States. I completed five interviews with the questions straightforward and understandable to the participants to assure the alignment of the study and research instrument with the experience of the healthcare leaders. After completion of the data collection, I used the key topics from the interview protocol to manually code the data, organized by key themes relevant to the main research questions of the study.

I did not find any additional information in the interview with P5. At this point, I was confident that I was at the data saturation point. I followed up with all participants with additional questions to confirm data saturation and to conduct member checking. All participants agreed that the meaning of what they stated was the analysis I presented to them during the member checking process.

Regarding Wallace and Iyer's (2017) HIT hierarchy, I concluded the HCOs of P1 and P5 achieved the maturity of integrated information. The HCO of P3 was in the maturity of integrated information stage. The HIT consultants P2 and P4 experienced all levels of maturity in their client organizations. All participants were aware of the importance of project management skills in quality improvement and its application of the theories for the success of a project. They were all struggling to overcome impediments in collaborating with other organizations and governments. I also found the evidence of a shortfall in cybersecurity. Two CIOs and a CISO relied heavily on workstations, servers, and clouds, but they did not use mobile cloud computing systems in their organizations nor did they closely follow recently issued laws, regulations, or new technology in cybersecurity.

The themes that emerged from the study included the application of disruptive technology in healthcare, the ownership and management of mobile health equipment, and cybersecurity. Although participants came from five different hospitals and consulting companies with different business models, common themes were recognizable early in the interviews. In all the interviews, participants emphasized the use of disruptive technology in healthcare, the ownership and management of mobile health equipment, and cybersecurity. I identified these as the major themes emerging from the study.

Theme 1: Application of Disruptive Technology in Healthcare

The first theme that emerged from this study was the application of disruptive technology in healthcare. Use of disruptive technology was the paradigm shifting in healthcare. P1 experienced increased requests from the executives to have a smartphone

when he took his position seven years ago. P1 had felt that the change was coming. P1 observed that the CNIO of his organization was leading the changes in his organization. P1 acknowledged that he was noticing paradigm shifting in the leadership in his organization and emphasized the importance of utilizing the skills of change management to realize the shift, improving the ability provide the best services to his customers—the executives, physicians, staff, and patients. P1 noted that Vocera was leading the healthcare industry for better communication with disruptive technology. "Since 2000, Vocera has been developing solutions that effectively solve healthcare communication and workflow challenges," P1 added. The use of disruptive technology in healthcare was a collective experience to healthcare CIOs.

I collected and reviewed the organizational documents from the company website for a within-case analysis to confirm the information I obtained in the interview. P1 managed HCO1, an IHN consisting of six primary-care hospitals, allied clinics, and outpatient facilities—the second-largest health system in the metropolitan area. According to the internal documentation, P1 was accountable for the strategic direction and integration of information system, serving to empower the organization, aiming clinical quality, patient safety, excellence in patient experience, physician alignment, and cost-effectiveness. The HCO was pursuing positive changes in healthcare in the region. The HCO strived to develop paradigm shifting and were rapidly responding to the needs of the community.

Most CIOs I interviewed provide the health mobile app to their patients for finding and scheduling an appointment, viewing health records, messaging the doctors,

and others. HCO1 announced in the company website, “Everything you need to take charge of your health, now in one place.” HCO1 also provided online visits using mobile devices. Their slogan was, “Tab into trusted care, from your computer or mobile device – without seeing a provider live. Simply answer questions online and stay put.”

P2 successfully installed mobile EHRs in the local hospitals and for physicians in the region “about 10 years ago.” She “helped the regional healthcare providers implement e-prescribing in the mobile networks.” With the EHR app with e-prescribing in their smartphone, the providers could provide prescriptions efficiently in any place. P2 stated, “I am continuously seeking a new technology to assist my clients in taking the advantage for their patients.“

The HIT consulting company which P2 was a member of was driving EMR incentives for the physician’s offices and clinics in the region. The mission of the HIT consulting company was to provide education, outreach, and technical assistance necessary to help providers in the region improve their quality of care by attaining or exceeding meaningful use of EHR systems. Because of the sheer number of vendors and the complexity of choices available, choosing a suitable EHR software is a daunting and time-consuming task. The HIT consulting company stated on their website they were “playing a crucial role in guiding physicians through the selection and implementation process for the EHR software the physicians have purchased.” However, the news posted on their website was behind. The last news updated was on October 1, 2014.

P3 stated that his organization just started to experiment with mobile technology on the nursing floors at the national level. He was a CISO of the regional hospital of the

federal government. He did not have much knowledge about what was going on at the national level.

The central office website of the organization of P3 provided plenty of evidence for their support for technical advancement. Within the website, the HCO announced that the organization was undertaking another major transformation aimed at creating a comprehensive array of interlinked, technologically advanced services centered on patients' needs and preferences, with their nation-wide infrastructure of primary care practices serving as the hub. They admitted that the earlier reorganization attempts were unsuccessful. They contended that the attempt was a natural experiment in providing access to specialty and hospital care, but not to primary care, because federal regulations prohibited the system from delivering primary care. They assessed the current, rapid bottom-up and top-down reorganization of the government system to correct these problems was disruptive but highly productive.

P4 stated that his business strategy is to provide effective and affordable solutions to his clients to compete with other bigger HIT consulting companies out there. He stated, "The mobile technology is great for healthcare." P4 agreed that mobile technology could be a disruptive technology for the healthcare industry. The within case analysis of their financial records showed their aggressive marketing strategy and fast growing in the field.

P5 actively engaged in modifying and upgrading the HCO's mobile network. P5 articulated, "I installed the mobile technology in my hospital in 2012 for the first time. Since then, I upgraded infrastructure in [*sic*] a few times already." P5 continued, "We just

contracted with Verizon for their 4G services and upgraded all iPhones. “We also use AWS,” P5 stated. AWS is the cloud service provided by Amazon Web Services (2019). According to their internal document, nurses are using tablets for interviewing and getting signatures of patients on the online consent form before surgery.

All healthcare CIOs I interviewed believed that they were innovative, closely collaborating with the executive leaders, and attentively listening to the customers of their HCOs. However, the secondary data I collected for the cross-case analysis showed otherwise. In the assessment of the skills and experience of the CIOs and HIT consultants, I felt the participants were somewhat lagging in advanced technology. The large size hospitals and IHNs were utilizing disruptive technology, such as mobile technology and tele-health, but smaller HCOs seemed to struggle to advance. The disruptive technology is continuously changing in the market. To remain current, the HIT leaders must invest their time and resources to do more. In addition, the strict government regulations and the third-party reimbursement systems can retard the advancement even further.

Theme 2: BYOD and Equipment Ownership and Management

The second theme that emerged from this study was how CIOs manage the ownership of mobile equipment. The HYOD strategy includes an emphasis on the ownership of the equipment belonging to HCOs. BYOD is the opposite; the users have the ownership of the equipment and manage the equipment. HYOD and BYOD are two different management strategies. Many CIOs were deploying both strategies by differentiating users.

P1 categorized four types of users, “executives, physicians, staff, and patients.” The primary reason to use mobile technology was “to boost communication.” That was “especially a true for the executives.” However, the executives “used the company issued equipment, not their own.” In contrast, P1 stated, “Physicians prefer to use their phone because of the convenience of using the phone as the dual purpose, in the hospital and their office.” P1 also stated, “The staff, such as nurses, midlevel managers, and administrators do not like to use their smartphone at work.” Therefore, he was deploying the HYOD strategy for executives and staff and BYOD for physicians and patients.

The investigation of the internal documents showed the use of variety strategies in the organization. P1 and his CISO developed the policies and procedures for mobile equipment use of each user group. The CIO and CISO particularly emphasized the importance of education and training of the staff. They required the patients and visitors to accept the terms of use and information disclosure consent before the use of their wireless network. They provided training to all employees annually without exception. The BYOD strategy was not allowed for the staff.

Participant P2 described the challenges she encountered related to the ownership management. In the phone interview, P2 stated:

> The device-related decisions and challenges faced including device and accessory selection, integration, information and device security, infection control, user access, and ongoing operation and maintenance for an m-health project were challenges for us, but we overcame those roadblocks with our teamwork.

To my question about the mobile technology deployment strategies, P2 stated, "The individual practitioners want the BYOD setting." P2 also reported, "A BYOD strategy should improve accessibility. With a BYOD strategy, providers can use m-health apps that serve to engage patients in understanding and managing their care during recovery and after leaving the hospital".

According to the secondary data I collected from the website of the HIT consulting company, most of their clients were individual physicians and small clinics with a private practice. The physicians were self-employed, and they were using their own devices for their business anyway. The BYOD strategy was the major mobile technology deploying strategy for P2.

P3 stated, "Physicians and patients want to use their equipment." P3 continued, "The executives expect the hospital to issue the equipment for them. At the same time, they also want the IT department to manage the settings." That was an HYOD strategy. An HYOD strategy costs more for employers. Therefore, the HCO limited the issue of mobile equipment to privileged employees.

In the internal document review, I found that no policies or procedures existed for the BYOD strategy. As a government organization, the HCO strictly prohibited their employees from bringing their equipment to work. However, the HCO was allowing the patients and visitors to have a limited access to the infrastructure through the wireless network. The maximum time allowance was 30 minutes. They did not allow the inpatients to bring their equipment. The inpatients shared online equipment on the floor.

P4 reported, “I deployed BYOD equipment for patients and physicians in my client organizations.” P4 also stated, “The BYOD strategy is the choice for physicians and patients. However, administrators and nurses use desktop computers for communication and workflow automation rather than mobile equipment.” P4 explained the reason, “They do not like to spend money to purchase their equipment used at work.”

In the review of the project management documents for mobile technology of the HIT consulting company, I found P4 used a variety of mobile technology deployment strategies. However, most of the strategies were HYOD, especially for the administrators and staff. Most of his client HCOs allowed physicians to bring their own devices in limited cases. The HCOs allowed their patients to have BYOD.

P5 discussed in the interview about the experience using the BYOD strategy. “We use BYOD sparingly,” P5 affirmed. “We do not use BYOD for all mobile systems, but we allow our patients to access the Internet with their smartphone,” P5 stated. P5 added, “We also let our privileged physicians use their phone to connect to our infrastructure.” P5 stated, “We do not issue smartphones to nurses nor allow them to bring their own to the floor. They use computers on the wheel from a room to a room. A computer on the wheel is mobile enough for them.”

I confirmed the information with the internal documents. The HCO of P5 documented the BYOD strategy and the related policies and procedures. The CIO and CISO prepared the training materials for the employees and integrated the documents to the policies and procedures for m-health and tele-health.

According to my cross-case analysis, most HCOs used the HYOD strategy for

administrators and staff. HCOs used the BYOD strategy for providers, patients, and visitors. For providers' equipment, most HCOs allowed the equipment wirelessly connected to their infrastructure. According to Ventola (2014), the use of mobile devices by healthcare professionals was common in healthcare settings. White (2016) reported the most common staff members who were permitted to use their own mobile devices for work were physicians (89% of HCOs surveyed), administrators (75%), IT staff (66%), and nurses (50%). Healthcare providers used a variety of mobile devices, such as handheld computers, tablets, cordless barcode scanners, and mobile printers (Landi, 2018). Ninety percent of 600 healthcare IT decision-makers surveyed said their HCO had implemented or would implement a mobile device initiative (Holloway, 2018). Healthcare CIOs needed to work on the heterogeneous environment. CIOs provided HYOD to the privileged employees, and BYOD to the patients, families, and guests but did not allow mobile equipment to staff.

CIOs did not have one solution fit to all. For the maximum integrated information and interorganizational integration, CIOs differentiated the users. However, this mix-and-match approach was reactive to the situation, not proactive. To be in the highest maturity of paradigm shifting, CIOs must continuously search for solutions. Healthcare CIOs should invest in research and development to be more innovative and to achieve the highest maturity stage of paradigm shifting.

Theme 3: Cybersecurity

Cybersecurity vulnerability of BYOD. The third theme that emerged from this study was cybersecurity. In this study, I explored whether any paradigm shifting occurs

in the healthcare industry. In the interviews, most CIOs were concerned with the vulnerability of the BYOD strategy. P1 explained why he did not deploy the BYOD strategy for the nurses. “I do not want to deploy the BYOD strategy for nurses because of the requirement of stringent cybersecurity measurements,” he explained. P2 affirmed that she had been cautiously moving in the arena of the BYOD for healthcare. She stated she understood the cybersecurity vulnerability of mobile technology. In using a BYOD strategy, she was searching for an advanced technology fortify the cybersecurity, such as blockchain. She understood the cybersecurity vulnerability of BYOD. P3 stated, “I do not recommend deploying the BYOD strategy in a healthcare setting due to its security risk.” P4 agreed, “We are very much concerned with all kinds of the hacking activities currently going on in the healthcare industry.” P5 stated that BYOD is mandatory for patient-centric care. However, P5 also stated that she was aware of the security vulnerability of the BYOD strategy. “We use the BYOD scheme sparingly because of the demand from our customers. The use of a BYOD scheme is not avoidable. Hence, we implemented a very strict user policy and provides great care for cybersecurity,” P5 voiced the concern.

The CIOs and HIT consultants considered mobile technology to be vulnerable to cyberattack. In the within-case analysis, however, I found no issues related to the vulnerability in the internal documentation. The HCOs which deployed the BYOD strategy all had the policies and procedures in place.

Paradigm shifting in cybersecurity. In the final stage of analysis, I reviewed the organizational and government documents, media articles, Internet reports, and other

literature for triangulation. In the process, I searched for any paradigm shifting in the healthcare industry. As a result, I found that paradigm shifting occurs in cybersecurity. Spremić and Šimunic (2018) discussed the technological paradigm shifting from information security to cybersecurity. Spremić and Šimunic posited that, in the era of information security, it was enough to conduct necessary protection from common attacks, but, in the era of cybersecurity, organizations needed to implement smart, innovative and efficient controls to detect and prevent advanced and emerging cyberattacks. Spremić and Šimunic called the need for smart, innovative, and efficient, the highest executive-level controls. blockchain is the technology of the paradigm shifting in cybersecurity. The U.S. federal government is leading the industry with healthcare cybersecurity laws and regulations.

Some cybersecurity experts were exploring the possibility of utilizing the underlying ledger system of Bitcoin for cybersecurity. HIMSS announced its opening of the online library for blockchain (Health Information Management and Systems Society, 2019). HIMSS also offered several sessions in the HIMSS19 conference first time. M. Gupta (2018) recognized the key benefits of blockchain as following: (a) time savings, (b) cost savings, (c) tighter security, (d) enhanced privacy, (e) improved auditability, and (f) increased efficiency. Not like the hierarchical, transactional, MUMPS-based databases, such as VistA (Kuzmak et al., 2018) and other databases used in the healthcare and bank industries, blockchain is superior in cybersecurity. I posit that blockchain technology has the potential for a significant paradigm shifting in HIT and cybersecurity.

The U.S. Department of Health and Human Services leading the healthcare industry for cybersecurity. The U.S. Congress passed the Cybersecurity Act of 2015 to direct HHS to regulate the industry for cybersecurity. HHS published the cybersecurity guideline for the healthcare industry in 2018 (U.S. Department of Health & Human Services, 2018d; SANS Institute, 2019; BNP Media, 2019). The industry-led guideline would be cost-effective. The guideline covers the range of HCOs at every size and resources level that can be used to reduce cybersecurity risks (U.S. Department of Health & Human Services, 2018c) to ensure the confidentiality, integrity, and availability of online health records (Shin, 2017).

To investigate if the CIOs and HIT consultants were aware of the paradigm shifting in healthcare cybersecurity, I asked the follow-up question to all participants. The follow-up question was whether any participants were aware of the use of blockchain in healthcare and of the Cybersecurity Act of 2015. “No, what is it?” was the response from P1. P2 jubilantly answered, “Didn’t I already say that I attended the blockchain forum in HIMSS17? You should know my answer!” P2 and P4 knew about blockchain and the Cybersecurity Act. P3 stated that he was not aware of any of the information. P5 knew about blockchain but not about the Cybersecurity Act. I provided the information if they answered they did not know. In the subsequent follow-up, they all stated that the use of blockchain would be beneficial to HCOs. They welcomed the additional information about the Cybersecurity Act. With the strict application of the guideline and the advancement of technology, HCOs should be able to securely deploy the BYOD strategy. With the paradigm shifting, HCOs can achieve the highest maturity stage in HIT.

Applications to Professional Practice

According to Wallace and Iyer (2017), an HCO grows incrementally from the early stage of needs of infrastructure and connectivity to the stage of stability and security needs, integrated information, interorganizational integration, and paradigm shifting. Most HCOs remain in the stage of integrated information, but a few are in the stage of interorganizational integration, rarely in the highest maturity stage of paradigm shifting. To achieve the highest maturity, healthcare CIOs must work hard in the several battle fronts. To support healthcare CIOs, business administration practitioners should conduct evidence-based studies and disseminate the learned knowledge and wisdom in the maximum extension.

Healthcare CIOs, HIT consultants, and IT technicians must update their skills to support their HCOs' HIT maturity. According to Wallace and Iyer (2017), mature HCOs provide not only bare minimum services but also the highest stage of technology need—paradigm shifting. In this stage, the IT team seeks a paradigm shifting in technology (Wallace & Iyer, 2017), such as disruptive technology, tele-health, m-health, and application of blockchain or others in cybersecurity. Many large HCOs in the United States have been growing to the lower stage—interorganizational integration. To reduce cost, to increase quality, and for better access to care, many hospitals and healthcare clinics merged to a mega healthcare organization—IHN. To grow further to the highest maturity, all IHNs need to turn their attention to research and development.

The U.S. federal government, many governments of affluent countries in Europe and Australia, and the IT industry are providing vast resources for growth and maturity

for healthcare. HHS provides tools for cybersecurity. NIH is sponsoring many studies in m-health. Professional associations, societies, academic organizations, such as HIMSS and SANS, provide opportunities for discussions, education, research, and training. The open source movement offers many economical alternatives. IHNs need to take advantage of these offerings. Healthcare CIOs must take the lead. In the process, change management is essential. Healthcare CIOs, HIT consultants, and technicians are change agents. New ideas and development must be spread quickly in the field.

Implications for Social Change

Many HCOs in the United States, Europe, and Australia lead the industry by proactively seeking the way to provide patient-centered care. IHNs provide a vast number of tools that enabled their providers to provide quality care. Nevertheless, most HCOs have been reactive, not proactive in adopting advanced technology. By applying new technology, HCOs can provide quality care to their patients, reduce cost, and resolve the issues of access to care. The mature HCOs with paradigm shifting can bring social changes for better healthcare services.

The iron triangle—the triangle of cost, quality, and access to healthcare—is a challenge to HCOs (Myers & Twigg, 2017). HCOs should use disruptive technology, such as smartphones, RFID, tele-health systems to resolve the issue of the healthcare iron triangle (Cheng et al., 2017) and apply blockchain or other cybersecurity measurements for cybersecurity. With paradigm shifting, HCOs can bring social changes. With disruptive technology, HCOs can enable their providers to offer more affordable healthcare service, of higher quality, and more accessible to patients (Myers & Twigg,

2017). With the identification of the most effective mobile technology deploying strategy and cybersecurity, healthcare CIOs can provide the additional mode of communication supportive to enhanced care, safety, peace of mind, convenience, and ease of access.

Recommendations for Action

Healthcare CIOs, HIT consultants, and IT technicians must update their skills to support their HCOs' HIT maturity. Healthcare CIOs must take the lead. In the process, change management is essential. New ideas and development must be spread quickly in the field. Hence, I recommend healthcare CIOs learn and disseminate the advanced technology information and knowledge through reviewing the research literature, attending conferences and training, and implementing new technology immediately.

Many technical writers use weblogs (blogs) as a vehicle to disseminate advanced technology. The professionals in the field should utilize blogs, white papers, case studies, conferences, seminars, and training opportunities provided by professional organizations, such as HIMSS, SANS, CompTIA, IEEE, ISSA, to learn new skills. Healthcare CIOs and CISOs should run the HCO infrastructure conservatively and trained the administrator, staff, and providers appropriately. HIT consultants disseminate new knowledge and wisdom to lead HCOs to a new paradigm.

Recommendations for Further Research

By exploring the current strategies that healthcare CIOs use in deploying mobile technology, I was able to assess the current state of m-health. In this study, I identified a lag in the implementation of advanced technology in healthcare, especially cybersecurity for mobile technology. The healthcare industry must focus on research, development, and

training to remain current. For stimulation of research and development, I recommend further research on the application and implementation of the technologies already developed and apply to healthcare. Ongoing studies in project management and quality improvement for healthcare are essential.

This study results showed healthcare CIOs were unwilling to accept the BYOD strategy even with its cost effectiveness due to its perceptual vulnerability in cybersecurity. In contrast, many studies for enterprises and educational settings showed otherwise (Keyes, 2014), even with the cybersecurity vulnerability. Therefore, I recommend other scholars conduct additional studies to validate the results of this study.

I reviewed the survey studies sponsored by WHO (2011) and HIMSS (2016). I found many studies, both qualitative and quantitative, on BYOD in educational settings. I also extensively reviewed the literature on information technology and cybersecurity, searching the new way of protecting patient information and privacy. Engineers and cybersecurity specialists have experimented with many technologies and systems to advance cybersecurity. I recommend more active literature reviews in new technology and cybersecurity by HIT scholars to adopt new ideas to bring paradigm shifting to the healthcare industry. By reviewing the literature, the business practitioners in HIT can lead HCOs in making positive changes.

Reflections

Over years of my full-time academic doctoral study, I learned a great deal about the research process. I viewed the phenomena with my own lens. Thus, I might have introduced bias from the preconceived values and ideas that I had developed through my

previous experience. In contrast to my younger years of academic and professional career, my view now becomes broader because I conducted this qualitative multiple case study.

I became purpose-oriented and holistic. I was able to remove some obvious bias through objective observation, delimiting the perception that I gained, and implementing and observing controls, protocols, and strategies—such as member checking, triangulation, studying multiple cases, expert validation, audit trail, peer debriefing, thick description, data saturation, and others. I have grown to view the world more holistically.

Conclusion

In Section 3, I presented the study findings, applications to the professional practice in HIT, implications for social changes, recommendations for action, recommendations for further research, and reflections. Ineffective deployment of mobile technology jeopardizes healthcare quality, cost, and access, resulting in healthcare organizations losing both customers and revenue. In this qualitative multiple case study, I explored the strategies that CIOs use for the effective deployment of mobile technology in a healthcare organization. The conceptual framework that grounded the study was Wallace and Iyer's (2017) HIT value hierarchy. The implications for social change include the potential for CIOs to deploy mobile technology effectively to benefit healthcare providers, staff, and patients in providing enhanced care, safety, peace of mind, convenience, and ease of access, utilizing the most secure mobile equipment deployment strategy. The themes that emerged from the study include the application of

disruptive technology in healthcare, the ownership and management of mobile health equipment, and cybersecurity.

Many HCOs in the United States, Europe, and Australia lead the industry by proactively seeking the way to provide patient-centered care. IHNs provide a vast number of tools, enabling their providers for quality care. Nevertheless, most HCOs have been reactive, not proactive in adopting advanced technology. By applying new technology, HCOs can provide quality care to their patients, reduce cost, and resolve the issues of access to care. The mature HCOs with paradigm shifting can bring positive social changes for better healthcare services.

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Appendix A: Template Version of the Cell Phone Use Policy

Purpose

The purpose of this policy is to promote a safe and productive work environment and increase public safety. This policy applies to both incoming and outgoing cellular calls.

Scope

This policy applies to all employees.

Policy and Procedure

1. Cell phones shall be turned off or set to silent or vibrate mode during meetings, conferences and other locations where incoming calls may disrupt normal workflow.

2. Employees may carry and use personal phones while at work on sporadic basis. If employee use of personal cell phone causes disruptions or loss in productivity, the employee may become subject to disciplinary action per company policy.

- Department managers reserve the right to request that the employee provide cell phone bills and usage reports for calls made during the working hours of that employee to determine if use is excessive.

3. Personal cell phone shall be used for company business on a sporadic basis, the employs may be reimbursed for the incoming calls to their personal cell phones. Employees shall not be reimbursed for outgoing calls made from their cell phones unless prior authorization is obtained from their immediate supervisor.

- If an employee is operating a company vehicle and receiveds a call on a cell phone, the employee may answer, but shall ask the caller to hold, put the phone down and pull to the side of the roadway, into parking lot or other safe location to respond to the call. Failure to follow the policy result in disciplinary action up to and including termination.

.

Adapted from "Cell Phone Use Policy," retrieved from https://www.shrm.org/resourcesandtools/tools-and-samples/policies/pages/cms_015089.aspx by Society for Human Resource Management. Modified with permission.

Appendix B: E-mail Invitation to Prospective Interviewees

Good morning, _____.

As I mentioned in my LinkedIn message, I am sending you an invitation to my study. I am a Doctor of Business Administration (DBA) candidate at Walden University and conducting research to complete my DBA degree. With the Internet of Things (IoT) healthcare market expected to reach $117 billion by 2020, the rapid adoption of m-health by healthcare professionals poses crucial challenges for clinicians, users, and policymakers. Ineffective deployment of mobile technology jeopardizes healthcare quality, cost, and access, resulting in losing customers and revenue. For instance, Cook County hospitals in Illinois lost roughly $165 million in revenue over the past 3 years because of ineffective use of information systems and mobile technology. Do you know that more than 90% of physicians reporting using mobile devices to enhance their work efficiency? Currently, the use of Internet is the prevailing mode for entertainment.

Health organizations must meet patients, providers, and employees' needs to sustain the business by increase job satisfaction and quality patient-centered care. Health organizations are losing their clients and, therefore, revenue, due to ineffective deployments of mobile technology systems. Nevertheless, some CIOs lack strategies for deploying mobile technology systems that benefits healthcare providers, staff members, and patients.

I heard your organization's reputation on successful deployment of mobile technology. I am looking for interviewees of chief information technology, informatics, or information security officers and consultants who knows about the successful

implementation of mobile technology in their or client organization. I thought you are one of the knowledgeable professionals. If you meet the criteria and agree to be in my study, please contact me via e-mail at won.song@waldenu.edu or by phone at (240) 899-0319. You can decide if you would rather I interview you in person, in a video - conference, or by phone. I will schedule an appointment convenient for you, respecting your busy schedule. The interview should last no more than 30 to 60 minutes and the follow-up e-mail communication of no more than another 30 to 60 minutes.

I hope you will participate in this important study. Attached is the consent form you will sign before the interview.

Cordially yours,

Won Song

Appendix C: Case Study Protocol

A. Case Study Introduction

1. Research Question

    a. What strategies do CIOs use to deploy mobile technology effectively?

2. Conceptual Framework

    a. Wallace and Iyer's HIT value hierarchy (2017)

B. Protocol Purpose and Intended Use

1. Use the protocol for guiding myself with the study data collection, analysis, findings and conclusion preparation of case study methods, findings, and conclusions

2. Use the protocol to ensure dependability of case study methods, findings, and conclusions

C. Data Collection Procedures

1. Data to be collected from the review of organizational documents, on-site observations and the conduct semistructured interviews with the CIOs and HIT consultants

2. Recruit healthcare CIOs for primary data in the United States that have successfully implemented mobile technology

3. Specific study sites and contact persons at each site to be identified whenever the person is contacted or the response is received, for an audit trail

4. Expect preparation activities before site visits to conduct interviews

D. Case Study Interview Questions

1. What strategies do you use to deploy mobile technology effectively?
2. Why do you use these strategies?
3. What strategies were unsuccessful in deploying mobile technology effectively?
4. What barriers have you encountered during and following your use of these strategies to deploy mobile technology effectively?
5. How have you overcome these barriers?
6. What additional observations would you like to share about strategies to deploy mobile technology effectively?

Appendix D: Interview Protocol

A. Research Question

a. What strategies do CIOs use to deploy mobile technology effectively?

B. Protocol Purpose and Intended Use

a. To use the protocol to guide myself for data collection for interviews of the CIOs

C. Interview Procedures

a. Observations will only be done at the time of the interview process if and only if conducted at the HCO site of the interview participants and only if the interview participant has the authority to permit the observation and only if permitted the observation. Only a written permission is allowed

b. On entering the HCO site, note any artifacts related to health information and mobile technology

c. Comment on the activity and emotional/affective atmosphere (e.g. energy, exciteent, engagement, boredom, irritation, indifference) on the workstations.

d. Comment on what seems to be the most important things happening or not happening at the workplace

e. During the interview, Observe and document facial expressions and mannerisms of the interviewee

f. Immediately after completing the interview, Document and summarize all observations in a case study journal

Table D

Interview Script

Script prior to interview [This script is for healthcare CIOs. For HIT consultants, the script will be adjusted accordingly]:
I'd like to thank you once again for being willing to participate in the interview of my study. As I mentioned to you before, my study seeks to understand what strategies CIOs use to deploy mobile technology effectively. The purpose of this study is to explore the strategies healthcare CIOs use to deploy mobile technology effectively. Our interview today will last approximately 30 minutes to one hour during which I will be asking about your mobile technology deployment strategy you use in implementing wireless network for your organization.
[Review the aspect of consent form]
You have completed a consent form indicating that I have your permission (or not) to audio record our conversation. Are you still (or not) okay with me recording our conversation today? ____Yes ____No
If yes: *Thank you! Please let me know if at any point you want me to turn off the recorder or keep something you said off the record.*
If no: *Thank you for letting me know. I will only take notes of our conversation.*
Before we begin the interview, do you have any questions? [Discuss questions]
If any questions (or other questions) arise at any point in this study, you can feel free to ask them at any time. I would be more than happy to answer your questions.

Research Question	Background Information		In-depth Interview Questions			Closing
What strategies do CIOs use to deploy mobile technology effectively?	1. What strategies do you use to deploy mobile technology effectively?	2. Why do you use these strategies?	3. What strategies were unsuccessful in deploying mobile technology effectively?	4. What barriers have you encountered during and following your use of these strategies to deploy mobile technology effectively?	5. How have you overcome these barriers?	6. What additional observations would you like to share about strategies to deploy mobile technology effectively?

Note. Adapted from “Preparing for Interview Research: The Interview Protocol Refinement Framework,” by M. Castillo-Montoya, 2016, The Qualitative Report, 21, p. 814-821. Licensed under Creative Common Attribution-Share Alike 4.0 License.

Appendix E: Activity Checklist for Close Reading of Interview Protocol

Read questions aloud and mark yes or no for each item depending on whether you see that item present in the interview protocol. Provide feedback in the last column for items that can be improved.

Aspects of an Internet Protocol	**Yes**	**No**	**Feedback for Improvement**
Interview Protocol Structure			
Beginning questions are factual in nature			
Key questions are majority of the questions and are placed between beginning and ending questions			
Questions at the end of interview protocol are reflective and provide participant an opportunity to share closing comments			
A brief script throughout the interview protocol provides smooth transitions between topic areas			
Interviewer closes with expressed gratitude and any intents to stay connected or follow up			
Overall, interview is organized to promote conversational flow			
Writing of Interview Questions & Statement			
Questions/statements are free from spelling error(s)			
Only one question is asked at a time			
Most questions ask participants to describe experiences and feelings			
Questions are mostly open ended			
Questions are written in a nonjudgmental manner			
Length of Interview Protocol			
All questions are needed			
Questions/statements are concise			
Comprehension			
Questions/statements are devoid or academic language			
Questions/statements are easy to understand			

Note. Adapted from "Preparing for Interview Research: The Interview Protocol Refinement Framework," by M. Castillo-Montoya, 2016, *The Qualitative Report, 21,* p. 825.

Appendix F: Trustworthiness Protocol

Table F1

Basic Trustworthiness Criteria

Criteria	Technique
Credibility	Peer debriefing, member checks, journaling
Transferability	Thick description, journaling
Dependability	Inquiry audit with audit trail
Confirmability	Triangulation, journaling

Table F2

Recommended Activities and Plan for Credibility

Peer debriefing/ debriefer	1. Write the plans within this proposal. 2. Commission a peer to work with me during the time of interviews and data collection. 3. The peer must complete an attestation form to work with researcher. Plan to meet the peer after each interview. 4. During visits with the peer debriefer, research and peer discuss interviews, feelings, actions of subjects, thoughts, and ideas that present during this time. Discuss blocking, clouding and other feelings. Discuss dates and times needed for these activities. Will meet once a week for 30 minutes to an hour.
Member checks	1. Outline different times and reasons you plan to conduct member checks or collect feedback from members about any step in the research process. 2. Member checks will consist of communication with members after significant activities. 3. These activities may include interviews, data analysis, and other activities. 4. Within two weeks of the interview, send members a copy of their interview so that they can read it and edit for accuracy 5. Within two weeks of data analysis completion, member will review a copy of the final themes. 6. Members are asked the question, “Does the interview transcript reflect your words during the interview?” 7. Choose negative cases and cases that follow pattern. 8. I will ensure these checks recorded and are computer files so that you may use this information in data analysis
Journaling	1. Journaling will begin with the writing of the proposal.

plans	2. Journaling will be conducted after each significant activity. These include each interview, weekly during analysis, after peer debriefing visits, and theme production. 3. Journals will be audited by research auditor – the committee chair 4. Journals will include dates, times, places, and persons, on the research team. 5. Journals need to be computer files so that I may use them in data analysis.
Protocol	**Create a timeline with planned dates for each activity related to credibility before commencing the study. The protocol with dates and activities should appear in the appendix.**

Table F3

Recommended Activities and Plan for Transferability

Thick description	1. Reviewing crafted questions with the peer reviewer for clarity. 2. Planning questions that call for extended answers. 3. Asking open ended questions that solicit detailed answers. 4. Interviewing in such a way as to obtain a detailed, thick and robust response. 5. The object is to reproduce the phenomenon of research as clearly as detailed as possible. 6. I will replicate this action with each participant and with each question (subquestion) or statement. 7. This continues until all questions and subquestions are discussed. 8. The peer reviewer along with the researcher review responses for thickness and robustness. 9. Two issues related to thick description are (a) receiving think responses (not one sentence paragraphs) and (b) writing up the responses of multiple participants in such a way as to describe the phenomena as a thick response.
Journaling	1. Planning journal work in advance is an option, such that I could decide what dates and how often the journal occur. 2. Journaling after interview is common. 3. Journaling after peer-review sessions. 4 Journaling after a major event during the study. 5. I will discuss journal entries with peer reviewer such that I can connect expression of thoughts and ideas gleaned during research activities to participants' experiences. 6. I can maintain journals in various formats. I can receive information for the journal in the form of e-mails, documents, recordings, note cards/note pads. I will decide on one of the options.

	7. Journaling includes dates of actions related to significant and insignificant activities of the research. 8. Journal may start on the first date a decision is made to conduct the research. 9 Journaling ends when I complete the research and I have interviewed all participants. 10. As with each of the concepts here, create a timeline with a date-line protocol for each activity before commencing the study.
Protocol	**Create a timeline with planned dates for each activity related to transferability before commencing the study. The protocol with dates and activities should appear in the appendix.**

Table F4

Recommended Activities and Plan for Dependability

Audit Trail	1. Make the list of documents planned for audit during the research work. 2. Commission the auditor based on plan for study – The review committee chair 3. Decide audit trail review dates and times. 4. Write up audit trail results in the journal.
Journaling	1. Planning journal work in advance is an option, such that I can decide what dates and how often the journal will occur. 2. Journaling after interview is common. 3. Journaling after peer-review sessions. 4 Journaling after a major event during the study. 5. I will discuss journal entries with peer reviewer such that I can connect expression of thoughts and ideas gleaned during research activities to participants' experiences. 6. I can maintain journals in various formats. I can receive information for the journal in the form of e-mails, documents, recordings, note cards/note pads. I will decide on one of the options. 7. Journaling includes dates of actions related to significant and insignificant activities of the research.
Auditor	1. The auditor is reviewing the documents for authenticity and consistency. 2.The review committee chair is the auditor, who has comprehension of the research process. 3. Planning in advance for the time commitment as an auditor is crucial. 4. The auditor provides constructive feedback on processes in an honest fashion. 5. Auditor, I, and participants should speak the same language.

	6. Auditor must be able to create and maintain audit trail documents.
Protocol	**Create a timeline with planned dates for each activity related to dependability before commencing the study. The protocol with dates and activities should appear in the appendix.**

Table F5

Recommended Activities and Plan for Confirmability

Triangulation	1. Determine triangulation methods. 2. Document triangulation plans within journal. 3. Discuss triangulation results with peer reviewer. 4. Decide if further triangulation is needed. 5. Write up the triangulation results.
Journaling	1. Planning journal work in advance is an option, such that I can decide what dates and how often the journal will occur. 2. Journaling after interview is common. 3. Journaling after peer-review sessions. 4 Journaling after a major event during the study. 5. I will discuss journal entries with peer reviewer such that I can connect expression of thoughts and ideas gleaned during research activities to participants' experiences. 6. I can maintain journals in various formats. I can receive information for the journal in the form of e-mails, documents, recordings, note cards/note pads. I will decide on one of the options. 7. Journaling includes dates of actions related to significant and insignificant activities of the research. 8. Journal may start on the first day a decision is made to conduct the research.
Protocol	**Create a timeline with planned dates for each activity related to confirmability before commencing the study. The protocol with dates and activities should appear in the appendix.**

All tables in Appendix F adapted from "Creating Protocols for Trustworthiness in Qualitative Research," by L. Amankwaa, 2016, *Journal of Cultural Diversity, 23*(3), p. 123-127.

Appendix G: Flow Chart for Synthesized Member Checking

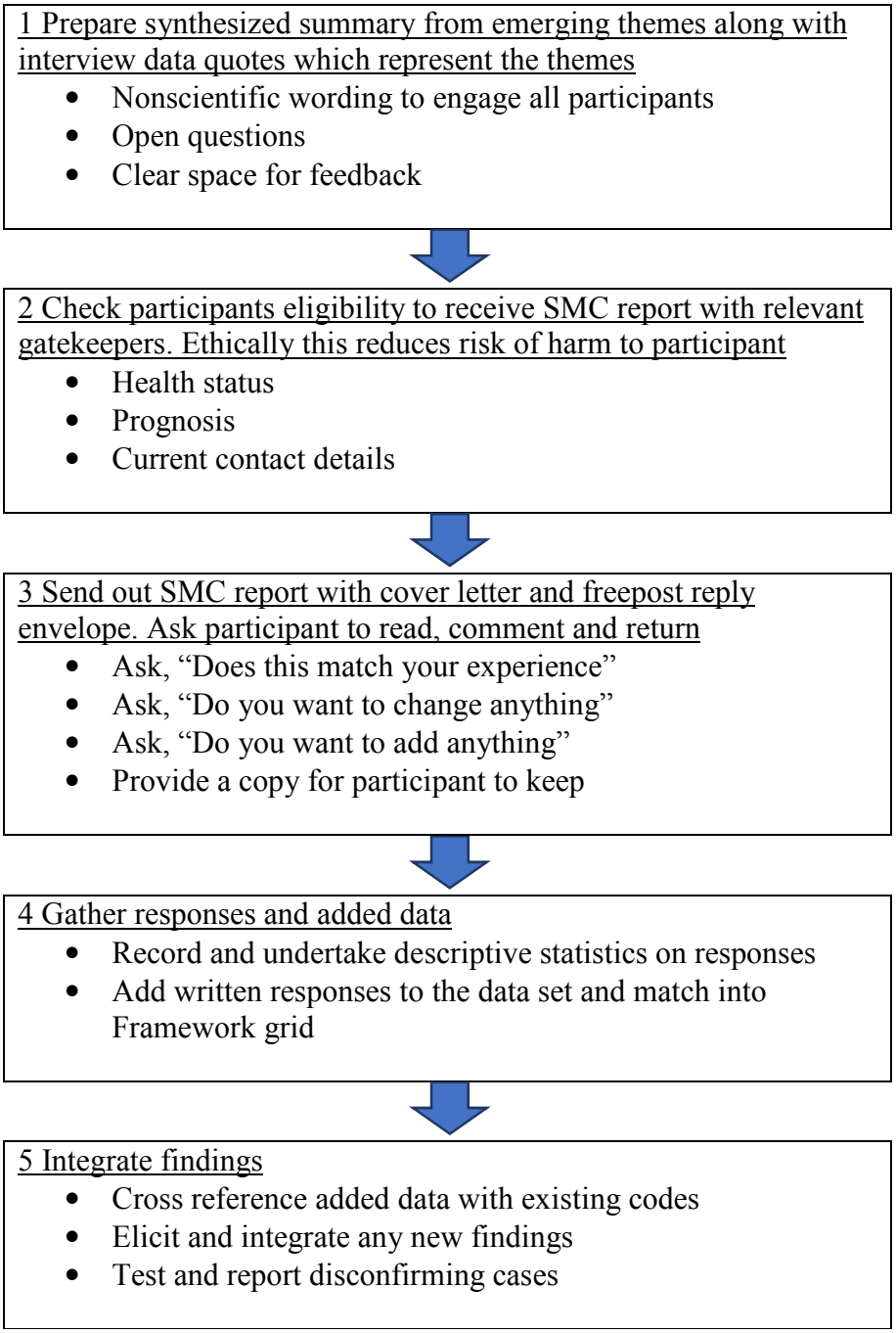

Figure H. Flow chart of the processes undertaken in Synthesized Member Checking, a five-step tool adapted from "Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?" by L. Birt, S. Scott, D. Cavers, C. Campbell, & F. Walter, 2016, *Qualitative Health Research*, *26*, p. 33-34. Author's e-mail: linda.birt@uea.ac.uk.

Appendix H: Example of Synthesized Member Checking

Awareness of skin cancer or melanoma

We found that people were not overly aware of their moles, freckles or spots, and it was only when changes happened to their skin that they started to look more carefully. People in the study seemed to have heard of skin cancer but there was less awareness of melanoma being a skin cancer. When people noticed a change in a mole they often found an alternative explanation for the change rather than thinking it was cancer.

- **Don't think about my skin –** People tended not to be conscious of their skin. Changes in moles happened slowly and appeared to go unnoticed, *"When you've got moles that are just so much part of the furniture you just don't take any notice of them anymore."*

- **Not really knowing about melanoma –** It seems many people had some awareness that a changing mole was a cause of concern. However, fewer knew that melanoma was a serious skin cancer, *"I thought melanoma was actually inside your body, I didn't even know melanoma was another word for tumor, I've found all this out since, I was naive about it all."*

- **Putting the change down to something else –** Several people thought a change in their mole or freckle was a normal change perhaps as part of getting older or being pregnant. A few thoughts they had an injury or a bite, "*Since I'd been outside to a barbeque and I thought, oh well I've been bitten, it's just bitten there on the mole."*

- **Being very aware of melanoma –** When people knew of others who had had a melanoma they knew that changes in moles needed to be checked by a doctor, *"Because my mum had melanoma, I've always been aware to keep to check on my moles."*

Please add any further comments and consider the statements in the box below.

It seems people have a general idea that a changing mole is something to be concerned about, but few people have a good understanding of the condition melanoma. Do you agree?
It seems that most people were not actively checking their skin for changes.

Figure I. An example of SMC from the member checking document of the melanoma interview study, adapted from "Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?" by L. Birt, S. Scott, D. Cavers, C. Campbell, & F. Walter, 2016, Qualitative Health Research, 26, p. 35. Author's e-mail: linda.birt@uea.ac.uk.

Appendix I: Strategies to Reduce Bias

(1) Accounting for personal bias which may have influenced findings.

(2) Acknowledging bias in sampling and ongoing critical reflection of methods to ensure sufficient depth and relevance of data collection and analysis.

(3) Meticulous record keeping, demonstrating a clear audit trail and ensuring interpretations of data are consistent and transparent

(4) Establishing a comparison case; seeking out similarities and differences across accounts to ensure different perspectives are represented

(5) Including rich and thick verbatim descriptions of participants' accounts to support findings

(6) Demonstrating clarity in terms of thought processes during data analysis and subsequent interpretations

(7) Engaging with other researchers to reduce research bias

(8) For respondent validation, including inviting participants to comment on the interview transcript and whether the final themes and concepts created adequately reflect the phenomena being investigated

(9) Data triangulation

Adapted from "Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?" by L. Birt, S. Scott, D. Cavers, C. Campbell, & F. Walter, 2016, Qualitative Health Research, 26, p. 35. Author's e-mail: linda.birt@uea.ac.uk. Modified with permission.

Appendix J: Correspondences with Authors for Permission to Use Intellectual Property

For Wallace and Iyer's HIT Value Hierarchy

August 16, 2018, 11:09 AM, CST:

Dear Drs. [redacted]:
I adapted the figure for your HIE Value Hierarchy model in my doctorate study which is in pending for Walden University IRB approval. Please permit me to use the figure. The attached is the figure I modified. Thank you.
Cordially yours,
Won, RN, MSN, RN-BC, CPHIMS

August 16, 2018, 11:13 AM CST:

Won:
Glad to note Dr. [redacted]'s work is being adapted. I am deferring him to approve.
[redacted], let me know if you have questions on this.
[redacted]

August 16, 2018, 12:18 PM CST:

Won,
Please use it and later, if you don't mind, I'd like to know how your study is going.
Regards,
[redacted]

August 16, 2018, 3:34 PM CST:

Thank you, Sir. I will send the proposal once it is approved by IRB.

For [redacted] Trustworthiness Protocol (Appendix . . .)

September 9, 2018, 7:13 PM PST:

Dear Dr. [redacted]:
I am preparing a dissertation for a doctorate degree in business administration, and I want to adapt your tables in "[redacted]," 2016, [redacted], 23(3), p. 123-127, to my dissertation. I will send you

the copy of my study proposal once it is approved by Walden University. I appreciate your help.
W/r,
Won Song
DBA Candidate
Walden University

September 3, 2018, 7:56 AM PST:

Hi,
Request granted.
Add a column with date planned, actual date started and actual date ended.....with all activities described in that column.
Questions?
[redacted], Ph.D, RN, FAAN

September 3, 9:24 AM PST:

Thank you, Dr. [redacted].
Yes. I will use the tables as the log for the study as you are advising (after blocking the PII of the participants for Privacy protection). I can send you the copy of the log to you after the study is completed, if you requested, with the report of the study. I am planning to add your e-mail of this permission as the appendix of the proposal too. Please let me know if you have any additional comments.
W/r,
Won Song, RN, RN-BC, CPHIMS
PS: I am planning to revise and publish my dissertation in the peer-reviewed journal. Please let me know if you are interested in co-authoring the article. My proposal would be ready within one to two months. I will send you the copy and you let me know after reviewing my proposal.

September 3, 2018, 12:12 PM PST:

Yes. I would be interesting in r/r process with co-authorship. Recall that all committee members have first options on authorship with you.
Questions?
[redacted], Ph.D, RN, FAAN

September 4, 2018, 7:27 AM PST:

Yes, I understand. My chair Dr. Laursen and second committee member Dr. Gaytan would welcome you. I think it would be nice to have another nursing professional as the author of my article. I do not have any questions now. I will keep you in the circle.
W/r,
Won

September 4, 9:57 AM PST:

Great!
[redacted], PhD, RN, FAAN
Professor
[redacted]

For Synthesized Member Checking

November 19, 2018, 9:59 AM PST

Dear Dr. [redacted]:
I am a student of the Walden University Doctor of Business Administration (DBA) program. I want to adapt in my study your flow chart of the processes undertaken in Synthesized Member Checking, a five-step tool adapted from "Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?" I will appreciate if you kindly allow me to use your flow chart in my study. I will forward my study proposal to you once it is approved by the Walden University IRB.
Cordially yours,
Won Song

Hi
that will be fine as long as you reference
Adapted from Birt et al. (2016) "Member Checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?" Qualitative Health Research 2016, Vol. 26(13) 1802 – 1811'
Good luck with your work
[redacted]

Appendix K: Sample Message to Solicit Prospective Interviewees in LinkedIn

Hi, (First Name).

As you might already know, as you see in my profile, I am studying at Walden University for a doctorate degree in Business Administration (DBA). I just completed the proposal of the study, and I am now looking for interviewees. I think you are one of the best candidates for my study. I have the study prospectus and proposal uploaded to my profile. Please review the prospectus and let me know if you are interested in. I need to know your e-mail address to send the invitation with the detailed information and the informed consent form. I am looking forward your enthusiastic acceptance of my invitation.

Cordially yours,
Won

Appendix L: Analytical Planning Worksheet

Table O

Analysis Planning Worksheet

<table>
<tr><td colspan="3">Project Name: Mobile Technology Deployment Strategies for Improving the Quality of Healthcare</td></tr>
<tr><td rowspan="2">Level 1: Objective and methodology</td><td colspan="2">Objective (Purpose): to explore the strategies healthcare CIOs use to deploy mobile technology effectively</td></tr>
<tr><td colspan="2">Guiding methodology: qualitative multiple case study</td></tr>
<tr><td rowspan="4">Level 2: Overall analytic plan</td><td colspan="2">Current conceptual framework: Wallace and Iyer’s HIT hierarchy (2017)</td></tr>
<tr><td colspan="2">Prior completed:</td></tr>
<tr><td colspan="2">Current:</td></tr>
<tr><td colspan="2">Next anticipated:</td></tr>
<tr><td rowspan="2">Level 2: Analytic tasks</td><td rowspan="2">Level 3: Translation</td><td>Level 4: Selected tool or</td></tr>
<tr><td>Level 5: Constructed tool</td></tr>
<tr><td>Task 1: Within-case analysis</td><td colspan="2">Units:
Purpose:
Possible components:
Chosen components:
Explanation:</td></tr>
<tr><td>Task 2: Cross-case analysis</td><td colspan="2">Units:
Purpose:
Possible components:
Chosen components:
Explanation:</td></tr>
<tr><td>Reflections</td><td colspan="2"></td></tr>
</table>

Note. Adapted from “Quantitative Analysis Using Atlas.ti.: The Five Level QDA Method,” by N. H. Woolf and C. Silver, 2018, p. 104. Copyright 2018 by Taylor & Francis. Modified with permission.