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Bahae Samhan

Illinois State University, bmsamha@ilstu.edu

Tara Crampton

Illinois State University

Regina Ruane

Drexel University

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The Trajectory of IT in Healthcare at HICSS: A Literature Review, Analysis, and Future Directions

Bahae Samhan

Accounting and Business Information Systems
Illinois State University
bmsamha@ilstu.edu

Tara Crampton

Accounting and Business Information Systems
Illinois State University

Regina Ruane

Drexel University

Abstract:

Research has extensively demonstrated that healthcare industry has rapidly implemented and adopted information technology in recent years. Research in health information technology (HIT), which represents a major component of the Hawaii International Conference on System Sciences, demonstrates similar findings. In this paper, review the literature to better understand the work on HIT that researchers have conducted in HICSS from 2008 to 2017. In doing so, we identify themes, methods, technology types, research populations, context, and emerged research gaps from the reviewed literature. With much change and development in the HIT field and varying levels of adoption, this review uncovers, catalogs, and analyzes the research in HIT at HICSS in this ten-year period and provides future directions for research in the field.

Keywords: Hawaiian International Conference on System Science (HICSS), Healthcare, HIT, IT in Healthcare Track, Literature Review, Research Gaps.

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1 Introduction

Health information technology (HIT) has the ability to greatly improve many facets of healthcare. Specifically, HIT allows healthcare providers to access relevant data in order to address particular needs, improves efficiency and outcomes through standardized processes, and helps support individual and organizational growth through knowledge sharing and storage (Buntin, Burke, Hoaglin, & Blumenthal, 2011).

With the increasing complexities of healthcare, knowledge management, and innovations in medical treatments, HIT has assisted healthcare professionals in streamlining and advancing how they care for and treat patients. The increasing number of healthcare-related organizations that adopt HIT has created novel phenomena in areas that concern the development and implementation of HIT; ensuring health data stays private and secure; analyzing data; and making decisions. As such, computer scientists and IT scholars need to address these issues and assist the healthcare industry with the challenges involved in integrating HIT. The research they have already conducted has contributed to better explaining the issues that surround IT integration in the healthcare sector.

Over the years, HIT has increasingly come to represent an integral component of the Hawaiian International Conference on System Science (HICSS). In this paper, we review the literature of HIT presented at HICSS from 2008 to 2017. Since the conference first offered the IT in healthcare track in 2000, the 2008 to 2017 period covers the majority of the research published in this area at the conference. We reviewed this research to determine what areas these papers have focused on and their outcomes and to make recommendations for future directions. Given that HICSS celebrated its 50th year in 2017 and given that research in the HIT field still demonstrates the need to continue developing and supporting the emerging phenomenon of HIT, we believe that reviewing research in HICSS presents a great opportunity to uncover the phenomenal developments in HIT and to determine the areas that need further research.

Since 2005, we have seen a revolutionary change in the healthcare sector in the US. The country has incorporated the Patient Safety and Quality Improvement Act of 2005 (PSQIA) and the mandated security rule of Health Insurance Portability and Accountability Act (HIPAA) of 2005. In addition, healthcare organizations began migrating from paper-based systems to electronic medical records (EMR). Additionally, the U.S. Government passed the meaningful use bill as part of the Health Information Technology for Economic and Clinical Health Act of 2009 (HITECH). These important mandates demand necessary efforts to maintain and uphold the standards and rules they stipulate. Further, when the Affordable Care Act (ACA) passed as a bill in November, 2009, the U.S. Government launched healthcare exchange websites for people to subscribe for health insurance coverage. Although the healthcare exchange websites operated at the state level, they received millions of users at the same time and, thus, many crashed. These dramatic changes in the health sector coupled with widespread HIT integration increased researchers' interests in these areas.

HIT affects the healthcare landscape. It allows transparency among healthcare staff and patients, faster communication, easier access to patient and health information, innovations in treatments, and so on. As both healthcare staff and patients become more adept in using these technologies, the benefits grow. We found that HIT papers in HICSS from 2008 to 2017 demonstrate an increasing attentiveness to the changing landscape of HIT and have provided much direction about what areas require more research and inquiry. Since HIT as a field changes quickly, once-pertinent topics may have since receded in importance but provide a historical view of the changes that have occurred in this field.

In reviewing the research from 2008, we found much diversity (e.g., research that involves various stakeholders, such as physicians, nurses, patients, healthcare executives and leaders, and various topics, such as new technologies and innovations), which demonstrates an increasing attentiveness to the changing HIT landscape.

In this study, we extensively review the HIT literature in HICSS from 2008 to 2017. Since this paper forms part of a special issue, we had timeline limitations, which explains why we chose to review HIT research at HICSS from 2008 to 2017. Additionally, we analyze the literature to help researchers better understand emergent research themes and gaps and, thus, to inform future studies. By analyzing research gaps and presenting possible future directions, we encourage researchers to broaden research in HIT areas, especially those that need more investigation and focused research.

2 Information Technology in Healthcare

HIT involves designing, developing, implementing, using, and maintaining technology for the healthcare industry. Automated and interoperable HIT have the potential to improve the healthcare sector by lowering care-giving costs, increasing efficiency, reducing errors, and improving patient satisfaction (Rouse, 2016; Samhan & Joshi, 2015). The majority of healthcare organizations currently focus on maximizing the many advantages of HIT. Healthcare organizations have or are implementing various HIT such as electronic medical records (EMR)—a vital HIT component (Samhan, 2017). EMR serve as digital records of patients' medical data that healthcare providers can share among themselves. In 2009, the U.S. Government introduced the HITECH Act to encourage and expedite the adoption of EMR. President Obama signed HITECH into law on 17 February, 2009, as part of the American Recovery and Reinvestment Act of 2009 (ARRA) economic stimulus bill (U.S. Department of Health & Human Services). The HITECH Act introduced the EMR meaningful use program, which offers incentive payments to healthcare organizations and practices that have met the criteria of EMR meaningful use. As a result, the EMR adoption rates have increased in the past few years (Rouse, 2016).

Healthcare-related organizations widely use HIT elements to store and manage patient medical images. Vendor neutral archives (VNA) and picture archiving and communication systems (PACS) allow radiology departments to integrate with other hospitals' workflows. In some cases, healthcare providers have installed VNA primarily to merge imaging data from separate image banks at different organizational levels (Agarwal, 2012).

The pervasiveness of technological advancements made HIT available to patients, and mobile apps in particular represent a leading area of growth. Mobile apps have dramatically influenced how patients can manage and participate in their healthcare. Healthcare organizations can now also facilitate communications with patients through newer HIT such as electronic patient portals (EPP). A patient portal refers to a secure online application that gives patients convenient access to their personal health information. Using EPP, patients can view information such as lab results or doctors' notes; patients can also communicate messages to their physicians regarding concerns or questions they might have (Samhan, 2017). Other patient-oriented technologies, such as monitoring devices and wearable technologies, allow patients to generate rich health information from their everyday activities to share with providers for more informed medical decision making (Pang et al., 2015). Further, the introduction of wearable biosensors has created newer ways to detect variety of diseases using real-time biometric data collection (Pantelopoulos & Bourbakis, 2010).

Social media has also changed the way healthcare organizations, consumers, and practitioners interact. Today, healthcare providers and organizations realize the opportunities of healthcare social media (HSM). HSM not only provides opportunities for physicians to network professionally with colleagues and share medical knowledge in the medical community but also allows users to perform a variety of health-related tasks such as researching and making health decisions, selecting a doctor, or researching courses of treatment (Bock & Rosen, 2017).

HIT is a broad concept that encompasses an array of technologies that deal with storing, sharing, and analyzing health information. The aforementioned technologies represent just some of most used HIT. HIT continues to make patient health records manageable electronically. Additionally, HIT provides data management platforms to healthcare organizations, and allows patients to use electronic communications with healthcare providers.

The first HICSS occurred in January, 1967. Few conferences have grown and developed at the same rate as HICSS has in its 50 years. During its first nine years, the conference's organizers all came from the University of Hawaii. Not until 1977 did faculty members from Texas A&M, UT Austin, Southwestern Louisiana, UC Berkley, and University of Oregon join HICSS, which gave it a broader perspective (Shriver & Sprague, 2015). The conference now has organizers and participants from all over the world and was one of the first conferences to realize the imperative need to bridge healthcare and information technology researchers/professionals to discuss HIT issues from different perspectives.

In 2000, the 33rd HICSS dedicated a specialized track to IT in healthcare called the "information technology in healthcare track". Every HICSS has offered the track since then. HICSS convenes researchers from different fields, healthcare providers, and general audience participants annually from around the world to advance our knowledge on variety of issues surrounding HIT. The IT in healthcare track at HICSS has become an immense opportunity for HIT communities to become involved in forums to

exchange ideas and research results and to develop activities and applications. Even though the track is young, it has garnered some papers over the years. Figure 1 illustrates the historical data for HICSS from 1977 to 2017. It is categorized by number of minitracks, number of papers, and number of authors for each year. "ITHlthCr" represents the IT in healthcare track. Although the graphs show that IT in healthcare has attracted a low number of papers, one can see that this number has grown over the years.

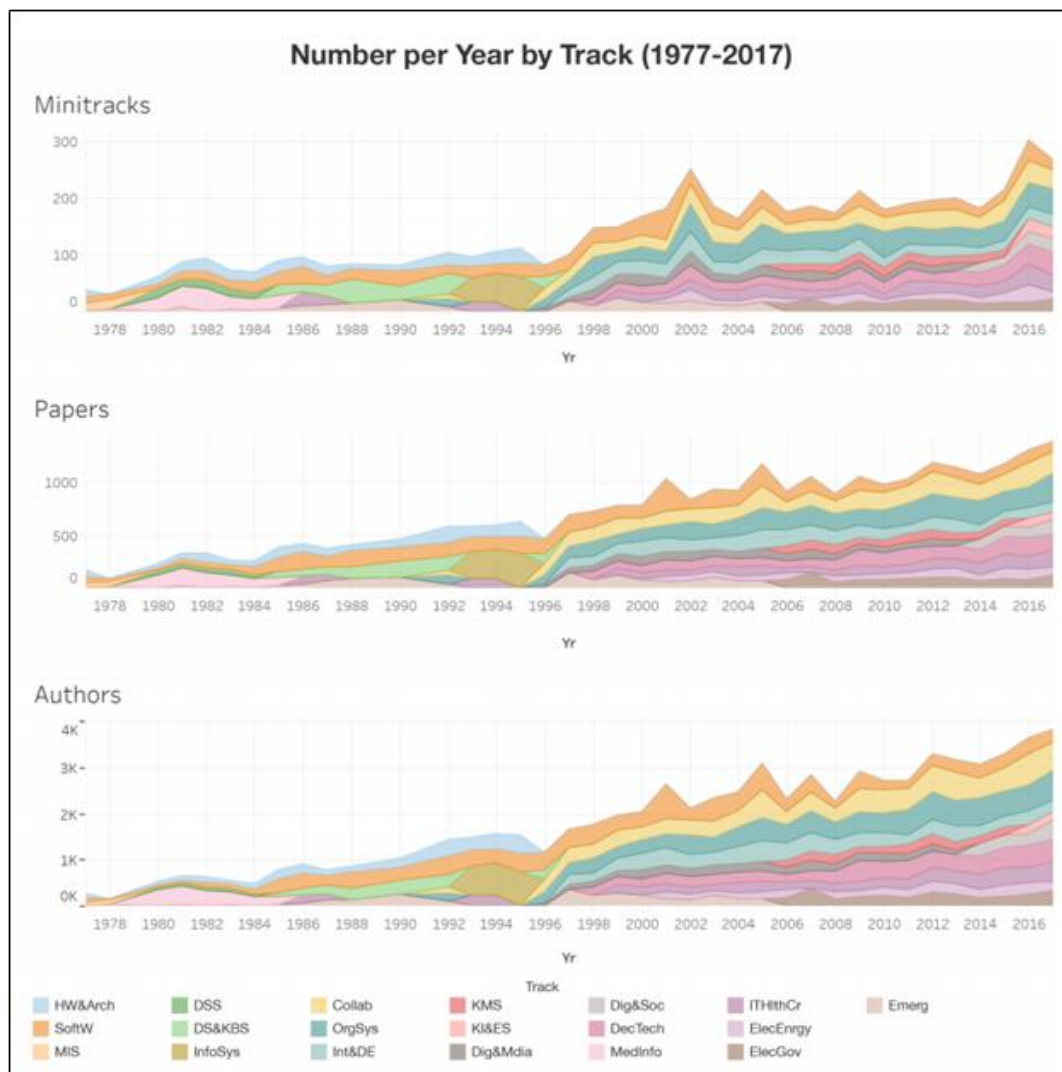


Figure 1. HICSS Historical Data (University of Hawaii at Manoa, 2017))

Prior to the introduction of the IT in healthcare track in 2000, other tracks accepted HIT studies. From 2000, minitracks in the IT in healthcare track involved novel HIT topics relevant at the time (e.g., the Y2K issue at the beginning of the new millennium motivated research to focus on global strategies of HIT). Additionally, the conference dedicated minitracks to cover state-of-the-art technologies such as telemedicine and virtual reality (VR). Nevertheless, the conference had space for the more traditional research on HIT such as database, data warehousing, and data mining in healthcare.

The 34th HICSS (2001) introduced the minitrack on privacy and security of HIT as a response to the change in health data privacy and security healthcare regulations in the US. HIPAA, one of these regulations, mandates that patients have full access to their health data and protects their information by limiting other parties' access to it. This regulation appeared along with the increased popularity of electronic medical records, which created a source for new research topics that focused on securing EMR data.

HICSS has had interesting, long-term effects on the HIT field. Some major areas of HIT research and development have been initiated, defined, and nurtured throughout the years at the conference. Some

entirely new HIT-related conferences branched out of HICSS tracks, such as IEEE computer society computational medicine conferences (MedComp) and the Pacific Symposium on Biotechnology Computing (Shriver & Sprague, 2015). The 36th HICSS (2004) introduced the first minitrack on HIT adoption. Since then, HICSS has offered minitracks related to HIT adoption each year. HIT adoption represents one of the most popular and successful minitracks at HICSS. From our review, we found that, since its existence, the IT in healthcare track has published the most papers compared to all other tracks.

In this paper, we review all minitracks under the IT in healthcare track from 2008 (the 41st HICSS) to 2017 (the 50th HICSS). Figure 2 illustrates all the minitracks we reviewed for this study. Specifically, we looked for all minitracks offered each year at HICSS under the IT in healthcare track and searched each minitrack for all papers that the conference proceedings published for that year. To ensure that our bibliography was as complete as possible, we searched for minitrack papers in the IEEE Xplore digital library, IEEE Computer Society, Scholar Space, and ACM digital library. Given that we limited our review to publications published between 2008 and 2017 we believe that our review covers an adequate period for IT in healthcare publications.

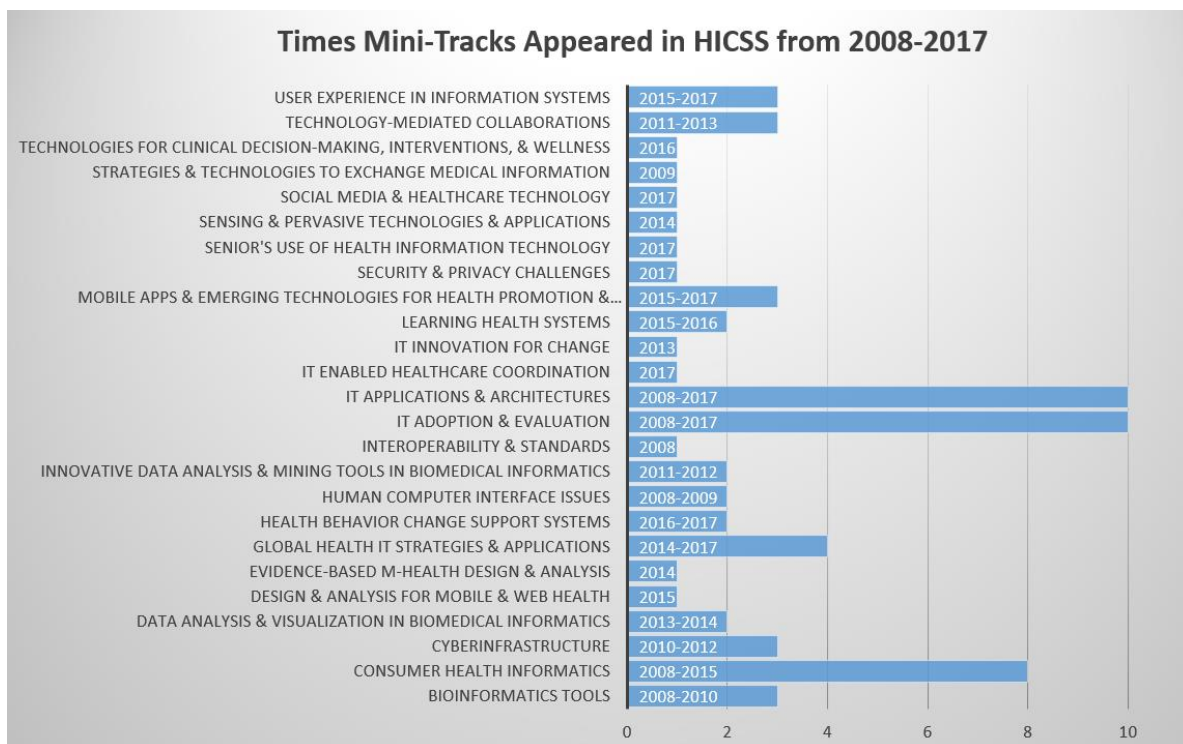


Figure 2. Reviewed Minitracks of HICSS under IT in Healthcare Track

We identified 409 papers, which we clustered into groups based on publication year and minitrack. To synthesize all relevant papers, we manually summarized each one. In this process, we broadly searched for keywords relevant to our summary. For example, to determine the population the papers examined, we searched for “sample”, “users”, “subjects”, “participants”, or “respondents” in each paper’s text and abstract.

Following Webster and Watson (2002), we used systematic criteria to produce our summary. First, we extracted the phenomenon that each paper presented as the work’s motivation and each paper’s research question(s), objective(s), and/or research statement(s). We then identified how the papers differed or not based on these criteria. Second, we outlined the research approach and methodology that each paper used. We followed the distinction Galliers and Sutherland (1991) provide between research approaches and methods. Research approaches refer to the way one conducts research. On the other hand, methods refer to the techniques and procedures one applies when conducting research (Wiener, Vogel, & Amberg, 2010). Following Dibbern, Goles, Hirschheim, and Kayatilaka (2004), we differentiated between empirical and non-empirical research approaches based on whether the papers used an empirical method or not. In empirical approaches, we recognized qualitative and quantitative research. We also looked at the unit of analysis and how the authors of each paper collected data. Third, we looked into the IT artifact in each

paper. We identified the purpose and functionality of the examined HIT and the different phenomena surrounding the same type of HIT in all reviewed papers. Fourth, we identified the sample used in each study. However, we did not summarize the demographic statistics of these samples. Rather, we recorded only the type of HIT users (e.g., patients, nurses, healthcare providers, etc.). Fifth, we recorded the context of each study in terms of the country in which its authors conducted it. We did not record a context for papers that conducted only a literature review. Sixth, we looked into the findings of each paper and whether they addressed the stated objective or not and why. Finally, we identified how researchers could use each paper to develop future work.

During the review, we concentrated on the determining each paper's content rather than each paper's attributes. Therefore, this step required some degree of interpretation on our part. For instance, not all papers explicitly referred to how researchers can use their work to develop future studies. In addition, some papers dealt with multiple concepts such as multiple phenomena or study objectives. We clustered these papers with other papers to which they most strongly belonged.

After summarizing and synthesizing all papers, we began coding them. At this stage, we grouped papers based on predetermined attributes that we determined based on synthesizing them. Before we independently coded the data, we assessed inter-rater reliability. Specifically, we compared our coding for all papers in our data set that HICSS published in a single year. Figure 3 summarizes our review process.

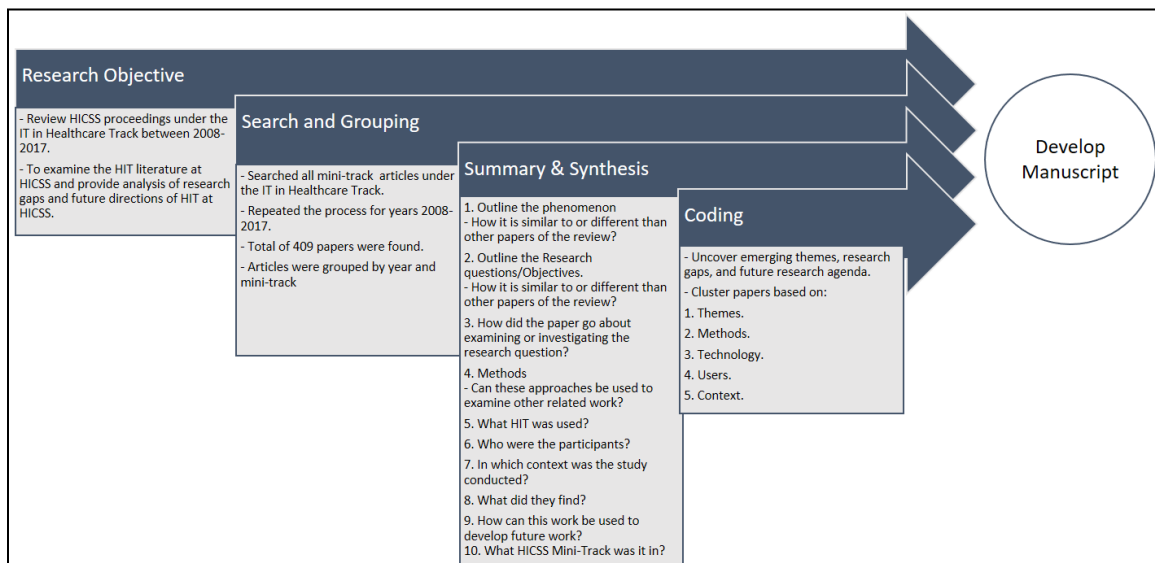


Figure 3. Literature Review Process

For this study, we considered five main attributes: 1) revealed themes, 2) research approach, 3) HIT, 4) type of users, and 5) study context. First, we developed research themes based on synthesizing the reviewed papers and the similarity of minitrack topics that HICSS has offered from 2008 to 2017. This dimension does not consider the research outcome; rather, it focuses on the similarity of research topics, interests, and needs. In addition, we analyzed the research methodologies conducted in each theme in detail. Second, we considered each study's research approach, which included the methodology used and the type of the conducted research (qualitative or quantitative). Third, we considered HIT: the nature of technology support system functionalities and supported work processes in each paper, which we distinguished based on the type of HIT the study focused on. Fourth, we considered the type of users, which we categorized into different HIT stakeholders. We looked at the type of users selected in each research arrangement. Fifth, we considered the context of each study, which we based on the country in which its authors conducted it. With this attribute, we could analyze diversity in research context. We detail each attribute in Section 4 in more detail.

3 Review Analysis

3.1 Themes

From analyzing each minitrack and synthesizing the papers in each one, we found 15 main themes (see Figure 3). Each theme included one or more minitrack. Table A1 in the Appendix shows our revealed themes and corresponding minitracks. We discuss these themes in more detail in Sections 4.1.1 to 4.1.15.

3.1.1 Bioinformatics and Translation Research

This theme included papers that focused on the transformation of large volumes of biomedical data and genomic data in proactive, predictive, preventive, and participatory health. It included papers published in the proceedings of the innovative tools for bioinformatics and translational research minitrack, the advanced biometrics tools for transitional research minitrack, and the bioinformatics tools for healthcare and translational research minitrack. HICSS included the minitracks in this theme for only a short time (i.e., between 2007 and 2010). Additionally, these minitracks published few papers. The specialty areas that these minitracks focused on (i.e., the phenomenon's medical aspect) may explain why. For example, Haynatzki, Haynatzka, Ghiorzo, and Sherman (2009) studied meat consumption, preparation, and meat-derived carcinogens and the risk of sporadic pancreatic cancer, while Freeze et al. (2009) analyzed patients' data to understand underlying patterns in chronic disease progression. Although HICSS is an interdisciplinary conference and attracts professionals from different academic and professional backgrounds, healthcare communities may find greater value in such findings than IS or IT communities. The theme only limitedly contributed to advancing our knowledge of HIT or general IT artifacts. As a result, HICSS stopped including it.

We learn from the translational medical research under this theme that moving medical innovations from labs to patients' bedside can improve diagnosis, prognosis, and treatment. However, translating medical discoveries into patient-care technologies involves many barriers, such as understanding health market size and forces, knowing the regulations in place, learning how to advance HIT for routine use, and how to navigate an increasingly complex intellectual property landscape.

3.1.2 HCI and Consumer Health Informatics

This theme included papers that focused on reaching, engaging, and empowering healthcare consumers directly through various HIT capabilities (Fruhling, Buckhard, & Djamasi, 2014). It included papers published in the proceedings of the consumer health informatics minitrack; the consumer health informatics, patient safety, and quality of practice minitrack; and the HCI and consumer health informatics issues in healthcare IT minitrack. These minitracks appeared at HICSS between 2005 and 2015 and covered a broad spectrum of research topics related to human-computer interaction (HCI) in the healthcare area. The papers in this theme focused on research topics such as the trend of healthcare consumers turning to the Internet for health information (Tao, LeRouge, Deckard, & De Leo, 2012); user-access patterns when interacting with HIT (Tulu et al., 2012); the relation between HIT online behaviors and demographic, psychographic, and lifestyle factors (Paek & Hove, 2014); and HIT access awareness (Culjak, 2012). These minitracks also included other interesting HCI topics. Kauchak, Mouradi, Pentoney, and Leroy (2014) examined the complexity of text in certain HIT and introduced the concept of "difficult text" and analytic tools to assess text difficulty for HIT consumers. They used six different machine-learning algorithms to predict the difficulty of health texts. Anderson, Baskerville, and Kaul (2017) explored the difference between how patients and doctors understand illnesses. They highlighted the importance of understanding these differences and provided suggestions for incorporating them in the design of e-health interfaces.

Research in this theme shows that successfully empowering healthcare consumers through HIT depends mainly on the extent to which healthcare providers and patients perceive HIT as usable and useful. Physicians and patients may develop divergent concerns when fighting illness using HIT. The research suggests that featuring HIT interactive design, providing hands-on training, and involving all stakeholders in the process of building HIT can mitigate these concerns.

While minitracks under this theme were offered for 10 consecutive years at HICSS, they were not offered after 2015. However, the user experience design for health and wellness minitrack has since covered this theme's topics. This minitrack overlaps with HCI topics but focuses more on HIT's design and visualization aspects.

3.1.3 HIT Adoption, Diffusion, and Evaluation

In 2004, the 36th HICSS introduced the implementation, adoption, and diffusion of IT in healthcare minitrack—one of the most popular and successful minitracks at HICSS. The minitrack has appeared at all future HICSS conferences and published more than 150 papers in the past 13 years. The IT adoption, diffusion, and evaluation in healthcare minitrack at the 50th HICSS (2017) had the most publications compared with other HIT minitracks at the conference.

The HIT adoption, diffusion, and evaluation theme included the IS implementation, adoption, and diffusion in healthcare minitrack; the implementation, adoption, and diffusion of IT in healthcare minitrack; the IT adoption, implementation, use and evaluation in healthcare minitrack; the IT adoption and evaluation in healthcare minitrack; the IT adoption in healthcare minitrack; and the IT adoption, diffusion, and evaluation in healthcare minitrack. These minitracks coincided with the golden era of technology adoption research. A large number of papers we found in these minitracks focused on the technology acceptance model (TAM) (Davis, Bagozzi, & Warshaw, 1989) and UTAUT (Venkatesh, Morris, Davis, & Davis, 2003). Given that this theme focused on HIT adoption, we found that this type of adoption had ties to broad areas of research that allowed studies to branch out and explore a variety of new topics, such as information quality (Byrd & Byrd, 2012), compliance behaviors (Wills, El-Gayar, & Deokar, 2012), and IS success (MacKinnon & Wasserman, 2009).

Additionally, we found that research studies used a wide variety of HIT to investigate adoption behaviors such as EMR (Sood et al., 2008; Wiggins, Trimmer, Beachboard, Peterson, & Woodhouse, 2009; Samhan, 2017), telemedicine (Mansouri-Rad, Mahmood, Thompson, & Putnam, 2013; Petcu, Ologeanu-Taddei, Bourdon, Kimble, & Giraudeau, 2016), and computerized physician order entry systems (CPOE) (Zhang, Levin, & Padman, 2013; Nsakanda, Grant, Vafei, & Leafloor, 2015). While papers in this theme mainly focused on HIT adoption (e.g., Vichitvanichphong, Talaei-Khoei, Kerr, & Ghapanchi, 2014; Pendergrass & Ranganathan, 2014; Jaana, Teitelbaum, & Roffey, 2017), other papers explored concepts of technology resistance, resistance to change, workarounds, and avoidance (e.g., Samhan, 2017; Samhan & Joshi, 2015; Smith, Grant, & Ramirez, 2014). Researchers have argued that the distinction between resistance and acceptance behaviors differs immensely (Samhan, 2017) and that HICSS needs a dedicated distinctive minitrack to cover topics of resistance and avoidance in healthcare settings.

The research studies in this theme showed that successful HIT adoption relies mainly on perceived ease of use and perceived usefulness. Most work in this area built on the findings of TAM. However, the main factors that influenced the diffusion of HIT concerned degrees of organizational support.

3.1.4 HIT and Social Media

This theme included papers in the social media and healthcare technology minitrack, which HICSS first offered in 2017. Prior to that, HIT social media research appeared in the digital social media track. Given how rapidly social media has begun to change the way healthcare organizations, consumers, and practitioners interact, HICSS realized the importance of dedicating this minitrack to research that focuses on evaluating the design, development, implementation, and impact of social media applications in the healthcare area.

Bock and Rosen (2017) explained how healthcare organizations avoided using social media at first and that some even restricted their employees from using it. Overtime, healthcare organizations began to realize that using social media has benefits and opportunities for healthcare stakeholders. Today, patients increasingly want to use social media for healthcare purposes (e.g., to research and diagnose symptoms or communicate with a nurse or doctor about them). Additionally, physicians can use social media to network professionally with colleagues and share medical knowledge in the medical community (Bock & Rosen, 2017).

The HIT social media minitrack debuted at 50th HICSS and included five papers. These papers covered interesting topics and contributed directly to research and practice despite their limited number. Gamache-O'Leary and Grant (2017) reviewed the literature on social media in healthcare, a relatively new topic at HICSS, which adds value to this work. Extensively reviewing prior research paves the way for future research to build on past findings. These studies used popular social media platforms as communication media. Chai, Rosen, Lewis, Ranney, and Boyer (2017) evaluated "Tweetchat" focus groups as alternatives to traditional in-person focus groups. Similarly, Farzan and Jonassaint (2017) explored the dynamics of a health support group over Facebook. Hemsley, Palmer, Goonan, and Dann (2017) analyzed tagged tweets (hash-tags) related to motor neuron disease (MND) and amyotrophic lateral

sclerosis (ALS). Finally, Pagoto et al. (2017) used social media to analyze the feasibility of incentivizing participation in an online social-network weight-loss program.

Given the popularity of social media and its applications today, HIT researchers can design their research to investigate a wide range of interesting topics using different perspectives from social media users. For example, HIT social media researchers may include patients' perspectives on HIT. In doing so, researchers can enrich our understanding of patient interaction with HIT, which researchers still consider underdeveloped in IS research (Samhan, 2017). Researchers can also address other interesting questions while investigating HIT social media topics such as remote diagnoses and telemedicine services. Additionally, HIT social media research allows researchers to conduct more studies on how social media provides a new shape to healthcare delivery in rural areas. Social media research in healthcare can address a wide variety of subjects of topical interest.

This theme focused on understanding the abilities of social media technologies in promoting healthcare. Papers explored how social media can revolutionize ways of healthcare delivery. For example, social media allows patients to give real-time data using electron sensors that are connected to social media platforms. Papers also explored ways to facilitate connections with patients from rural areas using social media networks. We believe that this minitrack has the potential to continue grow at HICSS and will soon become the center of attraction for many interested researchers.

3.1.5 HIT Architectures and Implementation

This theme included papers that appeared in the IT applications and architectures in healthcare environment minitracks, IT architectures and implementations in healthcare environments minitracks, IT architecture and application in healthcare environments minitracks. These minitracks started at the 41st HICSS (2008) and continued to appear in the conference every year after.

Papers in this theme focused mainly on human performance improvement, assessment, and technologies, which affect the way organizations build healthcare systems today (Juric, Kim, Panneerselvam, & Tesanovic, 2017). Research topics came from a wide variety of HIT implementation areas such as the modeling of HIT users' behavioral changes (Robinson, Akhlaghi, & Deng, 2013), HIT for process management (Ryan, Lewis, Doster, & Daily, 2014), and the development of effective healthcare apps on mobile operating platforms (Agarwal et al., 2013). The HIT architectures and implementation theme focused mainly on the architecture and implementation of HIT and, thus, on topics such as personalized medicine (Israelson & Cankaya, 2012; Bravhar & Juric, 2017), predictive HIT (Abidi, Cox, Shepherd, & Abidi, 2012; Rudra, Li, & Kavaki, 2012), HIT for drug administration (Bravhar & Juric, 2017), smart healthcare (Haghighi, Zaslavsky, Krishnaswamy, & Gaber, 2009; Mauro, Sunyaev, Leimeister, Schweiger, & Krcmar, 2008; Green & Young, 2008; Clarke & Steele, 2014), and tracking HIT (e.g., Ryan, Doster, Daily, & Lewis, 2016).

Arguably, topics that appeared this theme's minitracks overlapped with or extended the IT adoption, diffusion, and evaluation minitrack; however, this theme's minitracks have attracted several studies that uniquely deal with creating HIT's IT architecture. Compared to the other minitracks, the IT architecture and implementation in healthcare minitrack attracted the second highest number of papers at HICSS from 2008 to 2017.

3.1.6 HIT Cyberinfrastructure

This theme included papers in the cyberinfrastructure for public health and health services minitrack and the health cyberinfrastructure: applications and technologies for population health and health services minitrack. HICSS included these minitracks for only a short time (i.e., from 2010 to 2012). As such, this minitrack included a low number of papers compared to other minitracks that HICSS has offered for a longer time. This theme included papers that covered topics such as HIT structure (Horan, Shaikh, Chismar, & Feldman, 2012), HIT design aspects (Seror, 2011; Schooley, Fieldman, & Alnosayan, 2011; Strum, Frugling, & Schumaker, 2012), HIT compliance strategies (Majchrzak & Charkravorty, 2012), and HIT use expectancy (Beckjord, Rechis, & Hesse, 2012).

This theme's topics overlapped with the HIT adoption minitrack at HICSS, which, we suggest, largely explains why HICSS discontinued the two minitracks under this theme. We found that the two minitracks in this theme had a limited impact in terms of topic authenticity; however, the studies published under this theme had interesting outcomes that contributed directly to the field. Johnson and Willey (2011), for example, investigated the effect of HIPAA's privacy policies and HITECH's legislations on the security of

patients' health records. This topic has high relevance to the field because healthcare data security and privacy continue to constitute issues that need constant updates. Their findings indicate that the threat and vulnerability for the healthcare sector continued even as HIPAA and HITECH became effective.

From the research in this theme, we can conclude that healthcare cybersecurity represents a key public health concern that needs immediate attention. An insecure HIT can directly affect patient safety; therefore, researchers have called for more awareness about the impact that cyberattacks can have on various HIT.

We encourage researchers who are interested in topics relevant to this theme to consider other minitracks at HICSS that relate closely this theme, such as the HIT implementation minitrack and the HIT adoption minitrack.

3.1.7 HIT Data Analysis and Mining

This theme included papers from the data analysis and visualization in biomedical informatics minitrack and the innovative data analysis and data mining tool in biomedical informatics minitrack. These minitracks appeared at HICSS between 2011 and 2014 and published few papers (e.g., only two papers appeared in the minitrack at the 45th HICSS in 2012). By and large, the papers in this theme focused on the implementation of data-mining tools, subsequent data analysis in biomedical research, and highlights from the current state of research in bioinformatics and medical informatics (Ali, Dempsey, & Patton, 2012).

Many of the topics in these minitracks overlapped with what other important minitracks focused on, such as the HIT adoption minitrack and the HIT implementation minitrack. As such, they did not attract many papers, and the conference discontinued it only four years after they first appeared. Researchers who presented their work in this area looked into important and real health problems. For example, Gurr (2011) defined policies to determine how many influenza vaccine companies would be needed to provide a sufficient number of vaccines for a normal influenza season. Dempse, Bonasera, Bastola, and Ali (2011) used a novel approach to identify gene targets. Iqbal, Shepherd, and Abidi (2011) looked into an ontology-based EMR for chronic disease management. Lospinoso and Satchell (2011) used social network analysis to analyze the correlation between smoking behaviors and friendship formation. Lee, Jana, Mylavaram, Dinakarandian, and Owens (2012) suggested a workflow process for clinical trials in mental healthcare. Zurada, Shi, and Guan (2013) provided a fuzzy neural approach to classify low back disorders risks. Hammond and Laundry (2014) applied a hybrid text-mining approach to study suicidal behavior in large populations. Chuang, Lin, Chang, and Yang (2014) applied an algorithm to facilitate statistical methods in analyzing associated variations for breast cancer susceptibility. We found that this theme's research often focused on biomedical issues, which may add to why HICSS discontinued the minitracks associated with the theme. We believe that HIT data mining is an important topic that would attract a wider audience and encourage HICSS to offer a minitrack on it in the near future.

Papers in this theme showed that health-data analysis can enhance inter-operability, data standardization, and compatibility for all future health-data utilities. However, they showed that mining, sharing, and generating healthcare data requires additional investments in developing linkages across the different types of healthcare data and data warehouses to achieve optimal goals.

3.1.8 HIT Design and Visualization

This theme included papers that appeared in the HIT design and visualization minitrack, the user experience in information systems for health and wellness minitrack, and the user experience design for health and wellness minitrack. In addition, we included some of the papers in the data analysis and visualization in biomedical informatics minitrack in this theme. HICSS has offered these minitracks since 2013. The minitracks in this theme provided an outlet for HIT research that included user experience as a part of the HIT concept or evaluation.

The research in this theme evaluated HIT through the user-experience lens. An increase in consumers' needs from HIT is shaping this interesting, relevant phenomenon. Technology users today want more than basic usability and functionality and seek no less than a perfect user experience. The constant demand for positive user experiences has created the need for innovations in user experience approaches for health and wellness products and services.

Studies in this theme mainly focused on HIT and health mobile apps design (Heshmat, Mostafa, & Park, 2017; Choi & Tulu, 2017; Tulu et al., 2016). However, other papers looked into visual analytics (Al-Hajj, Pike, Riecke, & Fisher, 2013), HIT task performance (Redd, Rindfleisch, Nebeker, & Zeng-Treitler, 2013), and specialized HIT interface for people with disabilities (Shibata, Hattori, & Matsumoto, 2017; Liu, Stacey, Tarafdar, & Kourentzes, 2017).

Papers in this theme emphasized that proper data visualizations must consider all privacy and security guidelines by removing specific patient data and must allow users to access the information through multiple types of devices. The papers showed that good visualization includes personalization, storytelling, relevance, timeliness, connections, and comparisons.

Compared to other successful minitracks at HICSS, the HIT design and visualization theme did not have a higher number of papers, but the importance of the topics they covered makes this minitrack valuable. Arguably, some of the topics overlapped with HIT adoption and implementation; however, we encourage researchers to investigate areas unique to the user experience aspect of HIT, such as self-monitoring and management systems, fitness and exercise applications, doctor-patient communication systems, online information sources such as WebMD, preventive care systems, and HCI issues in using health technologies across cultures or geographic regions.

3.1.9 HIT for Clinical Decision Making, Interventions, and Wellness

This theme included papers in the technologies for clinical decision making, interventions, and wellness minitrack. HICSS offered this minitrack only once in 2016. We included only four papers in this theme. First, Chai, Roen, and Boyer (2016) described the patient-centered design of an ingestible biosensor system. Second, Moghimi, Vaughan, McConche, and Wickramasinghe (2016) explored how business analytics and business intelligence converge to improve care efficiency. Third, Banerjee, Ramanujan, and Agnihotri (2016) conducted a case analysis of a mobile application in a diabetes and hypertension clinic. Finally, Bock et al. (2016) produced an instrument to assess multiple aspects of individuals' relationship to their own mobile phones.

Although unpopular minitracks tend to merge with other minitracks due to similarities in their research objectives, the minitrack that comprised this theme uniquely focused on HIT that helps users make decisions about their health. Therefore, authors who conduct work with a similar focus may find it difficult to submit their work to other minitracks. We encourage minitrack chairs to consider offering the minitrack more frequently.

Papers in this theme provided a glimpse of the future of healthcare delivery. Precisely, they emphasized the importance of mobile health in increasing the likelihood of positive healthcare outcomes.

3.1.10 HIT Strategy

This theme included papers in the strategies and technologies to exchange medical information minitrack, global health IT strategies and applications minitrack, e-health strategies, strategies for healthcare information systems minitrack, and e-health strategies minitrack. HICSS offered the first HIT strategy minitrack in 2000 as part of the IT in healthcare track. We found that HICSS did not offer the HIT strategy minitrack between 2006 and 2013, though it returned in 2014 after changing its title to "global health IT strategies" and appeared in all future conferences.

While this theme included minitracks on topics that related to emerging trends of innovative HIT solution applications, later HIT strategy minitracks (i.e., those after 2014) focused more on global aspects when applying HIT innovations in areas such as population health and community healthcare, electronic solutions that emphasize low costs, and mobile and sensor-enabled or other new HIT. These HIT solutions provide a multinational perspective on the benefits of mobile health and other emerging information technologies. Additionally, we found topics related to new ways of delivering complementary and traditional healthcare.

Given that HICSS offered minitracks on HIT strategies for only three years between 2008 and 2017, we found a relatively high number of research papers in this theme. The papers mainly focused on global health but still included novel ideas such as change strategies (Tohouri, Asangansi, Titlestad, & Braa, 2010), HIT privacy policies (Chessman & Heminger, 2009), crowdsourcing medical diagnosis (Ghosh & Sen, 2015), and global health interoperability (Vo, Liu, Horan, & He, 2015). Because the minitracks under this theme initially focused on HIT strategy, we believe that future research may enrich this area with

studies that compare cross-regional strategies of HIT applications, consider socio-cultural-policy, and assess the impact of regional strategies on HIT implementation and new health regulations on HIT deployment.

Overall, the research in this theme showed that developing a successful managed healthcare program requires mastering a series of decisive, logical moves, which analysis, research, and insight drive.

3.1.11 HIT Innovation, Learning Systems, Big Data, and Change

This theme included papers in the health behavior change-support systems minitrack, the IT innovation for change in healthcare minitrack, and the learning health systems minitrack.

HICSS offered the health behavior change-support systems minitrack in 2013, 2016, and 2017. This minitrack focused on HIT with direct impact on a person's health and wellbeing behavior and its design, development, and implementation.

The IT innovation for change in healthcare minitrack mainly focused on HIT that can assist consumers to change their behavior by providing educational information. This minitrack focused on patient-centered care topics that make patients become more involved in their own healthcare process. Additionally, this minitrack highlighted how one can use persuasive models to develop behavioral changing HIT, such as persuasive decision support systems for self-care or persuasive games to support chronic conditions. Papers in this minitrack addressed technical, behavioral, social, and health issues. Brigham, Javitz, Krasnow, Jack, and Swan (2013) developed an online tool that interacts with smokers and provides them with treatment recommendations to help them quit smoking. McCusker et al. (2013) provided a novel data-analysis technique to explore how youth tobacco-access laws have affected the rate of change in cigarette smoking among high school students over time. Yoda, Nahl, and Crosby (2013) conceptualized a systematic intervention for college women and used mobile text messages to provide personalized and timely information about human papillomavirus (HPV) and its vaccines.

HICSS offered the learning health systems minitrack only in 2015 and 2016. This minitrack covered a wide range of topics related to HIT learning systems. Dealmeida, Al-Jaghbeer, Abdelhak, and Kellum (2015) presented a study to evaluate the effectiveness of an alert health system for acute kidney injury. Ben-Ari and Hammond (2015) used EMR text mining to predict suicidal behavior among U.S. veterans of the Persian Gulf War. Marungo et al. (2015) created a data science platform for developing complication risk models for planning personalized treatments in radiation oncology. Shi, Zurada, and Guan (2016) used a probabilistic graphical model to classify types of debt in hospitals and to identify "bad" debt.

In summary, papers in this theme commonly agreed that converting to EMR helps healthcare organizations produce vast amount of data that contains information that they can easily access via electronically mining it—a feat impossible with paper records.

3.1.12 HIT Interoperability, Standards, Collaboration, and Coordination

This theme included papers from the interoperability and standards in healthcare IT minitrack, the IT-enabled healthcare coordination minitrack, and the technology-mediated collaboration in healthcare minitrack.

HICSS offered the interoperability and standards in healthcare IT minitrack only once (i.e., in 2008), and it included only three papers. Chun and Geller (2008) evaluated ontologies based on the naturalness of their preferred terms, McGregor, Steadman, Percival, and James (2012) presented a method for modeling HIT capacity in patient journeys supported by inter-professional teams, and Gaynor, Myung, Gupta, Rawn, and Moulton (2008) conducted a conceptual study on HIT applications and devices interoperability.

HICSS offered the IT-enabled healthcare coordination minitrack for the first time in 2017 at the 50th HICSS. Healthcare coordination involves organizing and sharing information among all participants involved in patient care in order to provide safer and more effective care. Researchers have identified healthcare coordination as a key strategy to improve healthcare's effectiveness, safety, and efficiency. The IT-enabled healthcare coordination minitrack focused on designing and using technology and non-IT assets such as process changes, innovative IT artefacts, and interoperability standards to address these challenges to achieve and enable efficient coordination in healthcare.

In 2017, the technology-mediated collaboration in healthcare minitrack included five papers. Meyer and Pare (2017) provided a case study on the transformative role of telemedicine on coordination using mobile

communications. Sherer, Meyerhoefer, and Levick (2017) also conducted a case study on the challenges of aligning coordination technology with organizations, people, and processes in healthcare. Higa and Davidson (2017) investigated value co-creation in the chronic care model for rural under-resourced areas. Stephens et al. (2017) used boundary theory to explore what barriers prevent people from bringing their mobile devices to hospital (i.e., barriers in bring your own device (BYOD)). They provided divergent boundary management strategies to overcome those barriers.

HICSS offered the technology-mediated collaboration in healthcare minitrack from 2011 to 2015. The minitrack focused on collaboration technologies that allow healthcare providers to communicate with one another, review patient records, manage workflows, and improve the delivery of patient care. The papers in the minitrack addressed a wide variety of topics. Moghimi, Vaughan, McConche, and Wickramasinghe (2015) focused on developing an architecture to help clinicians, patients, and a computer agent (for analysis) to collaborate using various media to help them better care for patients. Ojo et al. (2015) focused on a system for patients and caregivers to exchange data and treatment using the web for care and education.

Papers in this theme found that the input from different HIT stakeholders lays out a clear path to ensure the stakeholders who will build and use the HIT infrastructure (which includes HIT standards and policies) can collaborate. Therefore, stakeholders need to collaborate to optimally use HIT for patient care.

3.1.13 HIT Mobile Apps, Sensors, and Wearables

This theme included papers from the evidence-based design and analysis for mobile and Web health minitrack; the mobile and sensing solutions for health promotion and maintenance minitrack; the mobile applications and emerging technologies for health promotion and maintenance minitrack; the mobile apps and wearables for health management, analytics, and decision making minitrack, and the sensing and pervasive technologies and applications for healthcare minitrack. HICSS offered these minitracks between 2014 and 2017; however, the conference offered the mobile and Web health minitrack only in 2014 and 2015.

Health mobile applications, wearable devices, and sensors have rapidly changed care-delivery techniques and brought new ways to detect and respond to disease through real-time biometric data collection. Detecting individuals' activity, diseases, and adherence to medication through personal sensors, smartphones, tablets, and advanced medical biosensors provide new insight into managing diseases and challenges in securing and processing data (Boyer, Chai, & Carreiro, 2018). As such, papers in this theme explored issues related to implementing and using mobile applications and biosensors in addition to concepts and techniques in processing large volumes of data.

Hsu, Benton, and Gottumakkala (2015) presented a flu-monitoring system that uses prescription-based data. The system has a real-time flu surveillance engine that reads e-prescription data. Next, the engine extracts prescriptions, dosage, patient information, and pharmacy location information from the prescriptions and presents a relative flu risk index by zip code. Loos and Davidson (2016) conducted a survey study to capture physicians' views on wearable HIT to gather data from patients. The study suggests that physicians have concerns about regulations, intrusiveness, and interruptions of wearable devices. Tulu et al. (2017) introduced the "SlipBuddy" mobile app that acts as an intervention system to implement stimulus control strategy to help users lose weight.

The mobile health area sees rapid changes and constantly improved products. The new apps, sensors, and wearables that constantly emerge generate rich areas for HIT researchers to explore. Mobile health is shaping new directions and methods for future care delivery, which one can see in the various interesting studies that appeared this theme's minitracks.

3.1.14 HIT Privacy and Security for Health Information Systems

This theme included papers from the privacy and security for health information systems minitrack, which HICSS offered only in 2001 and 2002. Not until 2017 did it begin to offer it again. HIT security and privacy have become critical issues in the healthcare industry. HIPAA rules mandate that patients must have full access to their health data and that healthcare organizations must protect this data's privacy by limiting other parties' access to it. Additionally, the rapid adoption rates of mobile devices and mobile applications, pervasive technology, and wearable sensors create challenges for keeping the large volume of generated data secure and private (especially when transferred between users). Furthermore, as security incidents and data breaches continue to arise, patient information continues to be at risk. Therefore, healthcare

organizations experience constant pressure to enhance the credibility and reliability of the health facilities that they provide (Plachkinova & Grispos, 2017).

Our review revealed a small number of papers in this theme partly because HICSS offered the associated minitrack in only one year in the period we reviewed (i.e., 2017). Despite these factors, the papers covered important and interesting topics. Lockett, McDonald, and Glisson (2017) studied ambulatory medical devices with modeled cyberattack graphs to assess these devices' potential security threat. De Mooy and Yuen (2017) conducted a qualitative research study using grounded theory to analyze data from the research and development of Fitbit wearables. Anderson et al. (2017) provided a framework for evaluating the tension between sharing and protecting health information. However, the HIT security and privacy work at HICSS needs more presence and researchers are encouraged to submit more research on HIT privacy and security issues to this minitrack. Suggested topics include challenges associated with EMR security/privacy, cloud computing, and mobile apps. Additionally, researchers may present effective tools, techniques, and algorithms for protecting healthcare data and its infrastructure.

Although this minitrack did not appear at HICSS from 2008 to 2017, other security and privacy tracks at HICSS attracted HIT researchers to present their work. However, data breaches and cyberattacks seem to be inevitable.

3.1.15 Elderly Use of HIT

This theme included papers from the seniors' use of health information technology minitrack and the technologies for healthy aging minitrack. HICSS offered these minitracks for the first time in 2016 and again in 2017. These minitracks provided an opportunity to examine the needs and motivations of seniors' caregivers and the design, social, and engineering processes that can make HIT successful among communities and their senior members in particular (Crandall, Cook, & Schmitter-Edgecombe, 2016).

The topics in this theme apparently overlapped with the HIT adoption minitrack; however, we continue to believe that we need dedicated research that focuses on improving IT-mediated healthcare delivery to seniors. The papers under this theme addressed various topics. Bao, Howue, and Wang (2016) explored the processes explaining adult children's decisions to use online health information for their aged parents' healthcare when balancing risk against increasing healthcare costs. They provided a framework of how people handle decision making in the information age. Keijzer-Broers, Florez-Atehortua, and de Reuver (2016) explained a process for developing healthcare platforms to help people age healthily. The process provides insights on key factors that make HIT products truly useful to their target aging users. Papadopoulos and Korakis (2016) used a design science approach and found a positive correlation between older adults' properly executing medicine and therapies and their ability to age in place (e.g., their own house). Alharbey (2016) conducted a study on a system to monitor, analyze, and predict patients dealing with chronic obstructive pulmonary disease (COPD). The system uses machine-learning techniques to provide information about monitored patients. Rockmann and Gewalt (2017) provided suggestions on how to motivate adults to check for Alzheimer's disease.

Overall, the research in this theme showed that HIT usage behavior differs across different age groups and that HIT designers must consider all types of users when building any HIT.

We believe that future research should build on these relevant research studies about older adults, their needs for HIT, and the ways technologies can make their life better and improve their health quality and outcomes.

3.2 Methods

When analyzing the papers, we coded them based on their methodological approach. Few papers used multiple methodologies. We grouped papers based on the research methods they used. We found that the 409 HICSS papers in this review used 10 main methods. Figure 4 illustrates how frequently each method occurred.

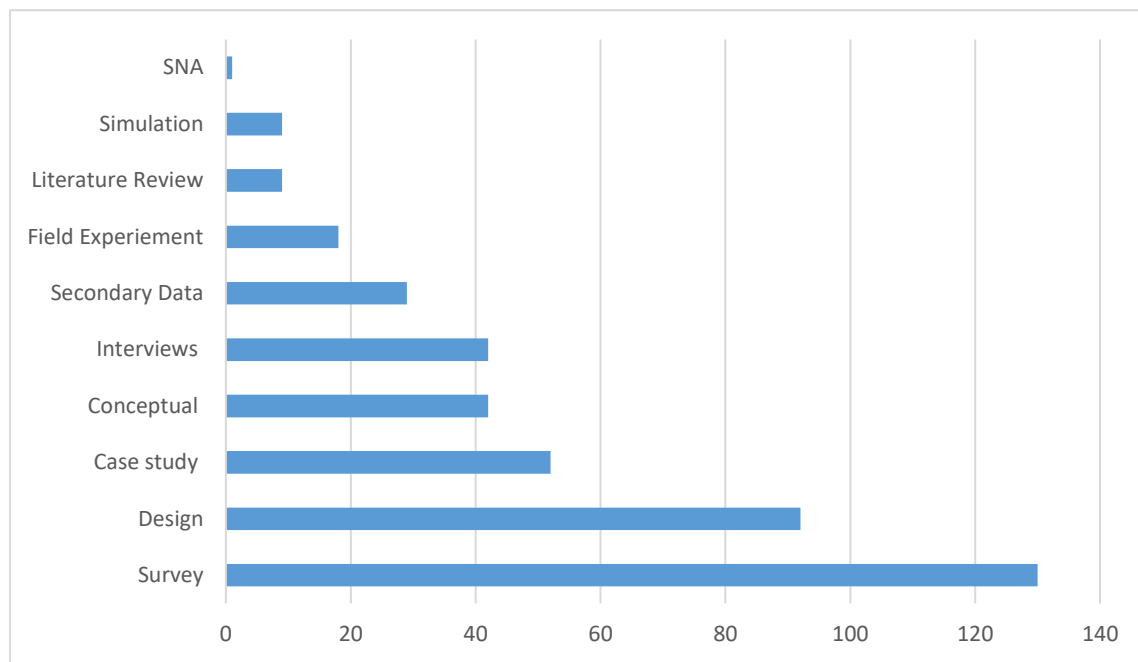


Figure 4. Frequencies of Used Methodology

The highest number of papers used the survey methodology (31% of all papers); that is, they distributed hard/soft copies of questionnaires to subjects. Such a result is not uncommon to IS research, which focuses on self-reported data about technology users' behaviors. However, many researchers in the IS field have begun to focus on producing more studies that use qualitative analysis to explore a variety of topics related to IS and its applications.

The second highest number of papers used the design methodology. Papers that used this methodology focused on testing and evaluating systems and technologies using design principles (March & Storey, 2008), which is becoming a more popular method in HIT studies due to the current widespread use of health mobile applications and wearable technologies. Some studies we reviewed developed, tested, and analyzed mobile apps for healthcare purposes (Agarwal et al., 2013; Hamper, 2015).

The third highest number of papers used the case study methodology (12.7% of all papers). Papers that used this methodology examined HIT-related phenomena by employing multiple methods of data collection to gather information. For example, Kutz and Ekbia (2011) used the case study methodology to evaluate undergraduate students' perceptions of different health-management tools and online personal health records, and they collected data from focus groups using surveys.

An equal fourth highest number of papers used the conceptual methodology and the interview methodology (i.e., 10.3% of all papers used each methodology). However, conceptual papers rely mostly on developing frameworks or providing management guidelines and do not use a specific data-collection method. They focus on assumptions, premises, axioms, assertion, and so on (Dadgar, Samhan, & Joshi, 2013; Hirschheim, 2008; Wiener et al., 2010). Therefore, qualitative studies that do not collect data tend to use a conceptual methodology.

Alternatively, researchers normally conduct interviews with smaller samples and use them in multi-method studies that apply other forms of data gathering, but one can use interviews as a standalone methodology as well. We found that papers used both structured and semi-structured interviews. While a structured interview has a rigorous set of questions that one cannot divert from, a semi-structured interview allows the interviewer to bring new ideas up during the interview based on what the interviewee says. For example, Topacan, Basoglu, and Daim (2009) used semi-structured interviews with open-ended questions to doctors and nurses to study aspects of telemedicine adoption in a hospital in Turkey. On the other hand, MacKinnon and Wasserman (2009) used structured interviews with healthcare professionals involved in implementing EMR systems to uncover critical success factors of EMR implementation.

Additionally, some studies also a mixed-methods approach. For example, Xie and Pearson (2010) used interviews and surveys to collect data in order to test how usable older people in nursing homes found a

prototype Google map website; however, only six percent of the papers we reviewed used mixed-methods approaches and 15 percent of them used interviews. We encourage researchers to conduct more mixed-methods research to both explore and analyze HIT in the same study. Additionally, with such an approach and the variety of tools it affords them, researchers can collect more comprehensive data to provide results with a broader perspective of an overall issue or research problem.

The fifth highest number of papers used secondary or archival data (7.1%) (Henriques & Antune, 2014; Lu & Rui, 2015; Nambisan, Luo, Kapoor, Patrick, & Cislser, 2015). Researchers who used this methodology collected data only from unreported publications, magazines, multimedia, and so on. We found that secondary data sources for HIT studies mostly came from social media platforms such as Twitter (e.g., tags) and Facebook (e.g., posts). Further, we found that most studies that used secondary data applied novel data-analysis techniques. Further, one third of the studies that used secondary data methodology had an international perspective. Thus, we encourage future scholars to consider using secondary data in their research because it provides better opportunities to access data that can help in conducting longitudinal and international investigations.

In our study, we differentiated between case studies and field experiments. Field experiments study phenomena in their natural settings (Harrison & List, 2004). In order to collect data in field research, researchers have to pick a particular site and stay in that site for a long period. Shaffir and Stebbins (1991) describe field research as a continuous process including entering the area, learning the culture, maintaining relationships, and leaving the area. Our analysis shows that the sixth highest number of papers (only 4.4%) used field experiments—possibly because field studies typically take a long time to gather data for. With that said, we note that all the field experiments in the studies we reviewed took place outside the United States.

An equal seventh highest number of papers conducted a literature review or a simulation study (only 2.2% of all papers used each methodology). Literature review studies reviewed, analyzed, and commented on prior research in a specific area of HIT. For example, Samhan and Joshi (2015) reviewed prior literature on technology resistance and analyzed the emerging research gaps in depth. They reviewed all prior IS and healthcare journal publications and conference proceedings.

Simulation research involves imitating the operation of a real-world process or system. Most of these studies used computer simulations such as agent-based modeling (Dadgar et al., 2013). Helbig, Stoeck, and Mellouli (2015) conducted a simulation of a decision support system for evaluating flexible ward clusters in hospital occupancy management. Nsakanda et al. (2015) performed a simulation approach at a hospital in Ottawa to understand workflow changes when deploying a new computerized physician order entry system (CPOE). Simulation research produces useful findings in that it provides predictions for uncertainty situations and can easily analyze cost-effective what-if scenarios.

Finally, the lowest number of papers used social network analysis (SNA) as a research method. Research that used this method investigated social structures via networks and graph theory (Borgatti, Mehra, Brass, & Labianca 2009). SNA is not a common methodology in IS research in general (Samhan & Joshi, 2015) because it focuses more on social interactions between subjects. Educational research and sociology research uses it on a larger scale (Ruane & Koku, 2014). We found only one paper that used SNA: Lospinoso and Satchell (2011). These authors looked at effects of designated smoking areas on relationship formation among university students.

Our analysis indicates that researchers have drawn from a wide spectrum of methods to conduct their research. Next, we categorized the papers by methodology across each of our 15 themes. Table 1 shows methods by themes in terms of percentages. We also looked into the type of the study (i.e., qualitative or quantitative). The numbers in the table represent how often each method occurred (in percentage) in each HICSS minitrack of the IT in healthcare track from the 41st to the 50th HICSS.

Table 1. Method Occurrence by Theme

Method Theme	Case study	Conceptual	Design	Field experiments	Interviews	Literature review	Secondary data	Simulation	Survey	SNA	% Total themes	Qualitative	Quantitative	Mixed methods
Bioinformatics and translation research	.12	.12	.12	-	.40	.12	-	-	.12	-	.02	.43	.43	.14
HCI and consumer health informatics	.14	.03	.25	.02	.20	.10	-	.05	.21	-	.10	.25	.51	.24
HIT adoption, diffusion and evaluation	.12	.08	.24	.03	8	2	8	5	42	-	.29	.46	.47	.07
HIT and social media	.20	-	.80	-	-	-	-	-	-	-	.02	.40	.40	.20
HIT architectures and implementations	.13	.08	.20	.02	.08	.01	.08	.02	.35	-	.18	.60	.39	.01
HIT cyberinfrastructure	.20	.20	.20	-	-	-	.10	-	.30	-	.02	.10	.90	-
HIT data analysis and mining	.2	.06	-	.06	.20	-	-	.06	.33	.06	.03	.27	.73	-
HIT design and visualization	-	.11	.55	-	.22	-	.11	-	-	-	.03	.77	.23	-
HIT for clinical decision making, interventions, and wellness	.25	-	.50	-	-	-	-	-	.25	-	.02	.75	.25	-
HIT strategies	.07	.03	.26	.07	.07	-	.03	-	.42	-	.06	.53	.47	-
HIT innovation, learning systems, big data, and change	.09	-	.22	.09	.09	-	.18	-	.31	-	.05	.50	.36	.14
HIT interoperability, standards, collaboration, and coordination	.30	.03	.11	.03	.11	-	.07	-	.30	-	.06	.73	.27	-
HIT mobile apps, sensors and wearables	.03	.03	.12	.12	.06	.03	.15	.06	.37	-	.07	.48	.42	.10
HIT security and privacy	-	-	-	-	-	-	.33	-	.67	-	.02	1.00	-	-
Seniors' use of HIT	-	-	.36	.18	.18	-	-	-	.27	-	.03	.36	.54	.10
% Total methods	.13	.10	.22	.04	.10	.02	.07	.02	.31	.002	1	.43	.51	.06

3.3 Technology

In performing the literature review, we uncovered that researchers have used several different HIT. We considered the type of HIT each paper studied as an important attribute in our process. The different functionalities of the examined technology and its performed tasks can impact the healthcare environment (e.g., users' perceptions and opinions about a HIT can vary when introduced to different technologies (Samhan & Joshi, 2015).

We found several interesting patterns. First, studies in the HIT adoption, diffusion, and evaluation theme have looked into EMR the most. Specifically, 28 percent of all papers, excluding those that had no HIT or that we coded under the general category "other HIT", in the IT in healthcare track at HICSS used EMR in their studies. The popularity of EMR stems from the constant change it brings to the healthcare industry. The U.S. Government has mandated its use and offered incentives to healthcare providers and practices that implement and use it meaningfully. As such, EMR generate many topics on technology adoption, resistance, avoidance, and change—all of which fit with the overall theme of HIT adoption, diffusion, and evaluation.

Second, authors under the HIT data analysis and mining theme used data analysis tools the most and social media platforms the second most in their studies. The popularity of the social media platform in this theme may result from the pervasiveness of these platforms, which generate large volumes of data. The

fact that data-analysis methodologies produce the best results when used with large quantities of data may also contribute to the popularity of this platform in this theme. One can relatively easily connect data from social media platforms for data-analysis purposes.

Third, our analysis revealed that cloud computing-type applications, patient portals, radiology information systems, and virtual reality devices represented the least-used HIT—a counterintuitive finding given the widespread adoption of these technologies and applications. We call on researchers to submit more work on these technologies to keep this field current and as engaged as possible with practice.

Our review revealed 13 types of HIT. Figure 5 illustrates these HIT by the number of papers that conducted a study using these technologies (studies could use more than one technology).

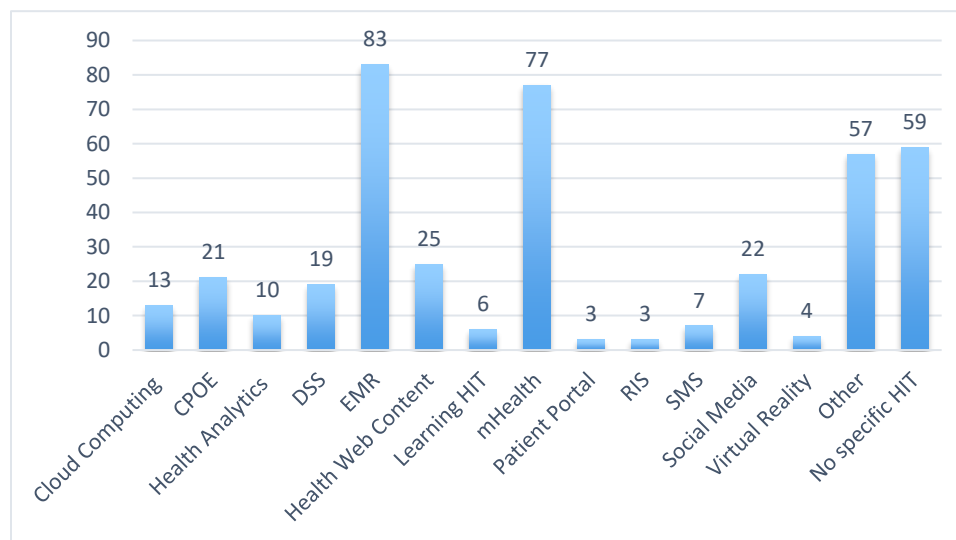


Figure 5. Frequencies of Studied HIT

As one can see, researchers studied EMR and m-health the most. Almost one third of the papers included EMR in their studies. EMR includes all types of electronic health records (i.e., EHR and PHR). Most of these studies appeared in the HIT adoption, diffusion, and evaluation theme. For example, Noteboom, Dempsey, and Fruhling (2014) recognized patient safety importance through validating the instruments on physicians' assessment of EMR, and Nambisan (2014) looked at the impact of peer-to-peer interactions, peer support, and online forums on EMR adoption among office-based physicians and practices.

M-health technologies include mobile devices, mobile applications, wearable sensors, tracking systems, portable devices, telemedicine applications, and mobile health monitors. The second highest number of studies examined these technologies. However, with the rapid advancements of today's technologies, especially the mobile gadgets, researchers need to continuously conduct more research on topics related to m-health such as security and privacy challenges of mobile devices and remote communications, mobile app developments, adoption of health wearables, and so on. We believe that HICSS is a great fit for these types of studies and will continue to attract scholars interested in conducting research using m-health and its applications.

Cloud computing applications provide remote storage services. These include the software as a service (SaaS), infrastructure as a service (IaaS), and platform as a service (PaaS). Few papers in our review (around 5%) used cloud computing. As one example, Botts, Noamani, Horan, and Thoms (2010) provided the architectural design for a personal health record system called "HealthATM" that uses and integrates services from Google's cloud computing environment. We encourage researchers to conduct more studies using cloud computing to enrich the IT in healthcare track with interesting phenomena surrounding cloud computing and to enrich our knowledge about this vital component of today's HIT advancements.

A computerized physician order entry (CPOE) refers to process in which medical practitioners electronically enter their instructions to treat patients (particularly hospitalized patients) under their care. Today, EMR has begun to slowly replace CPOE systems (Samhan & Joshi, 2015). Our review indicates that around eight percent of the studies looked at CPOE. However, our figures obviously apply only to HICSS—other research outlets have investigated CPOE extensively for years.

The term health data analytics refers to the healthcare analysis activities that one can undertake with data that different HIT have collected. Healthcare analytics is a growing industry in the United States that some sources expect to grow to more than US\$18.7 billion by 2020 (Fan, Han, & Liu, 2014). HIT generates large volumes of data (big data), which calls on research efforts to make sense of it. However, our review revealed that only around four percent of the studies used data analytics. We encourage researchers to consider more data analytics in their studies, especially in this era of big data where researchers can advance our knowledge based on the raw data that the interactions between different types of HIT generate.

Only seven percent of the reviewed papers used a decision support system (DSS) in their studies. We categorized most of the DSS papers into the HIT for clinical decision making, interventions, and wellness theme. DSS generally refers to a set of related computer programs and the data they require that assist an organization in conducting analyses and making decisions. However, in the context of our study, we refer to DSS as an application that analyzes data to help healthcare providers and patients make clinical decisions. For example, Abidi et al. (2012) proposed a knowledge-management solution in an ontology-based clinical decision-support framework for handling comorbidities, and Weber-Jahnke and McCallum (2008) introduced a lightweight component for adding decision support to different HIT.

The health web content (HWC) category of our review includes healthcare websites used for gathering health information. For example, Evans, Manaszewicz, and Xie (2009) used a health information portal for a breast cancer community to assess the role of domain expertise in using the portal. Almost 10 percent of the papers used these technologies. Health information portal and websites such as WebMD continue to rapidly grow, and consumers largely use them. Therefore, we expect to see more papers that use data from HWC in future conferences.

Learning HIT educate users about their health concerns or any other health specific of their interest. For example, Dealmeida et al. (2015) presented a study to evaluate the effectiveness of an alert health system for acute kidney injury, while Ben-Ari and Hammond (2015) used EMR text mining for predicting suicidal behavior among U.S. veterans of the Persian Gulf War. Only two percent of the papers we reviewed used these technologies. Interested scholars could explore phenomena related to HIT learning systems and target the minitrack for publications to address the small number of studies that have adopted these types of systems.

Patient portals (PP) refer to secure online applications that give patients convenient 24-hour access to their personal health information from anywhere with an Internet connection. Using a secure username and password, patients can view their private health data such as recent doctor visits, lab results, and doctors' notes, and, in some cases, patients can leave their doctors a message about a concern or a question they might have. Because PP are a relatively new type of technology in the healthcare sector, we do not know much about their challenges, advantages, effectiveness, usefulness, and ease of use. Despite how little we know about this type of technology, this HIT was the least popular in the studies we reviewed.

Radiology information systems (RIS) refer to imaging systems that radiologists use to store, retrieve, transfer, and manage patients' medical images. These types of technology are not popular in IS studies in general due to the limited interactions that they involve. Only one type of user can interact with the system (the radiologist), who can perform only simple tasks with them. Therefore, HICSS also had limited work on RIS.

A small number of papers used the short message service (SMS). While this service saw popularity in the late 90s, available and affordable technology has advanced and, thus, made text messages less popular than multimedia messages that can include pictures, audio clips, and/or video clips. Additionally, a handful of studies used virtual reality (VR) equipment and devices. However, we have much to learn about these new technologies in terms of how they may improve healthcare delivery to users. Given that the technology is new, we expect to see more research using HIT VR advancements.

Surprisingly, only three percent of the studies used social media—possibly because HICSS did not offer the HIT social media minitracks frequently and because another digital and social media track at HICSS may have attracted HIT researchers who used social media in their studies. However, we encourage scholars to continue submitting HIT social media research to the associated minitrack under the IT in healthcare track to enrich the track's contribution to the field, especially since social media has high popularity among different age groups today.

3.4 HIT Users

The papers we reviewed concentrated on four main types of HIT users: healthcare providers, healthcare staff and managers, patients, and laypeople. We also found studies that used both healthcare providers and patients in the same study (Botts et al., 2010). In addition to the four main groups, we coded the papers that had no subjects in their studies (generally the conceptual papers or literature review studies) (Dohan, Gale, & Tan, 2015; Samhan & Joshi, 2015).

Healthcare staff and managers include executives, managers of healthcare organizations, technical staff, and administrative staff (Jaana et al., 2012; Hansen, Gogan, & Baxter, 2012). Healthcare providers include physicians, clinicians, nurses, medical laboratory specialists, pharmacists, and radiologist (Venkatesh, Sykes, & Zhang, 2011; Li, Moore, Akter, Bleisten, & Ray, 2010; Sampalli, Shepherd, & Duffy, 2011). Laypeople refer to subjects who are not part of a direct healthcare activity at the time of the study, such as a random selection of subjects from a pool of college students (Tao et al., 2012).

Most of the papers we reviewed (36%) focused on healthcare providers. This finding is similar to those of most HIT studies that have focused on physicians, nurses, medical laboratory specialists, pharmacists, and radiologists (Samhan & Joshi, 2015). Our analysis shows that 19 percent of the studies focused on patients. With patients being a major stakeholder in the healthcare process (Campbell, Shield, Rogers, & Gask, 2004; Samhan & Joshi, 2015), the percentage of research in this area does not match their stature in the healthcare process. With that said, this number increased to 26 percent when we considered papers that focused on both healthcare providers and patients.

The research with healthcare providers as the population of focus had many studies that focused on how healthcare providers can better transmit information to patients using EMR systems. Lytle et al. (2012) examined the potential for a personal health record (PHR) system to aid in providing social security administration (SSA) disability determination-process information.

Figure 6 depicts the populations and the percentage of papers for each population.

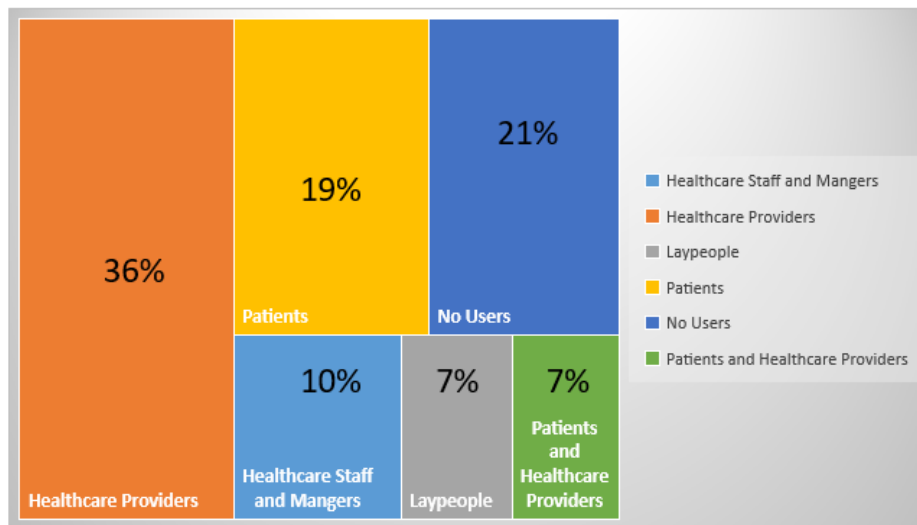


Figure 6. Frequency of Population Studied

We also coded papers from the reviewed literature based on the study's geographical location. We excluded the literature review papers and conceptual studies from the process since they lack such a context. Orlikowski and Iacono (2001) argued that conceptualizing technology is unique to its context; therefore, what may be considered as a successful HIT implementation in a developing country may not be equally true when implementing similar technology in a developed country. As for why, one simple reason may concern how outcome demands and expectations vary across contextual groups (Hong, Chan, Thong, Chasalow, & Dhillon, 2013). Further, HIT's usage context and users' characteristics represent important attributes of IS research (Hevner, March, Park, & Ram, 2004). Outcomes of interactions with the same technology will differ when tested in different settings (Boiney, 1998). Similarly, Gopal and Prasad (2000, p. 512) noted that "technology cannot be studied outside its social context and that inconsistent results may be directly related to our lack of attention to this fact".

In our study, we grouped the reviewed papers based on context (i.e., US versus international). Future research may conduct further analyses; however, we found that majority of the studies (71%) focused on the US. International studies formed 28 percent of all studies, and only one percent of the studies focused on multiple countries (see Figure 7).

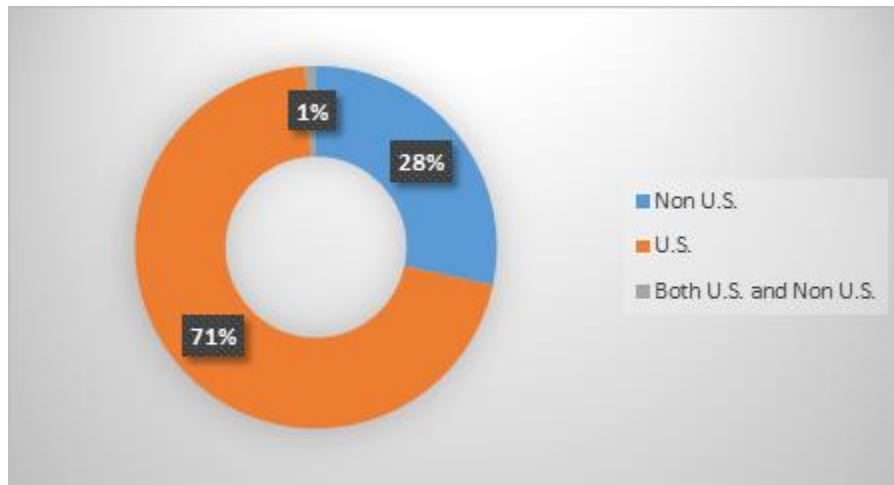


Figure 7. Percentage Submitted Studies per Context

We somewhat predicted these findings given that HICSS has always occurred in the United States. Figure 8 shows U.S. studies compared to international studies submitted to HICSS over the 10-year period we reviewed. One can see a slight increase in the number of international studies submitted to the IT in healthcare track at HICSS over time. The two peaking numbers of international submissions occurred in 2012 and 2016; however, in general, authors have submitted a low number of international studies to the IT in healthcare track at HICSS between 2008 and 2017.

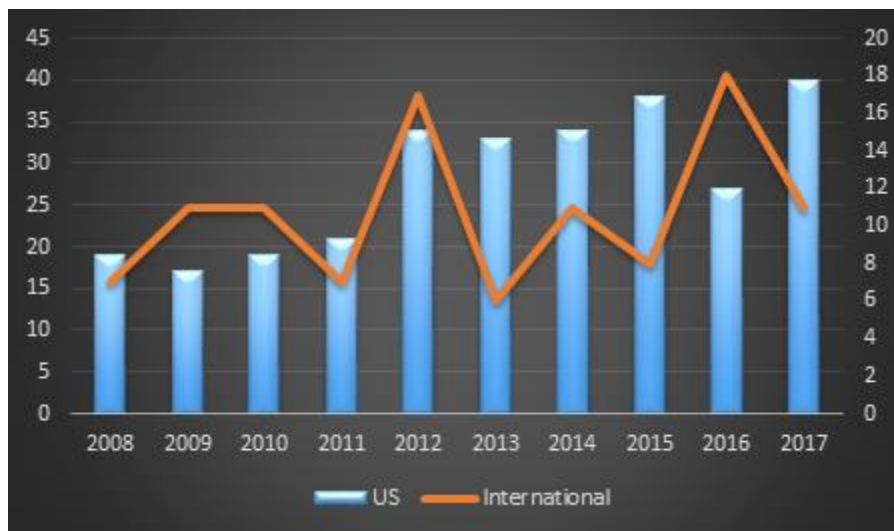


Figure 8. U.S. vs. International Submitted Studies (2008 to 2017)

4 Research Gaps and Topics for Future Research at HICSS

While we acknowledge it would be valuable to look beyond HICSS and analyze papers in ranked journals to better understand their impact, we focus on reviewing the IT in healthcare track in HICSS from 2008 to 2017 to reveal research gaps. As such, our findings apply predominantly to HICSS and serve our ultimate goal of identifying future directions for the IT in healthcare track at HICSS. In this section, we list the most prominent research gaps that emerged from the review.

4.1 Social Media for Healthcare

Given the exponential rate of social-media adoption among all age groups (Lenhart, Purcell, Smith, & Zickuhr, 2010), people seek to apply social media activity to various aspects of their lives. In healthcare, social media has many potential benefits from searching for a doctor to consulting with a healthcare provider about diagnoses and treatments. Social media in healthcare has attracted researchers from both IT and healthcare fields to engage in relevant research. Although HICSS has a dedicated track for digital and social media, it lacked a minitrack on HIT social media in the IT and healthcare track until 2017. As such, we found little research in the area of HIT social media in the conference's proceedings.

However, some papers on healthcare social media appeared in different tracks and minitracks. Those papers focused on the use of socially influencing technologies to promote healthcare. Other studies focused on translating social media analytics into consumer health solutions. However, many research topics in this area still require further investigation, such as the design features of social media healthcare (Myneni & Iyengar, 2016). We encourage scholars to continue investigating issues related to HIT social media and to consider HICSS as an outlet for their findings. We extend our encouragement to HICSS organizers, specifically the IT in healthcare track chairs, to keep promoting minitracks related to HIT social media, and we hope HICSS includes the social media minitrack present at all future years.

4.2 Social Network Analysis

We found limited work that used social network analysis (SNA) as a methodological approach for research. SNA provides a visual analysis of social communications, which can be a useful tool when analyzing HIT interactions and communications that occur over digital medium. SNA represents a valid tool for conducting research, and it paves the way for novel research ideas concerning HIT. For example, one can use SNA to study patient-doctor communications over digital portals or to evaluate the effectiveness of a DSS for interventions using digital communications. We encourage HIT researchers to consider using SNA as a methodological tool for their future research that target the IT in healthcare track at HICSS to enrich the track's methodological contribution to the field.

4.3 HIT Security and Privacy

Digitizing healthcare services introduced new research challenges in terms of protecting the security and privacy of patient data. Our review shows that HICSS offered the security and privacy challenges for healthcare minitrack only once in 2017. When we extended our search, we found that HICSS offered a security and privacy minitrack in 2001 and 2002 as well. The absence of a specialized minitrack on HIT security and privacy issues led to a very low number of papers in the proceedings of the IT in healthcare track. We encourage track chairs to keep promoting research in this under-researched area of the IT in healthcare track.

However, scholars have submitted papers related to HIT security to minitracks under tracks other than the IT in healthcare track. Those studies' findings, when combined with the few such studies in our scope, reveal the interesting paradox of the high demand for answers to important research questions in this area and, on the other hand, the evident absence of research efforts that tackle these issues. Healthcare organizations handle large volumes of (mostly private) data on daily basis that they need to secure properly. Additionally, healthcare organizations constantly endure cyberattacks and security breaches. Therefore, HIT security and privacy represents a fertile research area that requires further attention.

4.4 HIT Policies and Regulations

While the HIT strategy theme from our review included a fairly large number of papers, they generally focused on more global aspects when applying HIT innovations in areas such the improvement of population health and community healthcare, electronic solutions emphasizing low-cost, and mobile and sensor-enabled or other new HIT. However, due to the continuous mandates, rules, and regulations applied to HIT and its applications, it becomes necessary to dedicate a special section (minitrack) for research that focuses on better understanding these regulations and how they affect and shape the HIT, the way we perform tasks using the HIT, and user perceptions towards the HIT. If research addressed these issues properly, healthcare stakeholders could become more confident in a HIT's ability to effectively and efficiently enable healthcare organizations to achieve their goals. We call on interested scholars to consider submitting proposals for minitracks with a focus on the HIT policies and regulations.

4.5 Health Tracking Technology

While we found that the studies we reviewed focused on a wide range of HIT, little research has considered HIT for tracking health. Wearable devices track patients and analyze their clinical outcomes and results of treatments. These technologies are state of the art, which should motivate researchers to conduct work using these technologies so that we see more work on health tracking technology in the IT in healthcare track at future HICSS events.

4.6 Patient Portal

Our analysis revealed limited research that has considered patient portal systems. A relatively new technology, patient portals have experienced challenges in their adoption rate. The introduction of patient portals has created dynamics for research. Topics of research on patient portals include issues of their development, implementation, success/failure, communication effectiveness, social networking aspects, and so on. While some have viewed patient portals as an add-on of other types of technologies such as EMR, we still do not know much about patient portal challenges, advantages, effectiveness, usefulness, or ease of use. However, despite how little we know about this type of technology at HICSS, it represented the least studied HIT in our list of studies conducted at HICSS. Therefore, we urge scholars to build on current findings from journals and other conferences and advance our knowledge about patient portals and their applications. We also recommend interested scholars to submit minitrack proposals for creating a new patient-centered venue for relevant research under the IT in healthcare track at HICSS. Leading conferences in the field such as the International Conference on Information Systems (ICIS) host distinctive tracks dedicated to patient-centered HIT. Thus, we emphasize the importance of having a similar minitrack at HICSS in the near future.

4.7 Global Perspectives

We need to identify the context in which one tests technology and its users' characteristics (Hong et al., 2013). HIT conceptualizations and users' perception tend to differ in different contexts (Boiney, 1998). Therefore, researchers need to conduct studies that evaluate HIT at different geographical locations in order to better generally understand the examined phenomenon surrounding HIT. We found that the majority of the work presented under the IT in healthcare track occurred in the US. Thus, we call on researchers from around the world to continue submitting their relevant research to HICSS in order to have a more contextually diverse research at the conference, specifically under the IT in healthcare track.

4.8 Replication Research

Real methodological continuations and theoretical advancement arise when researchers repeat research studies. Replicating research means conducting the same study with different situations and/or different subjects to determine if we can generalize the original study's basic findings to other participants and circumstances. However, in IS research, we have seen limited work in this direction. We found no paper in the IT in healthcare track that focused on replication. We urge HICSS coordinators to address this important research gap and serve as a pioneer in offering a special minitrack on replication research, which has much relevance to the IT in healthcare track because most studies in the track are multidisciplinary and, thus, adopt theories, frameworks, and models from different fields. We hope to see an HIT replication research minitrack in the near future at HICSS. The conference may also offer it as a distinctive track because replication research can potentially cover a large area of research topics from a variety of fields.

5 Conclusion

We systematically reviewed and analyzed the current state of the HIT literature as it appears in the IT in healthcare track in HICSS from 2008 to 2017. We followed a systematic review procedure and analyzed the papers based on five main attributes: theme, methodological approach of the research, type of studied HIT, type of users (population), and context of the study. We then analyzed each of these attributes in detail. Fifteen themes emerged from our analysis. Each of these themes comprised one or more minitracks. While these themes cover all papers presented under IT in healthcare track at HICSS, many research gaps emerged. Because we reviewed only HICSS papers, we used the emerged research gaps as directions and recommendations for HICSS to consider in future meetings.

Our study revealed that studies have examined EMR and mobile health technologies the most and patient portals, RIS, and virtual reality the least. Additionally, we identified different type of studied populations. Studies used healthcare providers the most to gather data and patients and laypeople the least. Further, despite the importance of diversity in research findings, we found that majority of the studies occurred in the US. However, HICSS has been attracting more international scholars in the last few years, which may result in an increased number of international studies in the near future.

Our study has significant implications for researchers. We reviewed all papers in all minitracks of the IT in healthcare track from 2008 to 2017 and not just a certain topic, technology, or research area. As such, we contribute to HIT research by providing a holistic view of the past and present status of HIT at one of the biggest IS and system science conferences. Additionally, our analysis highlights research gaps from the literature presented at HICSS and a research agenda for HICSS in the future. We encourage scholars to build on the findings and address the research gaps we identified.

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Appendix

Papers Reviewed for this Study

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Table A1. HICSS IT in Healthcare Track Research Themes

Theme	Minitrack topics
Bioinformatics and translation research	<ul style="list-style-type: none"> • Innovative tools for bioinformatics and translational research • Advanced biometrics tools for transitional research • Bioinformatics tools for health care and translational research
HCI and consumer health informatics	<ul style="list-style-type: none"> • Consumer health informatics • Consumer health informatics, patient safety, and quality of practice • HCI and consumer health informatics issues • HCI and consumer health informatics issues in healthcare IT.
HIT adoption, diffusion, and evaluation	<ul style="list-style-type: none"> • IS implementation, adoption and diffusion in healthcare • The implementation, adoption, and diffusion of IT in healthcare • IT adoption, implementation, use and evaluation in healthcare • IT adoption and evaluation in healthcare • IT adoption in healthcare • IT Adoption, Diffusion and Evaluation in healthcare
HIT and social media	<ul style="list-style-type: none"> • Social media and healthcare technology
HIT architectures and implementations	<ul style="list-style-type: none"> • IT applications and architectures in healthcare environment • IT architectures and implementations in healthcare environments • IT architecture and application in healthcare environments
HIT cyberinfrastructure	<ul style="list-style-type: none"> • Cyberinfrastructure for public health and health services • Health cyberinfrastructure: applications and technologies for population health and health services
HIT data analysis and mining	<ul style="list-style-type: none"> • Some from data analysis and visualization in biomedical informatics • Innovative data analysis and data mining tool in biomedical informatics
HIT design and visualization	<ul style="list-style-type: none"> • Some from data analysis and visualization in biomedical informatics • User experience in information systems for health and wellness • User experience design for health and wellness
HIT for clinical decision-making, interventions, and wellness	<ul style="list-style-type: none"> • Technologies for clinical decision making, interventions, and wellness
HIT strategies	<ul style="list-style-type: none"> • Strategies and technologies to exchange medical information • Global health IT strategies and applications • E-health strategies, architecture and workflow management • Strategies for healthcare information systems • E-health strategies
HIT innovation, learning systems, big data, and change	<ul style="list-style-type: none"> • Health behavior change support systems • IT innovation for change in healthcare • Learning health systems • Learning health systems, big data and socio-technical change
HIT interoperability, standards, collaboration, and coordination	<ul style="list-style-type: none"> • Interoperability and standards in healthcare IT • IT-enabled healthcare coordination • Technology mediated collaboration in healthcare
HIT mobile apps, sensors and wearables	<ul style="list-style-type: none"> • Evidence-based design and analysis for mobile and Web health • Mobile and sensing solutions for health promotion and maintenance • Mobile applications and emerging technologies for health promotion and maintenance • Mobile apps and wearables for health management, analytics, and decision making • Sensing and pervasive technologies and applications for healthcare
HIT security and privacy	<ul style="list-style-type: none"> • Security and privacy challenges for healthcare • Privacy and security for health information systems
Seniors' use of HIT	<ul style="list-style-type: none"> • Seniors' use of health information technology • Technologies for healthy aging

About the Authors

Bahae Samhan is a Business Information Systems Assistant Professor in the college of business at Illinois State University. He earned his PhD in MIS from Washington State University in 2016. Beside his research on Health Information Technology, he is interested in Social Network Analysis and Replication Research. His work appeared in many specialized journals including the *International Journal of Electronic Health*, the *Australasian Journal of Information Systems*, and the *International Journal of Healthcare Management*.

Tara Crampton graduated in 2016 from Illinois State University with her Masters in Accounting. She is currently teaching at Illinois State University as an Instructional Assistant Professor. Eventually, she plans on furthering her education by obtaining a PhD in accounting.

Regina Ruane earned her doctorate from Drexel University in Educational Leadership and Learning Technologies in 2012 and completed her Master of Arts degree in Curriculum and Teaching at Teachers College, Columbia University. She completed her baccalaureate degree at Villanova University, where she studied education and philosophy. She currently works as a postdoctoral fellow with the Data Science Institute at Temple University, where she focuses her research on social network analysis, data analytics, learning analytics, computer-mediated communication, computer-supported collaborative learning, online learning, and online communities. Her research has appeared in the *Online Learning Journal*, *MERLOT Journal of Online Learning and Teaching*, and other publications.

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