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ENTERPRISE READINESS FOR IT INNOVATION: A STUDY OF MOBILE COMPUTING IN HEALTHCARE

Research-in-Progress

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Abstract

This research posits that enterprise-wide information technology (IT) innovation initiatives in uncertain economic times amplify the need and importance for decision makers to systemically evaluate their organization's capabilities, competencies, and potential risk areas that could either accelerate or impede adoption and implementation. The purpose of this research is to develop a theoretically-grounded, conceptual framework of healthcare enterprise readiness for IT innovation that will aid health IT decision makers with this complex task. We study this in the context of mobile computing which is poised to fundamentally transform healthcare delivery by improving patient care and lowering costs. Preliminary findings of our multi-phase exploratory empirical study with healthcare CIOs reveal the relative importance of several key assessment dimensions and indicators. Our research has important implications for both adopters and providers of health IT and contributes to our broader understanding of IT-enabled transformation of healthcare.

Keywords: Healthcare, Enterprise Readiness, IT Innovation, Mobile Computing, Expert Study

Introduction

The U.S. healthcare delivery system is facing tremendous cost and quality pressures that will require fundamental changes to remain viable . Many experts consider information technology (IT) to be a crucial element in the successful transformation of the healthcare delivery system (Burns, 2005; Porter and Olmsted Teisberg, 2006; Rouse, 2008). Indeed, there has been growing evidence that successfully implemented IT systems have improved healthcare delivery quality and lowered cost (Anonymous, 2009). It is thus not surprising that the design, implementation and management of both clinical and non-clinical health IT is a significant component of the American Recovery and Reinvestment Act of 2009 (Frisse, 2009).

The federal government's call for health IT investment, however, comes at a time when many healthcare organizations are facing a significant economic crunch and thus are cutting back, scaling down, or re-evaluating their ongoing or planned IT projects (AHA, 2009). Historically, healthcare has been considered one of the slowest sectors to adopt and implement IT (Hawn, 2009). One reason is that the complexity of health organizations and their fragmented internal structure constrain their ability to adopt enterprise-wide IT (England, et al., 2000). Others have suggested that adopting and implementing IT to improve efficiencies long-term will uncover a significant number of errors, inefficiencies, and waste in the short-term. As a result, the effort of preparing for adoption and implementation of health IT will require many healthcare organizations to review their processes and practices.

Consequently, despite the widely heralded value and benefits of health IT, there are have been many sobering reports commenting on the difficulties of adopting and implementing even small-scaled health IT projects; it has even been suggested that a majority of health IT initiatives in fact fail (Kaplan and Harris-Salamone, 2009). Key conclusions of a recent workshop sponsored by the AMIA suggest that the reasons for IT innovation adoption and implementation failure in healthcare organizations are more managerial and organizational rather than technical (AMIA, 2006). This is supported by Lee et al. (2005), who observed that many healthcare enterprises ignored to evaluate their change management practices, including clear formulation of objectives, and leadership buy-in. More recently, Frisse (2009) found that many organizations often underestimated the effort required for success in adopting health IT.

We posit that this stark contrast of failures, challenges, value, and opportunity raises the need and importance for health IT decision makers to systemically identify and evaluate their organization's capabilities, competencies, and potential risk areas that are critical in health IT innovations initiatives. The purpose of this research is to develop a theoretically-grounded, conceptual framework of *healthcare enterprise readiness* for IT innovation that aids decision makers with this complex task. We study this in the context of mobile computing, which is poised to fundamentally transform healthcare delivery by improving patient care and lowering costs (Hamblen, 2009; Junglas, et al., 2009; Varshney, 2006; Wu, et al., 2007).

The remainder of this research-in-progress is as follows. In the following section, we review the theoretical foundation and describe the development of the conceptual framework. Next, we discuss the research design, instrument development, and data collection process. We then present preliminary findings from an ongoing multi-phase expert study with healthcare CIOs. The article concludes with next steps and potential implications for healthcare IT theory and practice.

Theoretical Foundation and Conceptual Framework

The three major areas of research that provide the necessary theoretical foundation for this study are the organizational innovation literature, the change management literature, and the health IT literature. In this section we jointly examine the three research streams and present the development of our healthcare enterprise readiness framework.

The organizational innovation literature is extensive (Gallivan, 2001; Kimberly and Evanisko, 1981; Meyer and Goes, 1988; Tornatzky and Klein, 1982; Zaltman, et al., 1973). Previous studies have examined the relationship between numerous technological, organizational, and environmental factors and IT adoption (Frambach and Schillewaert, 2002; Tornatzky and Klein, 1982). Given that individuals make up organizations, the organizational innovation literature has also examined the relationship between numerous individual characteristics and IT adoption. Other studies have combined the bottom-up and top-down perspectives to understand how IT innovations are adopted and implemented (Gallivan, 2001).

Studies of IT innovation in the healthcare context have leveraged this previous work to study hospital's adoption of information technology (Burke, et al., 2002), adoption of different types of health IT, such as electronic health records (Davidson and Heslinga, 2007; Jensen and Aanestad, 2007), clinical decision support systems, patient-physician portals (Klein, 2007),and administrative systems (Kimberly and Evanisko, 1981). A comprehensive review of the historical evolution of health IT adoption and use over the past three decades can be found in Raghupathy and Tan (1999), Michelman and Kim (1990), and Haux (2006). A substantial amount of work of IT adoption in healthcare has also been conducted at the individual level. Individuals of interest include doctors, nurses, other medical staff, and patients. IT innovation studies at the individual level have focused on the differing characteristics and needs of these individuals for various types of health IT. Hennington and Janz (2007), for example, examined physician adoption of electronic medical records. Lapointe and Rivard (2005) and Bhattacherjee and Hikmet (2007), for example, examined physician resistance to health IT implementation and use.

Goldsmith (2004) argued that mobile computing is one of the most promising emerging IT innovation for healthcare, with the potential of fundamentally transforming the way healthcare services are delivered. Indeed, it has been shown that benefits of mobile computing in healthcare are plentiful (Andersson, et al., 2007; Chatterjee, et al., 2009; Lu, et al., 2005; Raghupathi and Tan, 1999; Sneha and Varshney, 2009; Varshney, 2006). Increased order fulfillment accuracy, reduced manual errors, increased employee productivity, and improved use of healthcare workers time are benefits directly attributed to the utilization of mobile technologies.

Given the increasing evidence of mobile computing benefits, we have seen a significant growth in studies examining the application, adoption, and use of mobile computing in healthcare (Andersson, et al., 2007; Finch, 1999; Guah, 2007; Varshney, 2006; Wu, et al., 2007). Lu, et al. (2005) provide an excellent review of mobile computing adoption and use in healthcare. Early studies have examined how mobile computing could change medical data delivery (Finch, 1999) and physician-patient interaction (Jen, et al., 2007). More recently, researchers have examined the adoption and use of mobile computing for computerized physician order entry (Junglas, et al., 2009), medication administration (Hamblen, 2009), emergency intervention (Katz and Rice, 2009), asset tracking and management (Lee and Shim, 2007), and patient monitoring (Sneha and Varshney, 2009; Varshney, 2008).

Despite the significant potential benefits, there have been many failed experiences of health IT, in general, and mobile computing in particular (Anonymous, 2009; Hamblen, 2009; Kaplan and Harris-Salamone, 2009). The common observation across all these studies is that adoption and implementation of health IT is a complex undertaking and one in which strategic planning, user involvement, leadership, and a viable business model are vital to success. Healthcare enterprises often have very diverse stakeholders with starkly differing needs; there is consensus that the "one-size-fits-all" is a failed model for mobile computing in healthcare.

In order to minimize the associated risks and maximize the potential benefits of mobile computing solutions, healthcare enterprises must thus not only understand the value and economics of enterprise mobility, but also carefully evaluate and measure their level of "readiness" for mobile computing. Readiness assessment enables decision makers to become more knowledgeable about the characteristics of mobile computing, form attitudes about it, and make a decision regarding the fit between the technology and the organization.

Drawing on the theoretical foundation of the aforementioned body of literature, we define healthcare enterprise readiness for mobile computing to be a healthcare organization's preparedness, potential, and willingness to adopt and implement mobile computing. We further argue that healthcare enterprise readiness is assessed along eight salient dimensions: (1) technology, (2) data and information, (3) process, (4) resources, (5) knowledge, (6) leadership, (7) employee, and (8) values and goals. It should be noted that we had initially identified several additional dimensions and different labels through a comprehensive evaluation of the literature. However, through multiple rounds of expert studies, we eliminated, integrated or merged some dimensions, ultimately leading to the final eight-dimensional framework. A complete healthcare enterprise readiness assessment will thus involve an evaluation across the three layers - preparedness, potential, and willingness – and along all eight readiness dimensions (see Figure 1). Preparedness is assessed for all eight dimensions; potential is evaluated along the process, employee, and value and goals dimensions; and, willingness is assessed along the employee and leadership dimensions.

There is ample theoretical support in the literature for each of the eight dimensions and associated assessment indicators. We briefly elaborate on each of them.

Figure 1. Conceptual Framework of Healthcare Enterprise Readiness
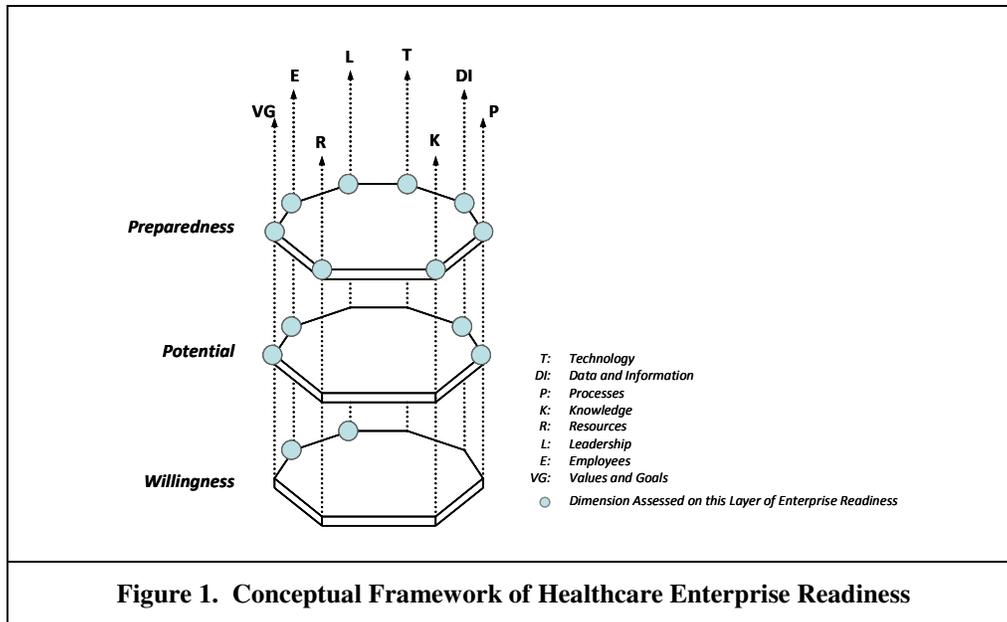
Technology (T)

Virtually all healthcare enterprises have some form of technological infrastructure in place. Technology readiness can thus be understood as the ability of a healthcare enterprise's existing technological infrastructure (e.g. hardware, software, network services, and security) to support the adoption and implementation of mobile computing. Previous work has shown that a robust, comprehensive, and open-standards oriented technological infrastructure, flexible and scalable to accommodate any change and emerging requirements, facilitates a higher level of technology readiness.

Data and Information (DI)

Healthcare can be considered one of the most information-intensive industries. Healthcare enterprises must keep track and administer a plethora of different information sources, including patient, treatment, administration related data. Given regulatory and privacy requirements, data and information capabilities must adhere to highest level of security standards. Data and Information readiness thus refers to the ability to federate data from multiple sources, provide a unified view of healthcare enterprise data, and make it available to any system at the time when it is needed. Higher levels of data and information readiness is achieved through a consistent, reliable, and secure data and information infrastructure that provides both synchronization and data recovery capabilities for highly disconnected and variable environments.

Process (P)

Every healthcare organization has some forms of processes. Processes can be broadly classified as work-related, behavioral, management, and change-related (Garvin, 1998). Processes are a formalized way to represent how enterprises work and shed light into the heart of enterprises. Previous studies have shown the organizations with higher level of process maturity are more prepared for IT-enabled change. As a result, we argue that process readiness refers to the ability of organizational processes (e.g. human, information, organizational change, incentives/rewards, governance, etc.) to facilitate and support the adoption and implementation of mobile computing. Well-defined, documented, managed, repeatable and optimized processes indicate a high level of readiness along this dimension.

Knowledge (K)

With the emergence of the information economy and the digitally-enabled healthcare enterprise, knowledge is often considered a key organizational asset. Knowledge readiness can be understood as a healthcare enterprise's capacity and capability of both general and specific knowledge required to adopt and implement mobile computing. General knowledge includes awareness and understanding of the state of emerging IT, regulatory requirements, IT-related decision-making processes, strategic planning capacity, and previous experiences with IT adoptions and implementations. Specific knowledge encompasses an awareness and understanding of the opportunities, challenges, barriers, and opportunities that come with the adoption and implementation of mobile computing.

Resources (R)

Previous studies have shown that healthcare organizations with financial, human, and social resources tend to be well prepared for the adoption and implementation of health IT (Abdinnour-Helm, et al., 2003; Chang and Chen, 2005; Kaplan and Norton, 2004). Indeed, the availability and appropriate allocation of resources to health IT initiatives is often considered a critical pre-cursor to enterprise readiness (Kaplan and Norton, 2004). Resource readiness refers to a healthcare enterprise's ability to allocate resources necessary to support the adoption, implementation, maintenance, and continued use of mobile computing. Resources may include financial (e.g. budget, training funds, etc.), human (e.g. support staff, innovation champion, expertise, consultants, etc.), and social assets (e.g. training, vendor support, alliances, partnerships, etc.).

Leadership (L)

The benefits of strong leadership and top management support are well established in the change management literature. It has been shown that management that have the ability to articulate the strategic vision of the healthcare organization and communicate the value and importance of IT tend to have a positive influence on the probability of success on health IT implementations (Hartman and Sifonis, 2000; Ward and Peppard, 2002). Leadership readiness can thus be understood as the healthcare management teams' ability to anticipate, manage, and execute the adoption and implementation of mobile computing. It reflects an appropriate level of skills, innovativeness, knowledge, and risk orientation of top management. It also indicates the level of commitment, encouragement, support, and strategic vision that management offers in association to the adoption and implementation of mobile computing.

Employee (E)

The success of healthcare enterprise adoption and implementation of mobile computing ultimately depends on if and to what extent employees are using it and whether it has infused into organizational processes (Parasuraman, 2000; Yi and Tung, 2003). Employee readiness (e.g. doctors, nurses, staff, etc.) can therefore be understood as individual characteristics necessary for the successful adoption of mobile computing. These characteristics include individuals' attitude and motivation towards innovation and change, their risk orientation, their level of computing skills and previous experience, and their computer literacy and learning capabilities (Bhattacherjee and Hikmet, 2007; Han, et al., 2006; Lapointe and Rivard, 2005; Lu, et al., 2005).

Values and Goals (VG)

The final dimension of healthcare enterprise readiness identified in this research is that of values and goals. This dimension can be considered the "glue" of all the aforementioned dimensions. Previous work has suggested that organizational culture can either support or stifle IT innovation initiatives (Callen, et al., 2007; Harrisburg, et al., 1999). Particularly with IT that has the potential of fundamentally changing the way work is done and the way people work, communicate, and interact – as the case with mobile computing – healthcare organizations must have a culture and environment that can embrace the change. Values and Goals readiness thus can be understood as a healthcare enterprise's ability to integrate mobile computing value propositions into its corporate philosophy, culture, and business environment and communicate it to its stakeholders.

It is important to note that all of these dimensions have an influence on each other and must therefore be considered as a whole. A reduced level in one dimension may influence the overall healthcare enterprise readiness for IT innovation. Similarly, a lack of readiness in one of the three layers will also result in a lower degree of enterprise readiness. As such, a comprehensive assessment of all dimensions on all layers should be conducted. In the following section, we describe our method of validating the conceptual framework and determining the relative importance of the dimensions and assessment indicators.

Method

While there is theoretical support for each of the dimensions of our healthcare enterprise readiness framework, we felt that it would be appropriate to use an expert research approach to validate our conceptual framework (Galliers and Land, 1987). The study consists of three phases and is shown in Figure 2.

Figure 2. Research Phases
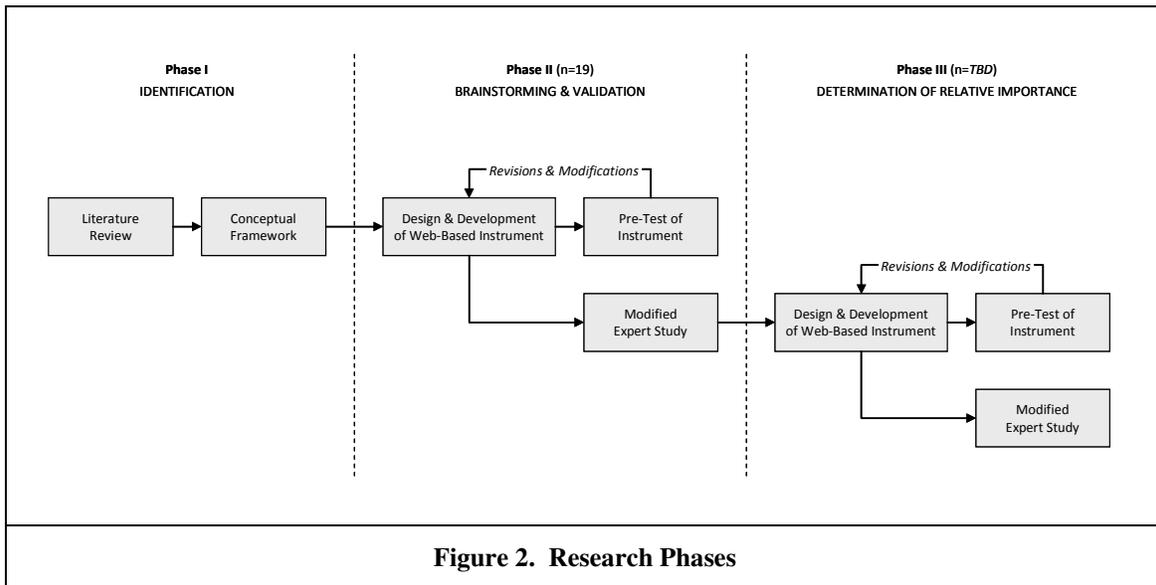
The empirical part of this study consisted of a two-phase expert study using a modified Delphi approach. The Delphi method was developed by the RAND Corporation and is primarily used as a method for structuring group communication processes (Delbecq, et al., 1975; Linstone and Turoff, 1975). The Delphi method lends itself especially well to exploratory theory building (Meredith, et al., 1989) on complex, interdisciplinary issues, often involving a number of new concepts or future trends.

The modified Delphi technique used in this research is similar to the full Delphi in terms of procedure (i.e., a series of rounds with selected experts) and intent (i.e., to predict future events and to arrive at consensus). The major modification consists of beginning the process with a set of carefully selected items to provide respondents with a context within which to consider their responses. These pre-selected items may be drawn from various sources including related competency profiles, synthesized reviews of the literature, and interviews with selected content experts. The primary advantages of this modification to the Delphi is that it (a) typically improves the initial round response rate, and (b) provides a solid grounding in previously developed work, and (c) decreases the number of rounds required to achieve consensus.

Development of the Web-Based Survey Instrument

The development of the expert survey instrument included the design and coding of a web-based questionnaire and quality testing of its overall usability. The web-based expert survey was implemented using the open-source scripting language PHP and MySQL database. The front-end interface was designed using Macromedia Studio. Radar charts were created using PEAR, an open-source PHP image library, because of its advanced graph display

capabilities. After several rounds of design modifications, a beta version was released for pilot testing to refine and restructure the instrument and ensure initial content validity, readability, and flow of the study (Dennis and Valacich, 2001). Using the responses of the pilot test, spelling changes and minor cosmetic updates were implemented. A final version of the instrument was then deployed to a public URL.

Identification and Selection of Experts

Since the information solicited for this study requires in-depth knowledge and sound experience about IT innovation adoption decisions in the healthcare context, we were looking to select a focused group of experts that could provide opinions on salient dimensions of healthcare enterprise readiness dimensions and their assessment indicators (Bryman, 1996). As a result we have targeted only CIOs of healthcare organizations.

Based on a list of industry members and affiliates of Georgia Tech's Tennenbaum Institute and the Health Systems Institute, we initially identified 30 potential participants for Phase II. An invitation with a link to the web-based expert study explaining the purpose and method of this study was sent out by email. Delphi studies typically utilize between five and 30 experts, based on the observation that larger groups create few additional ideas and limit the in-depth exploration of those generated (Delbecq, et al., 1975). Nineteen (19) health IT experts agreed to participate in our study (Response Rate: 63.3%), a number corresponding well within Clayton's rule-of-thumb of at least 8-20 experts (Clayton, 1997). The composition of the final group of participants resulted in a balanced view for the expert survey, with participants having significant experience in health IT strategy and mobile computing in both small and large healthcare organizations.[1]

For Phase III of the expert study, we plan to expand our pool of potential participants beyond the sources used in Phase II. We intend to accomplish this by reaching out to members of the American College of Medical Informatics as well as executives included in the HIMSS Analytics database.

Instrumentation

The objective of Phase II was to validate the eight readiness dimensions, their definitions, and relevant assessment metrics obtained from the literature analysis in Phase I. Since these dimensions were theoretically identified and defined in the literature, a semi-structured approach to data collection was used (Benbasat and Zmud, 1999).

Phase II contained three sections. The first section collected demographic information of the participants. The second section requested expert panelist to validate or modify each of the eight dimensions and associated assessment indicators. The third section asked respondents to identify and define any additional dimensions that were not included in the original list and that they thought were needed to adequately assess healthcare enterprise readiness for mobile computing.

To date, we have completed Phase I and II of our research and are currently in the data collection process of Phase III. The objective of Phase III is twofold: first, to determine the relative importance of each of the validated healthcare enterprise readiness dimensions and second, to determine what assessment indicator levels are generally observed for high dimensional readiness.

In order to do so, Phase III is split into four sections. The first section collects demographic information of the participants in order to stratify our data based on important respondent characteristics (e.g. enterprise type, size, location, etc.). The second section asks participants to comment on the importance of each readiness dimension when planning for mobile computing on a five-point Likert scale from Not Important (1) to Critical (5). The third section asks participants to consider any healthcare organizations, including their own, and indicate the extent to which they agreed or disagreed with statements associated with assessment indicators' relation to high dimensional readiness, also on a five-point Likert scale from Not Important (1) to Critical (5). The last section of Phase III uses a visual (radar graph) assessment approach to determine the relative importance of each of the eight validated readiness dimensions. Based on the common preference of executives, we are using a three-level ("high", "moderate", and "low") assessment denomination for the degree of dimensional readiness. Since an evaluation of

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[1] Given the page length limitations, we did not include the demographic breakdown of the expert panel in Phase II. We will present this information at the conference.

the relative importance of each of the eight dimensions at three levels would require participants to evaluate 3^8 unique radar graphs, we have opted to use a fractional factorial DOE (Wu & Hamada, 2000). In order to determine the optimal combination of readiness dimensions and assessment levels, a fractional factorial design with minimum aberration[2] is applied (Wu and Hamada, 2000). Given that eight dimensions are measured at three levels (i.e. high=3, moderate=2, and low=1), we utilize the k=8 27-run design with fraction and resolution of 3_{III}^{8-5} (Wu and Hamada, 2000). Using the design generators (D=AB; E=ABC; F=AB^{2}C; G=AC^2; H=BC^2), we obtain 27 healthcare enterprise readiness profiles, as shown in Figure 3. Participants are asked to indicate their perceived level of overall enterprise readiness for each of the 27 profiles on a five-point Likert scale from Very Low (1) to Very High (5).

Figure 3. Healthcare Enterprise Readiness Profile Examples - Experimental Design (k=8, 27-run, 3_{III}^{8-5})
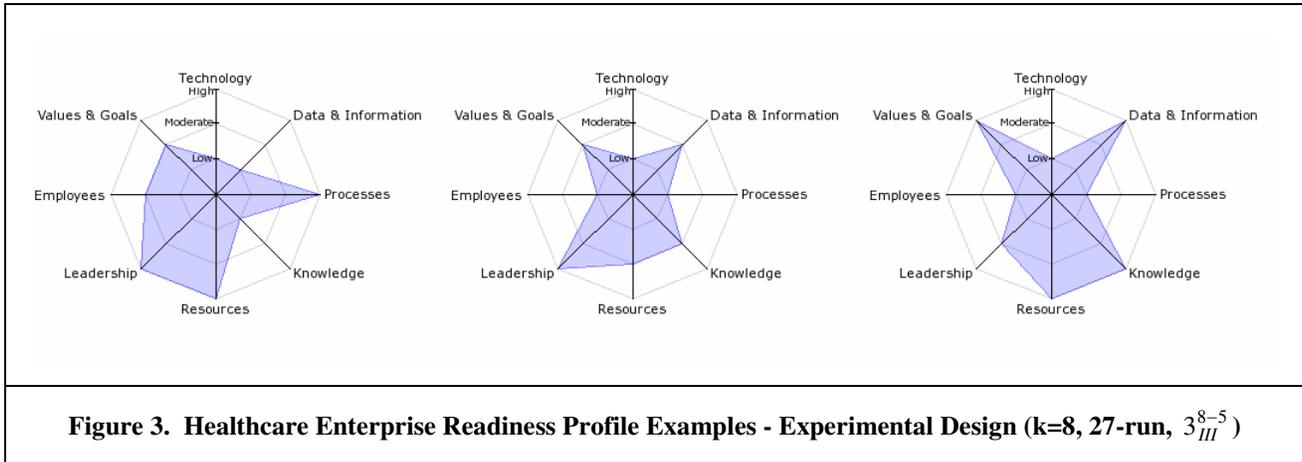
Preliminary Results and Conclusion

In this paper, we discussed our ongoing research on the systemic identification and evaluation of healthcare enterprise readiness for IT innovation. Our initial results revealed that all dimensions and associated assessment indicators theoretically identified from the literature are important – to varying degree – in the evaluation of healthcare enterprise readiness for mobile computing by our panel of 19 healthcare CIOs. Our conceptual framework thus provides health IT decision makers a preliminary means to understand what capabilities, competencies, and risk areas are of critical importance, thus contributing to our general understanding of IT-enabled change management initiatives in healthcare.

Our next steps include the completion of Phase III of the study, which will include the survey of a large sample of healthcare CIOs and the determination of the relative importance of each of the readiness dimensions and assessment indicators. Our analysis will include evaluation of our findings from our fractional factorial experimental of healthcare enterprise readiness profiles. We plan to perform extensive group comparison analyses to determine whether there are significant segment differences between various healthcare organization sizes, types, and other interesting healthcare enterprise demographics. We also intend to perform a cross-national comparison of healthcare enterprises, which we believe will provide critical insight to the regional differences in health enterprise readiness for IT innovation. The results of this study will provide important benchmark metrics for health IT innovation initiatives and the state of healthcare enterprise readiness. Lastly, we intend to develop a web-based assessment tool that will incorporate the findings of our three phases and make it available to the health IT community.

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[2] A minimum aberration design is one that achieves the greatest resolution and minimizes the aliasing of two-factor interactions in its class of designs (Fries and Hunter, 1980)

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