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Patient-centered care process enabled by Integrative Social Media Platform in an outpatient setting

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

PATIENT-CENTERED CARE PROCESS ENABLED BY INTEGRATIVE SOCIAL MEDIA
PLATFORM IN AN OUTPATIENT SETTING

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

BUSINESS ADMINISTRATION

by

Inkyoung Hur

2016

To: Acting Dean Jose M. Aldrich
College of Business

This dissertation, written by Inkyoung Hur, and entitled Patient-Centered Care Process Enabled by Integrative Social Media Platform in an Outpatient Setting, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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The dissertation of Inkyoung Hur is approved.

Acting Dean Jose M. Aldrich
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Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2016

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ABSTRACT OF THE DISSERTATION

PATIENT-CENTERED CARE PROCESS ENABLED BY INTEGRATIVE SOCIAL MEDIA
PLATFORM IN AN OUTPATIENT SETTING

by

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Florida International University, 2016

Miami, Florida

Professor Weidong Xia, Major Professor

As an effort to guide patients toward being more informed and more involved as healthcare decision makers in the clinical processes, health care organizations have adopted a new technology referred to as an integrative social media platform (ISMP). This ISMP combines features of mobile technology and those of social media technology, integrating healthcare systems in order to support a more patient-centered healthcare process. However, users, both physicians and patients, have showed varied usages of ISMP, as a results, have shown mixed results of ISMP.

To provide a better understanding of the use of ISMP, especially the interaction between patients and physicians, I turned to the concept of affordances. Affordances describe the possibilities for goal-oriented actions that a technical object offers to a user.

Using a mixed-method approach with real archival event log data, conversation texts, documents, interview, and focus-group data from a large hospital which had adopted an ISMP, I confirmed three types of affordance: perceived affordance, behavioral affordance, and interactive affordance. I identified two key affordances of ISMP that lead to patient-centered care, namely ubiquitous access and virtual healthcare consultation, which represent a behavioral affordance and an interactive affordance, respectively. I also explored how different types of affordances are actualized and how they interact with each other to contribute to patient-centered care.

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ABBREVIATIONS AND ACRONYMS

PCCP	Patient-Centered Care Process
ISMP	Integrative Social Media Platform
IS	Information Systems
IT	Information Technology
EMR	Electronic Medical Record

INTRODUCTION

A. Objectives

The objectives of this research have four aspects: 1) to understand the interactions between patients and physicians, enabled by the use of an integrative social media platform (ISMP) in healthcare, 2) to identify key affordances that facilitate patient-centered care processes, 3) to propose and examine affordance types and their relationships, and 4) understand how affordances are perceived and actualized. Practices are understood through relations among users with technologies (Orlikowski, 2007). Interaction and impacts have no independent existence outside of these relations. With this view, I identified healthcare practices and affordances of ISMP when individuals use ISMP for patient-centered care. In addition, I investigated how different types of affordances, perceived affordance, behavioral affordance, and interactive affordance, are actualized, and how they interact with each to produce desirable outcome.

- RQ1: What interactions are emergent when people (i.e., patients and physicians) use an integrative social media platform in the healthcare context?
- RQ2: What affordances of an integrative social media platform are perceived and actualized in the healthcare process?
- RQ3: What are the key factors influencing affordances?
- RQ4: How do different types of affordances offered by ISMP affect people behaviors in the healthcare context?

B. Motivation

Patient-centered care is a paradigm and has gained widespread acceptance in healthcare, but in reality it has not been put into practices in the overall healthcare processes and structures. Most healthcare applications are designed for only healthcare providers, not

patients, so patients are limited in their access to the health systems and health data. On the other hand, there have been efforts to develop technologies for healthcare consumers, such as mobile apps, sensory healthcare monitoring devices, and online applications. Patients who use these technologies become more knowledgeable and empowered in their healthcare. However, such technologies are often disconnected from core healthcare processes.

Patient-centered care has become feasible because of the advances of technologies that alter how healthcare data are collected, how they are shared, and how they are personalized. Patients express increasing interests in forging partnerships with their clinicians, along with gaining anytime access to their health records in order to have better quality of healthcare. There have been many empirical studies on online technologies for human connections, such as telemedicine. System data connection has also been studied with electronic medical records (EMR) systems and a feature of a patient-held medical record summary. They show positive effects of these systems on patients' knowledge and behaviors (Liaw, Lawrence, & Rendell, 1996; Young et al., 2011). However, many studies focus on healthcare providers' practices (Lau et al., 2012). Recently an ISMP has been adopted in healthcare to support processes for both patients and healthcare providers. This new technology, a mobile app in a social media platform, allows both human connections and access to healthcare legacy systems in a healthcare organization. It means that the technology integrates medical resources and healthcare information in a unified platform shared by both physicians and patients to support healthcare processes. However, the emerging nature of interactions between the patients and the providers enabled by the new technology in the health care context has not been studied. To the best of my knowledge, this is the first empirical study on an ISMP which integrates both system connections and human connections that examines if and how the two connections promote patient-centered

care. Additionally, this research investigates how we can find the best, right affordances that generate the desirable outcome. Answers may lie in the connections themselves (what) as well as in the characteristics of the connections (how).

There is a call for research on the interpretative features of, rather than, system features themselves, to explain the complex phenomenon of technology use (Burton-Jones & Straub Jr, 2006; Leonardi, 2013). Technology use is determined by not only material elements, but also users' goals and users' abilities to use (Leonardi, 2011; Markus & Silver, 2008). The users' interpretations and actions with a technology keep changing (Leonardi, 2013; Markus & Silver, 2008), especially interaction among multiple users, which reflects the complexity of the IT-use phenomenon. For these reasons, understanding IT phenomenon is challenging. In this study, I use the concept of affordance as a basis to provide insights on the use of ISMP in a healthcare context. Affordances come from relations of the material and the social actors. People's perceptions toward the technology use or their actions in using the technology represent different types of affordances: perceived affordances and actualized affordances, respectively. In addition, mechanisms and processes leading to different kinds of affordances by different users have not been adequately studied in the literature (Borghetti et al., 2012). I am interested in the relations among affordance types, impacts of affordance types, and factors influencing affordances. This leads to one of the research questions in this paper: "How do different types of affordances provided by a technology affect users' behaviors in the healthcare context?"

An affordance is a relationship between a user and a technology (Leonardi, 2011). It emerges during a user's interactions with a technology. Identifying specific affordances has a great utility in helping explain why people use the same technology but react differently in a similar or different situation. The concept of affordance is useful in helping us understand the key factors that matter in a user's particular actions. Even a simple

function of a technology can bring various affordances due to a user's interpretations and behaviors when the user interacts with the technology in different specific situations (Lukyanenko, Parsons, & Wiersma, 2014). In this study, I propose three types of affordances drawn upon prior literature on affordance (e.g., Leonardi, 2011; Strong, Johnson, et al., 2014). During the technology use, before and after the use, users continuously attach their interpretations to the technology (perceived affordance) and exhibit different interactions with the technology (behavioral affordance), and interact with other users through technology uses (interactive affordance). The different types of affordances generate varied outcomes. For example, resulted from a behavioral affordance, ubiquitous access of ISMP, requires only interactions with the technology, lead to better access to healthcare. In contrast, resulted from an interactive affordance, virtual meetings between a patient and a physician using ISMP, supports shared decision-makings which is a core aspect of patient-centered care. This study investigates how those affordances are actualized and thus contribute to the patient-centered care processes.

C. Current Study

The research context is a large hospital in which a new healthcare system, a mobile app in a social media platform, was recently implemented. The research site, an advanced healthcare organization well known for its adoption of a cutting-edge technology, provides an excellent setting to study emergence and routinization with an ISMP in a healthcare context.

This study focuses on the identification of affordances of ISMP in a real healthcare context and investigation on how the affordances are related to each other as well as key influencing factors to the affordances. Through a mixed-method analysis with the data collected from interviews, focus groups, conversation texts, and system event log data, I

identifies two key affordances of ISMP, virtual healthcare consultation and ubiquitous access, which are instances of an interactive affordance and a behavioral affordance, respectively. The ISMP affordances interact with each other and contribute to the patient-centered care processes, including shared decision-making and access to care. The actualized affordances are influenced by the user's perceived affordances resulted from combination of specific technology features, tasks, and users.

ISMP shares the properties of mobile technology as well as those of social media technology. One of the distinguishable mobile technical features is mobility which allows users to access the technology at any time and from any location (Abouzahra & Tan, 2013). The social media technology offers interactive and persistent features which provide a base for interpersonal associations among users (Hawker, 2010). Those technology features lead to the key affordances of the ISMP technology, ubiquitous access and virtual healthcare consultation, and contribute to the changes in the healthcare processes.

Not all affordances of a technology are actualized; only some are actualized in particular situations. For example, depending on the disease types and stages, the types and timing of care services affect the effectiveness of the services (Jacobson, 1986; Pearlin, Semple, & Turner, 1988). My analyses reveal that using a technology brings different perceptions and behaviors depending on a user's role, technology's features, specific situations of the uses including where and when, and relationships between users emerged during the use of the technology. Patients and physicians use the same technology, but their perceptions are different. Patients appreciate the technology's ability that enables them to access health systems or health care professionals anytime and anywhere, while physicians feel that the technology controls their time and interrupts personal lives. Patients and physicians access the same health data in ISMP, but the impacts of the access are different. Patients are able to more engage in understanding and managing their health conditions,

while physicians are able to consider and provide more holistic and more personalized care to individual patients.

D. Contributions

ISMP is a new technology that integrates healthcare systems with the properties of both social media technology and mobile technology. Even though it is just a tool, the implementation of ISMP has generated a new phenomenon which leads to significant changes in healthcare processes. The analysis results show that ISMP has changed how patients and physicians interact with each other and has enabled a more patient-centered care process.

This study provides three practical contributions. First, I identify the different uses of ISMP which brings a new phenomenon in the healthcare industry. ISMP use changes healthcare processes and people's perception about medical services. Patients use the ISMP technology to access medical services and health information anytime and anywhere, and they are willing to pay for a virtual meeting with a physician which was a new type of medical service. Second, this study identifies different types of affordances of ISMP, such as 'ubiquitous access' and 'virtual healthcare consultation' affordances. They are perceived and also actualized in the real healthcare setting. Third, the analysis results show how the affordances leading to care process changes are entangled by technology features, users, tasks, and situations. It provides healthcare organizations with an insight on how the use of a new integrated technology enables healthcare process changes toward patient-centered care.

In summary, this study provides practical contributions by:

- Finding that ISMP uses affect healthcare processes, which is a new phenomenon;
- Introducing different types of affordances of an ISMP in the healthcare context;

- Understanding how the use of an ISMP enables patient-centered care processes.

Theoretically, this study introduces a new concept of a healthcare technology, referred as to ISMP, which integrates data from an EMR system with social media features in a mobile device. ISMP as an emerging technology reaches beyond a hospital system; most functionalities designed to meet patients' needs are embedded in a pervasive platform that provide universal access to patients and physicians. This new concept created a new phenomenon emerged in healthcare context, which makes a theoretical contribution. Second, this study explains the relationships among different types of affordances: perceived affordance, behavioral affordance, and interactive affordance. Categorizing affordances into different types and examining the relationships among affordances, affordance dimensions, and their outcomes contribute to the existing body of the affordance theory. More specifically, this study

- introduces a new concept of a new technology composed of social media properties, mobile properties, and healthcare information systems and a new phenomenon due to the new technology uses in health care;
- proposes a new typology for affordance, which includes perceived, behavioral, and interactive affordance;
- explains the relationships among affordance types;
- analyzes factors affecting affordances;
- examines the impacts of affordances.

Methodologically, this study applies a mixed-method approach by collecting subject and objective data, and by analyzing these data both qualitatively and quantitatively in order to provide a rich interpretation of the emergent patterns and their meanings from the data. Factors related to affordances and their relationships should be reflected real practices recognized with real historical data. This triangulation approach helps me to have

confidence in understanding the complex health IT phenomena and in identifying affordances that are both perceived and actualized.

LITERATURE REVIEW

A. Patient-Centered Care Process

A main principle of the patient-centered care is that patient is the source of control. It means that patients should be informed of their health-related information and should be involved in making own healthcare decisions. Patient-centered care has been a focus in academia, emphasizing on key aspects related to the care processes. James and his colleagues address two constructs for the patient-centered care: patient activation and patient engagement (James, Hibbard, Agres, Lott, & Dentzer, 2013). Patient activation refers to the extent to which patients have the abilities, skills, and willingness to be involved in making decisions about their care. Patient engagement means that patients are not only activated but also involved in activities that promote positive patients' health behaviors, that is, they are taking some responsibilities for their own health (James et al., 2013). Wilson and his colleagues suggest that a patient-centered care application should integrate three themes: patient-focus, patient-activity, and patient-empowerment (Wilson, Wang, & Sheetz, 2014). Patient-focus means that healthcare applications are developed primarily based on the needs and perspectives of patients. Patient-activity assumes that patients meaningfully participate in providing and consuming health information. Patient-empowerment means that patients want to, and are able to, control far-ranging aspects of their healthcare through technologies (Wilson et al., 2014).

Many studies have used various terms to describe the concepts of patient-centered care. In Table 1, those concepts are classified under four constructs: patient-focus, patient engagement, patient empowerment, and patient activation. Patient-focus means that physicians attend to and understand the needs and perspectives of patients. Patient engagement and empowerment emphasize the roles of patients and physicians, and their

relationship. Patient activation refers to active participations by patients by involving in making medical decisions and by proactively seeking healthcare that meets their needs, including health-related information and medical services.

Table 1. Definition of Patient-Centered Care in Literature

Concept of Patient-Centered	Definition of Patient-Centered Care	Reference
Patient-focus	Respectful of and responsive to individual patient preferences, needs, and values, ensuring that patient values guide all clinical decisions.	(America, 2001)
	Meeting the patient's needs rather than simply providing diagnostic services and advice without support for following recommendations.	(Silow-Carroll, Alteras, & Stepnick, 2006)
	Respect for the patient's values, preferences, and expressed need: information, education, and emotional support to relieve fear and anxiety.	(Kahn, Schneider, Malin, Adams, & Epstein, 2007)
	Tailor treatment to patient needs, set patient goals based on patient preference, and increasing the humaneness of care.	(Robinson, Callister, Berry, & Dearing, 2008)
	The experience (to the extent the informed, individual patient desires it) of transparency, individualization, recognition, respect, dignity, and choice in all matters, without exception, related to one's person, circumstances, and relationships in healthcare.	(Berwick, 2009)
	Persons exist in relationships with other persons, persons are social beings, persons have a context through which their personhood is articulated, being recognized, respected and trusted as a person impacts on a person's sense of self.	(McCormack, 2004)
Patient engagement	The provider-patient relationship as one that integrates the patient perspective and preferences while involving the patient in decision making and self-care.	(Gerteis, Edgman-Levitan, Daley, & Delbanco, 1993)
	Person-centered requires the formation of therapeutic relationships between professionals, patients and their significant others, and that these relationships are built on mutual trust, understanding and sharing collective knowledge.	(McCormack & McCance, 2006)

	The patients' perceptions of how understood they feel, how 'at ease' the health professional appears and their willingness to accept the health professional's advice.	(Selfe, Matthews, & Stones, 1998)
Patient empowerment	A partnership among practitioners, patients, and their families (when appropriate) to ensure that decisions respect patient's wants, needs, and preferences and that patients have the education and support they need to make decisions and participate in their own care.	(America, 2001)
	The health professional's and patient's perceptions of their relationship, particularly mutual regard and agreement on goals.	(Gavin, Wamboldt, Sorokin, Levy, & Wamboldt, 1999)
	1) considering patients' needs, wants, perspectives and individual experiences; (2) offering patients opportunities to provide input into and participate in their care; and (3) enhancing partnership and understanding in the patient-physician relationship (all)	(Epstein et al., 2005)
	The similarity of health professionals' and patients' beliefs about the illness, treatment, patients' concerns, information given by the health professional.	(Romm & Hulka, 1979)
	Patients are equipped to make informed choices for themselves with sufficient skills and support from the health services.	(Anderson et al., 1995)
	Process that involves at least two participants — the patient and the doctor — and often many more (their respective networks of family or professional colleagues).	(Elwyn, Edwards, Kinnersley, & Grol, 2000)
	There is a jointly negotiated and agreed plan between the health professional and patient and the patient is given the resources needed to achieve it, such as information and skills.	(Schulman, 1979)
Patient-activity	Access to the kind of care that works for the patient.	(Kahn et al., 2007)
	Active participants in their own healthcare.	(Bergvik, Wynn, & Sørli, 2008)
Combination	1) considering patients' needs, wants, perspectives and individual experiences; (2) offering patients opportunities to provide input into and participate in their care; and (3) enhancing partnership and understanding in the patient-physician relationship; (4) Actions in service of patient-centeredness, including interpersonal behaviors,	(Epstein et al., 2005)

	technical interventions and health systems innovations.	
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From the four constructs, four dimensions of the patient-centered care process are identified: access to care, focus on patient, shared decision-making, and patient engagement. Table 2 shows the four dimensions in the patient-centered care process. Access to care refers to a patient's ability to access medical services and health information (Kahn et al., 2007). Focus on patient is a basic concept of the patient-centered care (America, 2001), which emphasizes holistic views on a patient as a whole person (McCance, Slater, & McCormack, 2008). Shared decision-making refers to a jointly negotiated and agreed upon plan between a health care professional and a patient, which has been studied by many researchers (Gavin et al., 1999; Schulman, 1979). Recently, patient engagement has become a promising construct that alters the outcome of healthcare (James et al., 2013). Patient engagement represents patients' active participations in their taking care of their own health (Bergvik et al., 2008). I focus on the four dimensions of patient-centered care process as they provide the necessary bases for studying ISMP technology use and the outcome on the healthcare processes.

Access to care means that the providers deliver accessible services to their patients with short waiting times (Davis et al., 2005). Examples of accessible services include the easiness of making an appointment for personal care, timely providers' responses to e-mails and telephone calls, and convenient electronic prescription refills. "With short waiting time" typically means that patients can make same-day appointments. Patients get healthcare services regardless whether or not it's within the regular operations hour, which make primary care readily accessible at nights, on weekends, and during holidays (Davis, Schoenbaum, & Audet, 2005). Patients can access any kinds of care that work for them (Kahn et al., 2007). Access to care is facilitated by patient-activation.

Table 2. Dimensions of Patient-Centered Care Process in Literature

Main Concept	Dimension	Definition	Reference
Patient-activity	Access to care	The primary care delivers accessible services including healthcare information with shorter waiting times, electronic access to a member of care providers (team).	(Davis, Schoenbaum, & Audet, 2005)
Patient-focus	Focus on patient	A physician understands a patient's biopsychosocial information by asking values, preferences, and needs to the patient. A patient provides their psychosocial information to the physician.	(Cegala & Post, 2009; Epstein et al., 2005; McCance et al., 2008; Mead & Bower, 2000; Stewart, 2001)
Patient empowerment	Shared decision-making	A patient is involved in medical decision-making process, and share power and responsibility with a physician.	(Elwyn et al., 2000; Epstein et al., 2005; Mead & Bower, 2000)
Patient engagement	Engagement	The cognitive aspect reflects a person's intellectual absorption in an activity. The emotional aspect reflects the emotional bonding or impact that occurs during the activity. The behavioral aspect entails how much attention, concentration, effort, persistence, and verbal participation the person shows during the activity.	(Brodie, Hollebeek, Juric, & Ilic, 2011; Furrer & Skinner, 2003)

Focus on patient is a common component of patient centered care addressed by many researchers (e.g., Epstein et al., 2005; McCance et al., 2008; Mead & Bower, 2000; Stewart, 2001). Cegala and Post (2009) described it as “exploring both the disease and the illness experience, understanding the whole person” (Cegala & Post, 2009). Medical professionals know the patients, which means that they should understand the patient as a social human being, including information on values, preferences, and needs of the patients, history of healthcare the patients has received, and the environments surrounding the patients.

Shared decision-making refers to reaching agreements on healthcare goals and plans made by both the patient and the providers during diagnosis and treatment processes (Schulman, 1979). Researchers have viewed patient involvement and shared power and responsibility as key elements of patient-centered care (Elwyn et al., 2000; Epstein et al., 2005; Mead & Bower, 2000), emphasizing the role of patients in their own care process and their relationships with the care providers. Shared decision-making is an important component in quality healthcare (Braddock, 2012), but in practice it is still challenging to realize shared decision making without necessary social and technological supports.

Patient engagement covers cognitive, emotional, and behavioral enjoyments in healthcare process (Brodie et al., 2011; Furrer & Skinner, 2003). The cognitive aspect reflects a person's intellectual absorption in understanding and transferring health information. The emotional aspect reflects a patient's emotional bonding or impact that occurs when the patient interacts with healthcare providers. The behavioral aspect entails how much attention, concentration, effort, persistence, and verbal participation a patient shows during health-related activities, such as dietary habits or physical exercise (Brodie et al., 2011). The patient engagement concept has been an important focus in health information system discipline.

Cognitive engagement is related to information (Protheroe, Rogers, Kennedy, Macdonald, & Lee, 2008), risk knowledge, and decision autonomy (Agarwal & Karahanna, 2000; Heesen et al., 2011). Emotional engagement plays a critical role in decision-making processes in which uncertainty exists, by marking different options as advantages or disadvantages (Naqvi, Shiv, & Bechara, 2006). It improves patients' relationships with healthcare providers (Morgan & Hunt, 1994), commitment, emotional attachment (Brodie, Ilic, Juric, & Hollebeek, 2013), and creating co-created values (Prahalad & Ramaswamy, 2004). The cognitive and emotional engagements extend behavioral engagement by

recognizing the iterative nature of engagement process (Brodie et al., 2011). Behavioral engagement is related to the use of healthcare technology or health information (Bonabeau, 2009). Patient engagement improves risk knowledge (Heesen, Solari, Giordano, Kasper, & Köpke, 2011), decision autonomy (Agarwal & Karahanna, 2000), relationship (Kuijjer et al., 2000), rapport, participation, satisfaction (Greener, Joe, Simpson, Rowan-Szal, & Lehman, 2007), cost of care, care experiences, and health condition (Hibbard & Greene, 2013).

Most prior literature focuses on the impacts of patient-centered care, not how to deliver patient-centered care. Some literature showed that health information systems enable patient-centered care. Patient-Centered Medical Home (PCMH), for example, improves clinical performance outcomes and patient experiences (Jackson et al., 2013). The system utilizes health information technology with team-based collaboration (Grumbach & Grundy, 2010), and payment functionality (Bitton et al., 2012) to offer holistic patient-centered healthcare services. As such, process changes enabled by using health information systems is a promising way for transformation towards patient-centered care (Paul A Nutting et al., 2009). However, this is a lack of understanding about how a health information system and what material properties of the system make patient-centered care possible.

B. Effects of Use of Technology in Healthcare

Health information systems have been an active topic of investigation in academia. For example, telemedicine systems have changed healthcare process (Constantinides & Barrett, 2006). Electronic services of the telemedicine systems support patient care, education, and monitoring, leading to significant positive impacts on patient's health outcomes (Clarke & Steele, 2012), quality of care, patient's satisfaction, and care costs

(Schwamm, 2014). The virtual world function of the telemedicine as a monitoring tool resolves patients' complaints and facilitates transparency, which in turn enhances patient experiences, patient engagement, and care coordination (Thielst, 2011). The literature has showed that telemedicine systems contribute to the changes in the healthcare industry.

The use of electronic medical record (EMR) has also been an active topic of investigation in academia (Bhargava & Mishra, 2014; Greenhalgh, Hinder, Stramer, Bratan, & Russell, 2010). Implementation of EMR systems change healthcare processes (Hillestad et al., 2005). Some case studies showed that patients who were able to review a consultation summary experienced less decisional conflicts with healthcare providers, and highly rated the systems (Belkora, Loth, Volz, & Rugo, 2009; Greenhalgh, Stramer, et al., 2010). In this study I incorporate EMR system data to investigate how some features of ISMP affect care processes.

Decision support systems have been extensively used in the healthcare industry. It mainly supports physicians' decision-making process, but haven't been extended to supporting patients' processes. There are a small number of studies which investigate how shared decision-making aids help both patients and physicians. One study showed that shared decision-making applications adjusted the expectations of patients and physicians, and improved their knowledge (Weinstein, Clay, & Morgan, 2007). Repository and infrastructure for data sharing and integration in the shared decision making applications play a role in building collaboration. Big data analysis has potentials to further enhance patient-centered care (Phillips et al., 2014).

Pervasive healthcare has started to be considered as a solution to provide better healthcare services to patients. Pervasive healthcare refers to making healthcare available to anyone, anytime, and anywhere by removing locational and time restraints, while increasing both healthcare coverage and quality (Varshney, 2005). Universal mobile

technologies enable a convenient anytime and anywhere access to healthcare services and health information. Mobile messaging as one of the salient features in the mobile technologies used in healthcare affects communication, healthcare-seeking behaviors, and health outcomes (Gurol-Urganci, de Jongh, Vodopivec-Jamsek, Car, & Atun, 2012). I believe that the ability to provide patients with healthcare information and services anytime and anywhere makes significant impacts on the healthcare processes.

C. Affordances

Giddens' (1984) structuration theory privileges human actions over structures without explicitly addressing technology. The adaptive structuration theory (DeSanctis & Poole, 1994) modifies the structuration theory to explicitly incorporate the concept of information technology (IT). It models the relationship between social structures inherent in IT and interaction processes of IT use. During social interaction with IT use, new structures emerge depending on the process of "appropriation" or "alignment," immediate visible actions with an IT-based rule or resource in a specific context at a specific time. However, Orlikowski (2000) recommends moving from the concept of "appropriation of embedded structure" to a practice-based view of "enactment of emergent structure." The base assumption is that if organizations are as much material as they are social and if technologies are as much social as they are material, then perhaps it makes sense to break down distinctions between the social and the material altogether. The sociomaterial view has led to new insights into important IS-related phenomena such as mobile IT usage (Leclercq, Carugati, Giangreco, da Cunha, & Jensen, 2009), work collaboration in Second Life (Orlikowski, 2009), digital innovation (Svahn, Henfridsson, & Yoo, 2009), the impacts of social media (Scott & Orlikowski, 2009), and digital entrepreneurship (Davidson & Vaast, 2010).

The sociomaterial theory reconceptualizes social worlds through the relations between the material agency of artifacts and the social agency of human (Orlikowski, 2007, 2009; Orlikowski & Scott, 2008). It recognizes the importance of the mutual relationship between the social and the material. The theory puts forth a relational perspective between the social and the material that challenges the privileged role of the human actors. The focus is on the agencies that have so thoroughly saturated each other in a way that boundaries dissolved between them. In this study, the “material agent” refers to constituent features in an ISMP that are available to all users in the same way. The “social agent” is goal-oriented patients or physicians who are involved in healthcare processes in a healthcare organization. However, the ways patients and physicians use same technology may be different depending on individual’s intentions to use it. The heterogeneity of the social agencies and the material agencies generates sociomaterial practices.

To discuss the mutuality relationships, new vocabularies (e.g., affordance entanglement, imbrication scaffold) were introduced. Leonardi (2011) addresses the concept of the affordances into the “imbrications” view of the human and the material agencies. Leonardi (2011) focuses on the affordance that arises in concert with actors’ goals as the mechanisms of organizational change, not IT features themselves. Zammuto et al. (2007) argue that a technological object has functionality but needs to be recognized as a social object, because technological possibilities of actions are not given, but depend on the intents and perceptions of social actors. This study takes the same view to see different usages of ISMP, which depend on users’ perceptions on ISMP and the context of ISMP use.

An affordance, according to Gibson’s original definition, is what is offered, provided, or furnished to someone or something by an object (Gibson, 1979). Recently, Strong et al. (2014) propose that an affordance is a potential for behaviors associated with

achieving an immediate concrete outcome and arises from the relation between an artifact and goal-oriented actor(s). They extend the affordance concept to actualization, which is defined as “the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals” (Strong, Volkoff, et al., 2014). This study builds on the concepts of the perception and the actualization of affordances. Table 3 summarizes the definitions of affordances in literature.

Affordances are considered as a mechanism for organizational changes. The imbrication of human agencies and the material agencies creates infrastructure in the form of routines, which is the result of previous affordances (Leonardi 2011). Coordination between the social agencies and the material agencies represent a capacity for actions. Affordance actualization leads to organizational changes (Volkoff & Strong, 2013)

However, what affordances emerge in specific technologies, and their impacts are not clear in literature. Because a technology carries various features, it brings a set of affordances. The technology for this study combines properties of mobile technology and those of social media technology, so I looked for the affordances of mobile technologies and social media technologies and their impacts. A summary of the literature on affordances of the two technologies and the effects of the affordances is provided in Appendix 1. Treem and Leonardi (2012) address four affordances of social media technology: visibility, editability, persistence, and association (Treem & Leonardi, 2012). Each affordance brings particular actions. Association of the social media, for example, gives a possibility of social connection and access to relevant information. Persistence is good for sustaining knowledge. Mobile technologies including smart phones have a capability to carry many functionalities in various technical features, enacting various affordances (Cochrane & Bateman, 2010). Common affordances of mobile technologies

are ubiquitous access that is good for education (Abouzahra & Tan, 2013; Melhuish & Falloon, 2010), interactivity that changes behaviors (Sundar, Bellur, & Jia, 2012), mobility, connectedness, interoperability, identifiability, and personalization that helps users achieve individual purposes (Cousins & Robey, 2015). Two studies with social media technologies focus on knowledge (Majchrzak, Faraj, Kane and Azad, 2013) and healthcare management (Pousti, Urquhart and Linger, 2014) respectively. They articulate that affordances have positive and negative effects, which means that various affordances interact with each other in the pursuit of a particular goal.

Table 3. Definition of Affordances

Category	Definition of Affordance	Reference
Properties of environment	"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. ...I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment."	(Gibson, 1979)
	"Affordances are dispositional properties of the environment that pose "real possibilities" for action".	(Turvey, 1992)
	"One can obviously perceive the affordances of objects and events without engaging in the afforded action, suggesting that affordances can be perceived as properties".	(Michaels, 2000)
Relations between an animal and its environment	An affordance is described as animal-environment fit.	(Warren, 1984)
	"Affordances are emergent relational properties of an animal-environment system".	(Stoffregen, 2003)
	"Affordances are relations between an animal and its environment".	(Chemero, 2003)
	"An affordance is the relationship between users' abilities and features of technology."	(Cousins & Robey, 2015)
Relations between an animal and its environment/ Possibility for action	"Affordance exists as a relationship between an actor and an artefact, it reflects possible actions on the artefact itself".	(Hutchby, 2001)
	"Functional affordances are a type of relationship between a technical object and a specified user (or user group) that identifies what the user may be able to do with the object, given the user's	(Markus & Silver, 2008a)

	capabilities and goals. More formally, functional affordances are defined as the possibilities for goal-oriented action afforded to specified user groups by technical objects".	
	Affordances are "not exclusively properties of people or of artifacts...[but] constituted in relationships between people and the materiality of the things with which they come in contact".	(Leonardi, 2011)
	"Affordances are new combinations of technology and organizational features continually create possibilities that affect organizational form and function." Technological functionality needs to be recognized as a social object, because technological possibilities of action are not given, but they depend on the intents and the perceptions of social actors enacting them.	(Zammuto et al., 2007)

CONCEPTUAL DEVELOPMENT

A. Affordance Types

Leonardi (2013) suggested the concepts of individualized affordance, shared affordance, and collective affordance. An individualized affordance is enacted by someone who uses a technology's features, reflecting a simple interaction between an individual and an object. The simple interaction has possibilities for actions, which is the traditional concept of the affordance. He also suggested the concept of shared affordance that a group of users use a system in similar way which leads to organizational changes (Leonardi, 2013). A collective affordance is proposed as an organizational affordance that is collectively created by many people to conduct non-interdependent tasks. An example lies in the study of "unity in diversity." Distinct capabilities of an EMR system and diverse feature uses allow people to complete work (Oborn, Barrett, & Davidson, 2011). Strong and his colleagues (2014) found a set of organizational affordances with dependency, named a bundle of affordances. One affordance is "Standardizing data, process, and roles" that emerges when many people in an organization use a system with rules which restrict format for data entry and who can access data (Strong, Johnson, et al., 2014). It simply makes many people use the system features in particular ways. Another affordance is "Coordinating patient care across sites, facilities and providers" when healthcare providers use a messaging feature and information on patients. The organization-level affordances are pooled individualized affordances (Leonardi, 2013). They are mixed without distinctions between affordances when users interacting with the system and affordances when users interacting with each other through the system use. In this study, I separate them into two different types of affordance, behavioral affordance and interactive affordance, to see how they contribute to certain outcomes.

There is a conceptual gap that affordances have not been studied at pair (one-to-one) level. Pair-level affordances, with individualized affordances, play a foundational role in enacting organizational affordances, but it is missing in the literature. Interestingly, Leonardi (2013) found that divergent uses occur at the beginning phase before people converged on the use of a common set of technology's features to enact a shared affordance (Leonardi, 2013). The diverse uses exist at the level of individuals, pair, or small-sized groups with a couple of people which I see as lower-level affordances. One-to-one interaction, especially interactions between a patient and a physician, is a core interaction in the healthcare processes. The mobile consulting feature in the ISMP technology was initially designed to support communications between the two. However, this feature has not been used as much as the traditional functions such as ISMP scheduling feature, especially when physicians are busy. It motivated me to study pair-level affordances, one-to-one interaction through the technology use. Understanding lower-level affordances is important because it helps organizations to find ways to enact certain affordances that lead to desired organizational changes.

B. Proposed Affordance Types and Their Relationships

Based on the literatures, I identify three types of affordances represented in Table 4: perceived affordance, behavioral affordance, and interactive affordance. A perceived affordance¹ reflects a user's perception of possibilities for action through technology use. It refers to not only the user's semantic and syntactic understanding of a technology (what) but also the user's interpretations about the technology use (how) (Vyas, Chisalita, & Van Der Veer, 2006). A user's perceived affordance is influenced by the user's intentions to use the technology. For example, a physician may value ISMP for a feature to communicate

¹ Norman (2004) acknowledged that he should have used the term 'perceived affordance.'

with patients (what), while a patient may value more ISMP's features of ubiquitous connection to medical data and real-time communication for timely care (how).

Perceived affordances are identifiable based on the interviews about users' perceptions on the values of the technology use and the documents about technology-created routines which are predefined by designers (Sjöström & Goldkuhl, 2003). The perceived affordances can be identified based on the information about predefined actions perceived by designers. In this case, possible actions using ISMP are scheduling for doctor's appointments, querying patients' medical records, and communication between patients and physicians. Besides technological functionality ("what"), "how" aspects that the technology offers, such as anytime, real-time, may enact a perceived affordance. It reflects easiness (appropriateness, visibility, comprehensibility, and accessibility) for action possibility in relation to comfort valued (Goldkuhl, 2008).

Behavioral affordances and interactive affordances are conceptualized as actualized affordances. A behavioral affordance is defined as a user's actualized behaviors in a task involving the use of a technology. An interactive affordance is defined as a user's actualized interaction in a task which two or more users are involved in the technology use. In this study, an instance of the interactive affordances is pair-level affordance, such as affordances that a pair of a patient and a physician use the technology. Behavioral affordances and interactive affordances are more contextualized, which means that the uses of a technology are determined by specific features uses under specific contexts.

Actualized affordances are recognized with actual actions. Consequences of human activities help to explain the presence of technologies and social structures that produce them (Stinchcombe, McDill, & Walker, 1968). An actualized affordance in an IT use context is reflected with an action when using technology features, which indicate a

user's needs in a certain situation. Therefore, the data of 'who', 'what technology features', and 'when' reflect a user's actualized affordances of a technology.

Measures to reflect behavioral affordances indicate a goal of a user to use the technology. An example of behavioral affordance measures in this case is intensity of actions which can be assessed by a ratio between actions. Time measures such as anytime can be used to assess the 'how' aspect of an affordance.

Measures of interactive affordances reflect multiple users' behaviors in using a technology. An action for an interactive affordance in this case is communication between a patient and a physician by using the mobile consulting feature in ISMP. Derived affordance measures include time, ratio and length of the mobile consulting usage, and the duration of time to get first response.

Table 4. Affordance Type and Definition

Affordance Type	Definition	Visualization
Perceived affordance	<ul style="list-style-type: none"> • A user's understanding of a technology itself (What) • A user's interpretations about the technology use (How) (Vyas, Chisalita, & Van Der Veer, 2006) 	
Behavioral affordance	<ul style="list-style-type: none"> • A user's actualized behaviors in a task involving the use of a technology 	
Interactive affordance	<ul style="list-style-type: none"> • A user's actualized interaction in a task which two or more users are involved in the technology use 	

Factors that influence the occurrence of an affordance include a social user with different abilities in various situations, a material object with many features, and tasks with various characteristics. In this study, those factors are referred to as affordance dimensions. A social user is an important factor that alters the nature of technology use, affecting the

emergence of an affordance (Gibson, 1979). Many material properties from even one object may enact many forms of affordances. For example, a mobile consulting technology has asynchronized posting and user-generated contents as properties; thus, a few of affordances (e.g., anytime or empowerment) could emerge from the technology properties. Task characteristics matter in enacting affordances (Leonardi, 2013). Table 5 represents affordance types I propose and their affordance dimensions with prior literature based.

Table 5. Affordance Type in Literature

Proposed Affordance Type	Level	Affordance Dimension		Literature	
		# User	# Material	Term of Affordance	Reference
Objective affordance	Object	-	1	Affordance	(Gibson, 1979)
Perceived affordance	Individual	1	1	Perceived affordance, Functional affordance, Symbolic expressions	(Norman, 2001; Markus & Silver, 2008)
Actualized affordance	Individual	1	1	Individualized affordance	(Leonardi, 2013)
	Organizational	Many	Many	Collective affordance Shared affordance, Bundles of affordance	(Leonardi, 2013; Strong, Volkoff, et al., 2014)

Interactive affordance is more complicated because of the additional complexity from more users. It may be determined by not only all users' perceived affordances, but also their social and cultural conditions as situations, besides technology features (Vyas et al., 2006). A user provides and reads information from systems, which may be considered as an action to interact with a system. However, the ultimate goal is to deliver information to other user(s) (Goldkuhl, 2008). Therefore, this affordance belongs to an interactive affordance that is influenced by the material component shaped by others (e.g.,

accumulative displays of other users' conversations), other users' perceptions toward the technology, and situations around the users.

Perceived affordances are relatively simpler because the things that mainly involved in the enactment of affordances are objects and users, not contexts. Markus and Silver (2008) addressed potential uses of a technology with only technical functionality and named them as functional affordances. Functional affordances are defined as the possibilities for action that are afforded by technical objects to a specified user group (Markus and Silver, 2008). Without considering contexts such as place, time, and situation, the potential technology use would be simple or a few or more, which affects a user's beliefs about the technology use, and eventually affects the actualization of affordances.

Affordance theory has investigated mechanisms that have explanatory power on how and why things happen. For example, network changes were found in organizations due to shared affordances of a new technology for collaboration work (Leonardi, 2013). However, those changes do not always occur (Markus, 2004; Poole and DeSanctis, 2004). Leonardi explained such issue with implication of affordances. Changes in material objects or social rules enact different affordances that can be actualized (Leonardi, 2011). On the other hand, a generative mechanism for organizational changes is investigated based on the dependences among affordances between technologies and complex assemblages of organizations (Volkoff & Strong, 2013). Contexts were emphasized in the enactment of affordances, because affordances resided in the domain of real situations. They found multiple affordances and dependences among them, which can collectively change outcomes.

Changes in affordance dimensions may result in the actualization of certain affordances. First, the material, as an affordance dimension, may be altered if it does not offer a desired affordance for the user. The material changes, often with the changes of the

object's properties, contain causal potentials for a new affordance to emerge (Leonardi, 2011). Goh et al. (2011) explain that technical artifact provides new technical features that affect the enactment of a new affordance with broaden capabilities. At the same time, it often eliminates affordances available in the old routine, forcing the flow to take a different path (Goh, Gao & Agarwal, 2011). This could entail the disappearance of existing affordances and the emergence of new affordances (Chemero, 2003). Next, user's characteristics may change. Self-modifying individual adaption behaviors relate especially to the capabilities of the individual, which increase through the acquisition of knowledge about the technology, the domain, or the affordance outcomes such as learning (Bernhard, Recker, & Burton-Jones, 2013; Strong, Volkoff, et al., 2014; Hutchby, 2001). Also, situations, albeit not in all cases, are changeable. If a user is too busy at work to use a technology for two-people communication, he or she can use it at a convenient time with a technology that provides free of time limitation for uses such as social media technology. Situations play a key role in the actualization of affordances. We may change these as affordance dimensions to increase the effectiveness; however, without a full understanding of related affordances, unintended consequences can occur.

C. Why Affordance Types Are Needed

The actualization of an affordance leads to certain consequences (Stoffregen, 2000). Impacts of the technologies are not always clear: similar outcomes from different technologies or distinct outcomes from the same technology use in different contexts. For example, social media technology supports social connection (Treem & Leonardi, 2012) or generates increased emotional engagement and freedom of communication (Merolli, Gray, & Martin-Sanchez, 2013). Mobile technology produces similar outcomes with smart

phones such as continuous communications and better relationships (Cousins & Robey, 2015) and sharing rich data and collaboration (Cochrane & Bateman, 2010).

Literature on technology affordances cover both behavioral affordances and interactive affordances. The literature on social media affordances identifies interactive affordances of social media technology that supports multidirectional communications (e.g., association (Treem & Leonardi, 2012), meta-voicing, networked informed associating (Majchrzak et al., 2013)). Social media technologies also show behavioral affordances, such as narration, flexibility (Merolli, Gray, & Martin-Sanchez, 2013), and triggered attending (Majchrzak et al., 2013). Mobile technologies show most behavioral affordances (e.g., mobility, connectedness, interoperability, personalization (Cousins & Robey, 2015), ubiquitous access (Melhuish & Falloon, 2010)). Smartphones offer interactive affordances such as social networking, enhanced podcasts, and image and video blogging, with behavioral affordances such as geo-tagging and text notifications (Cochrane & Bateman, 2010). As such, even a single technology could show behavioral affordances, interactive affordances, or both.

Even though affordance types are simply grouped based on the goals of the technology uses - people interaction or system interaction – the impacts of affordance types could be more clearly recognizable. As shown in the content in Appendix 1, behavioral affordances enhance engagement (Merolli, Gray, & Martin-Sanchez, 2013), promote learning (Majchrzak et al., 2013), or satisfy personal needs (Cousins & Robey, 2015), regardless of the place or devices used. Interactive affordances bring social connection (Treem & Leonardi, 2012), continuous information sharing (Majchrzak et al., 2013; Cousins & Robey, 2015), and collaboration (Cochrane & Bateman, 2010). As such, particular affordance types bring certain actions as the outcome; an interactive affordance enhances information sharing among people, while a behavioral affordance is related to

meeting personal needs such as learning. I believe that identifying affordance types helps us to more clearly conceptualize and examine the outcomes of the ISMP affordances.

METHODS

For my dissertation, I pursued a mixed-method approach that includes both quantitative and qualitative data analyses. The integration of quantitative and qualitative approaches helps address limitations of each approach (Kaplan & Duchon, 1988; Trauth & Jessup, 2000). This adds further analytical value by providing means to theoretically and empirically triangulate phenomena that are not available when utilizing only a single approach.

A. Data Sources

It is recommended to analyze digital traces for sociomaterial practice research. Digital traces are a new type of instrumentation that captures individual and technological activities (Hedman, Srinivasan, & Lindgren, 2013). It reveals an individual user's actions by capturing routines in digital artifacts. This study analyzed event log data, transaction data, and conversation text data in the ISMP technology as the digital traces. Besides, the data of interviews and focus groups were collected and analyzed to understand big pictures related to the use of ISMP. Patients' demographic information and clinical data were used to analyze the factors that affect the enactment of affordances and the outcome of affordances.

Case study

To explore the relationships around the use of ISMP, I conducted a case study. A large hospital in China (more than 3000 beds, 920 units, more than 2700 employees, more than 1,200,000 out-patient visits per year) was chosen as a research site, because the case setting provides an opportunity to explore healthcare process changes with the adoption of a cutting-edge technology, ISMP. The president of the hospital showed a clear vision of enhancing patient-centered care using technologies. Technology and processes as well as

culture and beliefs of employees are the concerns of the top managers. I judged this hospital to be an appropriate research site for studying technology-enabled phenomenon by gathering retrospective data over 1-year period of time (from September 2014 to October 2015) after June 2014 when the ISMP was put in use.

The hospital is the first in China to launch an ISMP in healthcare setting. At the time of the ISMP implementation, the hospital has a number of advanced health systems: A computerized physician order entry (CPOE) system, an electronic medical records (EMRs) system, a decision support system, data mining, a patient portal, online services platforms, knowledge/database management system, a medical card system for patient's identity and insurance coverage, and an ISMP. To design and implement the ISMP technology, an interface that integrates the various healthcare systems into a mobile device, a system development team of 60 personnel in four different companies were involved.

Before making a decision to implement the new technology, the hospital searched for an appropriate tool to meet patients' needs under the top management's direction. One solution is to use a social media platform (i.e., WeChat) which is one of the most popular mobile social media technologies used in China. It means that the hospital utilizes the space in the social media platform that is already popular among patients as a versatile technology. Integration of hospital system functionalities into a mobile technology allows patients to access virtual medial resources and efficient access to healthcare processes. Main functionalities of ISMP to support healthcare process for outpatients and healthcare providers are shown in Appendix 2.

Main users of the ISMP technology are outpatients and hospital staff: 5,914 outpatients (64%)² have been using ISMP and all physicians (100%) in the hospital are

² 5,914 patients have been using out of 9,241 patients who visited and registered in the hospital EMR system for the period between Sep. 2014 and Oct. 2015.

required to use ISMP. Patients and healthcare providers both access the same technology in a unified platform in order to perform e-healthcare processes or virtual healthcare consultations. The ISMP technology users would have benefits like real-time information sharing, alerts, and collaborations, which increase quality of care. It is an inexpensive, easy-to-use mean of communication to hold interpersonal or multi-group chatting sessions.

Interview

I conducted in-depth interviews with patients and healthcare providers to understand their perceptions of ISMP and their activities in the healthcare context. Interview results helped me to capture patients' and physicians' perceptions and actions with ISMP, which are defined as ISMP affordances in this study.

Semi-structured interviews were conducted in August 2015 with nine outpatient clinicians, three outpatients, a IS project manager, and two top managers, in total 15 interviewees. Interviewees are selected to represent the overall population related to clinical processes and administrative processes, considering age, position, and specialty. Table 6 shows the characteristics of the interviewees. The interview questions related to demographic information of interviewees, user perceptions and experiences (e.g., work experience of a physician and comfort level of ISMP technology use), technology (e.g., specific technical process), and behaviors and outcomes (e.g., how they interact with when using ISMP, and impacts on satisfaction and quality of care). The interview questions are shown in Appendix 3. All interviews, approximately 40 min on average, are audio recorded, transcribed, and coded.

Table 6. Interview Participants

Category	Role of Interviewee	Title of Interviewee (Number)
Persons related to administrative process	Top management	President (1)
		Vice presidents (1)
	IS manager	Project manager on the ISMP (1)*
	Clinical function managers	Chief of quality control department (1), Chief of patient satisfaction department (1), Chief of patient record (1), Chief of medical staff (1), Chief of nursing (1)
Persons related to clinical process	Physicians	Physicians in OB/GYN (1), Neuro surgeon (1), Neurology (1), Stomach surgeon (1), considering position, age, specialty
	Patients	Patients (3), considering age

- Two times of interviews are conducted with the project manager on the ISMP.

Focus Group

In addition to individual interviews, two focus groups with eight physicians were held in order to explore their views on what dimensions are important for the patient-centered care process and their perceptions of the ISMP uses. The topics consisted of how they use ISMP and the impacts in the healthcare processes that the ISMP technology use brought to the hospital. Detail questions of the focus groups are shown in Appendix 3. As Table 7 shows, specialties and positions of the eight clinicians participated are varied; Physicians in Urology, Pediatric, Oncology, Breast surgeon, Endocrinology, Liver surgeon, Gastroenterology, Orthopedics attended the focus groups. All the sessions were audio-recorded using digital audio recorders and later transcribed and coded.

Table 7. Focus Group Participants

Group	Title of Participants (Number)	Duration
Physician 1	Middle level physicians (3), low level physician (1)	90 min
Physician 2	High level physician (1), middle level physicians (2), low level physician (1)	90 min

Archived Documents

Documents on ISMP development and implementation are a valuable information source to understand the background around the technology implementation. The hospital documented the history of the ISMP technology development and implementation, from kickoff meeting records in March to ISMP release news article in June, 2014. In total, I was provided with nine documents which became the bases for the archival analysis. All nice documents specify potential users and potential usage of ISMP, indicating perceived affordances.

Archived Data from ISMP

Conversation contents and event logs were collected as digital traces to identify sequence of actions in the healthcare processes as well as ISMP affordances. Table 78 shows the data collected from ISMP and their statistics techniques for the analysis. The conversation texts between patients and corresponding physicians, all accumulative contents over a 14-month period, from September 2014 to October 2015, demonstrate longitudinal interactions. The event logs of all users in ISMP shows patients' and physician' all health care activities using the ISMP technology, representing actualized affordances. These data allow me to understand holistically healthcare activities and to develop a deeper understanding of the interactions between patients and physicians through the ISMP uses.

I collected ISMP transaction data for behavioral affordances and interactive affordances. As I mentioned before, behavioral affordances and interactive affordances are reflected with a user's actual actions when the users use specific technological features. Therefore, the ISMP system data, such as the number of scheduling requests that a patient

made, represent users' behavioral affordances. The data of mobile consulting that a patient and a physician created were collected to measure an interactive affordance.

Table 8. Archived Transaction Data

Functionality	Data	Period	Number of Patient	Number of Physician	Number of Data ³	Average(/week)	Max (of a patient)
Scheduling	ISMP Scheduling	September 2014 to October 2015	12,679	-	28,232	543	79
	Onsite Scheduling	September 2014 to October 2015	11,769	-	22,664	436	47
	Kiosk Scheduling	September 2014 to October 2015	4,736	-	8,923	172	38
ISMP Consulting	ISMP Mobile Consulting	September 2014 to October 2015	2,596	251	4,728	91	91
	Conversation Text in ISMP	September 2014 to October 2015	11,300	2,032	13,332	256	84
Payment	ISMP Payment	September 2014 to October 2015	1,939	-	2,164	42	8
	Onsite Payment	September 2014 to October 2015	20,883	-	58,678	1,036	67

Demographic information of patients and physicians are collected from the EMR system and the human resource system in the hospital. Those data are used as factors related to users that affect the emergence of affordances. Besides, I collected patients' clinical data from the EMR system for 3 years, one year before and one year after the introduction of the ISMP, so that I can compare the outcomes (e.g., the number of face-to-face visits or productivity) of patients and physicians who used the ISMP technology.

B. Data analyses

A mixed methods approach was applied 1) to identify various forms of ISMP affordances, 2) to reconfirm the affordance types, 3) examine the relationships of

³ Data are transaction data of scheduling, consulting, and payments completed.

affordance types, affordance dimensions, and outcomes, and 4) to investigate why users (patients and physicians) use /don't use the ISMP technology.

Existing affordance research in IS discipline suggests that the affordance theory naturally lends itself to qualitative means of examination (Michaels & Carello, 1981). Many studies utilize the case study methods (e.g., Cousins & Robey, 2015; Leonardi, 2011, 2013; Strong, Volkoff, et al., 2014). Recently, sociometric survey (Leonardi, 2013) and survey (Grgecic, Holten, & Rosenkranz, 2015) were used to collect the data for affordances in IS discipline.

For this study, I utilized a mixed-methods approach which is novel for affordance research. First, I learned from event log data and conversation texts about the overall patterns of healthcare practices using process mining techniques and text mining techniques. Perceived affordances are identified based on the information of the interview, focus group, and documents. Actualized affordances are identified from the actual digital trace data, such as event log data and conversation texts. In order to understand and test the relationships related to affordances, typical qualitative analysis techniques such as grounded coding and quantitative approach such as statistical methods were used. The overall approach of the data analysis was to use a qualitative approach to identify the types of affordances and perceived affordances of ISMP and their impacts, and then investigate the relationships among types of affordances, factors affecting affordances and impacts of affordances with objective quantitative data. The rich data in various sources provide me with holistic pictures into the healthcare practices with ISMP use and the relationships of the affordances for patient-centered care process.

I conducted grounded theory analysis according to the suggestions made by Berente and Seidel (2014) to build a theory using a mixed method approach. It guided me on how to analyze data, especially on sampling, synchronic analysis, reference lexicon,

and diachronic analysis. Table 9 represents each step with their guidelines and how I incorporated them in this study. The data from the different sources were analyzed using different techniques.

Table 9. Activities in Grounded Analysis (Adapted from (Berente and Seidel, 2014))

Activity	Goal	Manual Analysis	Computational Analysis	
Sampling	Develop dataset	Theoretical sampling (e.g., collect additional data based on findings and analysis)	Data extraction (e.g., map reduce a large amount of trace data to manageable volume based on goals and current knowledge)	
	Data in this study	15 Interview/ 8 focus group participants transcript, 9 documents	14-month of conversation text in ISMP	14-month of event log data in ISMP
Synchronic Analysis	Develop Categories and Associations	Coding - Identification of similarities - Identification of correlations	Synchronic relations: - Categorization—relationships among similar data - Associations—relationships of covariance among data	
	Technique in this study	Open, Axial, Selective coding	Text clustering ⁴ , Conceptual map,	Sequence analysis, Process mining ⁵ , (J. Gaskin, Berente, Lyytinen, & Yoo, 2014)
Reference Lexicon	Draw upon Grammar	In all cases, the lexicon provides the pre-theoretic reference for the identification of patterns in relation to a goal, using the language and causal relations determined by one or more scholarly communities.		
	Lexicon ⁶ in this study	Affordance dimension (e.g., user, goal, technology feature, situation, etc)		

⁴ Text clustering analysis results are created by SAS Text Miner software. SAS Text Miner software analyzes text data (unstructured data) to help discovering new information, topics and term relationships.

⁵ Process mining analysis results are created by Fluxicon process mining software. The process mining technology in Fluxicon creates visual maps from process data, providing statistics and cases with filtering feature.

⁶ Lexicon I used is shared by scholarly community.

Diachronic Analysis	Generate Theory	In both cases, the generation of theory requires a sensemaking process; that is, the analyst decides—based on the empirical evidence—what concepts and relationships (pre-theoretic understanding) are included in a coherent theoretical scheme (theoretic understanding).
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The first step is sampling to determine the datasets for this study. Three different sources and types of data were sampled for the analysis: 1) the interview scripts, the focus group transcript, and the documents; 2) the patient-physician conversation texts, and 3) the ISMP event log data archived in ISMP. Importantly, the conversation contents made by patients and physicians and the ISMP event log data were included as the digital trace data to reflect the actual usages of the technology. The written conversations show interactions between a patient and a physician when using the ISMP mobile consulting feature. The ISMP event log data allowed me to reveal real sequences of activities of patients and physicians in the healthcare processes.

Secondly, I analyzed the data to develop categories of affordances and to understand associations among the categories. For the analysis with the interview transcripts, the focus group transcripts, and the documents, I used coding techniques associated with a grounded theory method (Corbin & Strauss, 2014; Urquhart, Lehmann, & Myers, 2010). I used grounded theory coding strategies to identify open, axial, and selective codes (Corbin & Strauss, 2014). During open coding, using an inductive approach allowed for common patterns to emerge about the ISMP technology uses. During axial coding, the data were coded for affordance dimensions (e.g., action, object properties, user characteristics, or goals). Sub-dimensions were adapted from the study of Gaskin et al. (2014), which are shown in Appendix 4.

Figure 1 provides an example for how I executed the coding processes. This example with an interview data for ‘virtual healthcare consultation’ shows how a theme of

virtual healthcare consultation comes up and how the information are coded under the affordance dimensions. A pattern regarding virtual healthcare consultation comes up with a technological feature, ISMP mobile consulting feature. The participants of the interviews and the focus groups clearly mentioned how the use of the ISMP mobile consulting feature supports communications between patients and physicians, thus enables virtual medical consultation. This specifies the goals of their usages of the ISMP mobile consulting feature. Next, the information was codified using abstracted codes for the affordance dimensions. During selective coding, the emerging themes were consolidated into distinct theoretical patterns through constant comparisons of affordance dimensions and existing affordance literature. Then, I developed a theoretical explanation of the behaviors demonstrated in the ISMP uses with the abstraction of affordance dimensions. This was how I identified affordances and practices related to the ISMP uses.

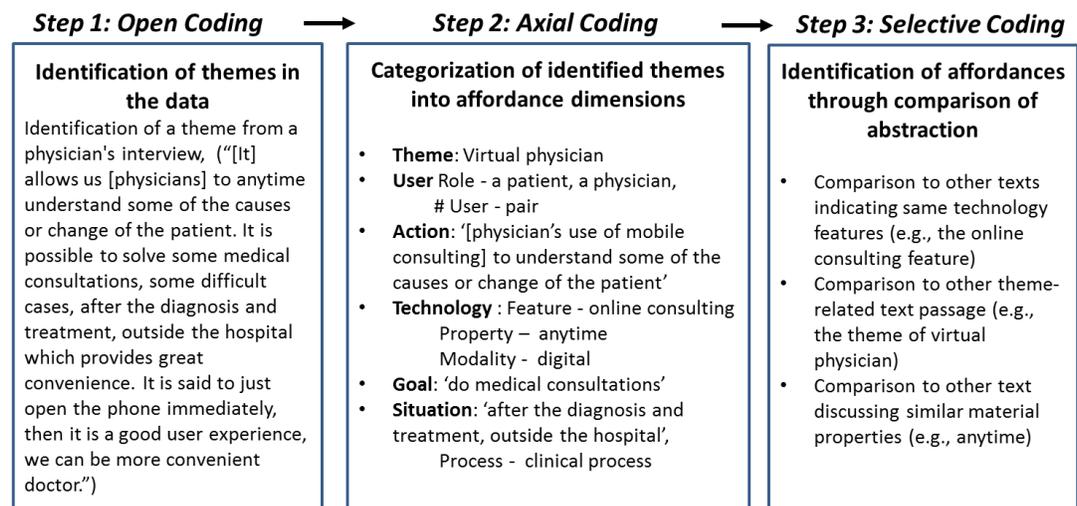


Figure 1. Data Coding Process for 'Virtual Physician'

The same basic ideas can be applied to analysis with the trace data, the conversation texts and the ISMP event log data. Text clustering techniques and conceptual map were applied to find patterns from the text data. For analysis with the event log data, I applied a sequence analysis technique proposed by Gaskin et al. (2011). A technique of

process analysis was performed with clustering statistical methods which enable analysis of sequences of the healthcare activity routines. Process mining technique supports the analysis of real healthcare processes in a bottom-up fashion from the actual data. The results of the process mining analysis reveal key actions in the real healthcare processes and clusters of affordance dimensions. In this way, the process mining techniques and the text mining techniques helped me to find key affordances of ISMP and their relationships.

Third, I utilized affordance theory shared by IS discipline researchers. I compared patterns from the various analyses using affordance dimensions, such as an activity, an actor, a tool property, a goal, a task, and a situation (Berg, Lune, & Lune, 2004; J. Gaskin et al., 2014). The affordance dimension information were examined through continuous comparisons of the abstractions of the information from the three difference data sources. Identified themes were triangulated across three different sources by comparing the analysis results with the qualitative data, the patient-physician consultation conversation texts, and the ISMP event log data.

RESULTS

As I discussed earlier, I proposed three types of affordances (i.e., perceived affordance, behavioral affordance, and interactive affordance) and affordance dimensions (i.e., user, technology and information, and context including time, place, and situation). A mixed-method approach was applied 1) to identify healthcare practices with ISMP, 2) to identify key affordances of ISMP, 3) to reconfirm the affordance types, 4) to examine the relationships among affordances, affordance dimensions, and outcomes in the healthcare context, and 5) to investigate why users (patients and physicians) use / don't use technological features in ISMP. I tried to jointly consider, rather than separately, various aspects of the same practices in order to holistically understand the interactions between patients and physicians. Understanding different types of affordances requires different sources of information. To capture perceived affordances, for example, data of interviews and focus-groups were used with documents accumulated during the period from the development to the release ISMP in the hospital. User's perceived affordances are identified from the user's expressions through the interviews and focus-groups. Designer's perceived affordances are specified in the documents, reflecting objective functional affordances of ISMP. However, actualized affordances can be captured by digital trace data such as ISMP log event data and conversation texts made by patients and physicians during their virtual consultations. Through the investigation of the interactions in terms of social structure, procedural structure, and contents in ISMP, I could understand how affordance dimensions are involved in the emergence of new healthcare practices and emergent affordances with the ISMP use. In addition, I could uncover how the relationships and the streams of activities are associated with each other.

Two affordances of the ISMP technology were identified that led to patient-centered care: ubiquitous access and virtual healthcare consultation. During the

identification process, I also confirmed three different types of affordance: perceived affordance, behavioral affordance, and interactive affordance. Patients' and physicians' technology actual uses as actualized affordances are often different with their perceptions about the technology as perceived affordances. This finding is consistent with the literature that addresses perception of a technology is a necessary but not sufficient condition for actualization (Stoffregen, Gorday, Sheng, & Flynn, 1999). The occurrences of an affordance may be affected by configurations in affordance dimensions, leading to certain outcomes.

A. Practices with ISMP

Healthcare practices with ISMP were identified by applying analysis techniques of process mining and text mining with various sources of information, conversation texts, ISMP event log data, interview, focus group scripts, and documents. Figure 2 gives an overview of ISMP usage of main users, outpatients and physicians. Among 9,241 patients who visited the hospital for the studied time period, more than half of them (56%) had used the ISMP scheduling feature, some patients (8%) used the ISMP consulting feature. However, there were 36% of the patients who showed no use of the ISMP. All of the 579 physicians and 1,349 nurses were registered and should have used the ISMP technology, but only 19% of the physicians used the ISMP consulting feature, mainly because participating in the ISMP consulting put their additional time and efforts.

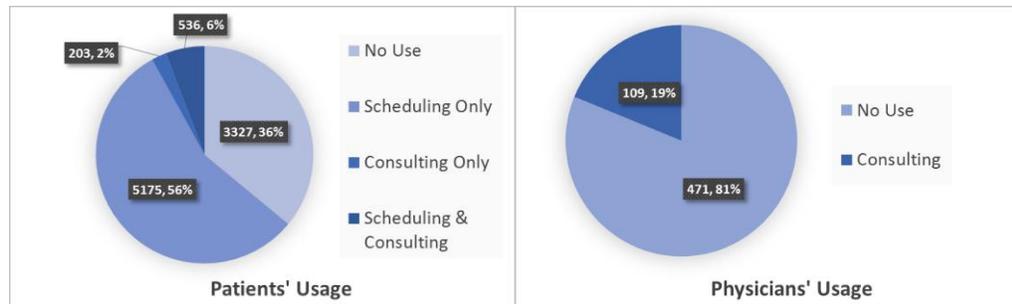
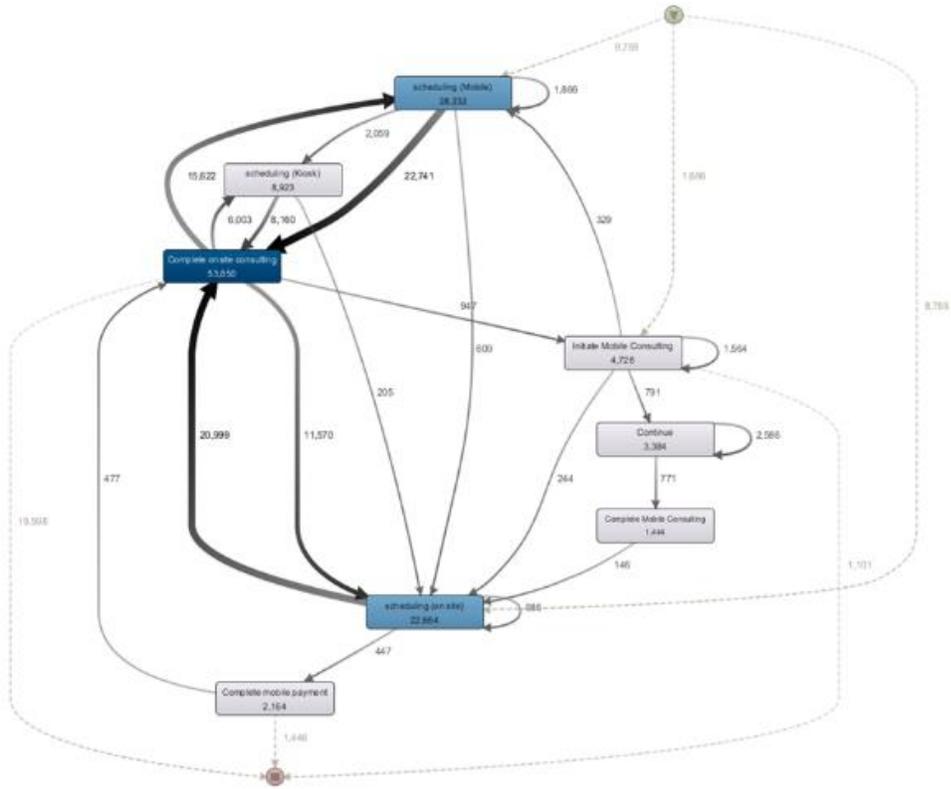
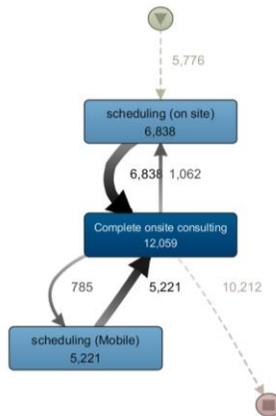


Figure 2. Overview of Patients' and Physicians' ISMP Usage

First, with the ISMP event log data, I applied the procedures of sequence analysis proposed by Gaskin, Schutz, Berente and Lyytinen (2010). The results of the process mining analysis with real historical data revealed the real healthcare practices, specifically sequences of activities. They allowed me to find patterns of affordance dimensions including activities, users, technology features, location, and time. Figure 3 shows results of the process mining analysis with the actual usage data (125,389 event log data over the 14-month period of time). Figure 3(a) looks somewhat spaghetti-like as the analysis using all the data. Nevertheless, Figure 3(a) reveals two dominant healthcare routines as highlighted by dark-colored boxes: scheduling and consulting. The scheduling actions happen with three options: ISMP mobile scheduling feature, Kiosk, and through registration staff at the hospital. The consulting actions happen with two options: ISMP mobile consulting in a virtual world and face-to-face consulting at the hospital. With the data I have, I could figure out sequences of the activities with the ISMP mobile consulting feature, which show a sequential pattern (i.e., initiating a text conversation, sending texts, and then completing the conversation).



(a) Activity Flow (with All Data)



(b) Activity Flow (From Top 4 Variations)

Figure 3. Results of Process Mining Analysis with Event Logs Data in ISMP

All the event logs generated 3,438 variants defined as specific sequences of activities. These patterns based on the digital trace data are much more complex than what the healthcare routines have been perceived of, which is illustrated in Appendix 5. The top variants consist of majority of the events. Table 10 summarizes the top 4 Variants. Variant 1, onsite scheduling then face-to-face consulting identified with 4,714 transactions (20%), and Variant 2, ISMP scheduling and then face-to-face consulting with 3,651 transactions (15%). Variants 3 (5% of events) and 4 (3% of events) repeat the activities of Variants 1 and 2, respectively. Most of Variants 1 and 3, which activities occurred through the use of onsite registration desks, happened during the morning operation hours as indicated by the blue-colored portion along the time dimension. Variants 2 and 4, which activities occurred through the use of the ISMP scheduling feature, happened during the period between 5 pm and 7 am. Figure 3(b) shows the result of analysis with only the top four Variants, and now it clearly reveals two dominant sequences of activities: the onsite scheduling and with the ISMP scheduling followed by face-to-face consultations.

Table 10. Overview of Top Four Variants

Variant	Frequency	Activity Sequence	Technology used	Time Distribution
Variant 1	4,714 (20%)	<pre> graph LR A[Onsite Scheduling] -.-> B[Onsite Consulting] </pre>	Registration desk	
Variant 2	3,651 (15%)	<pre> graph LR A[ISMP Scheduling] -.-> B[Onsite Consulting] </pre>	ISMP	
Variant 3	1,062 (5%)	<pre> graph LR A[Onsite Scheduling] -.-> B[Onsite Consulting] </pre>	Registration desk	
Variant 4	785 (3%)	<pre> graph LR A[ISMP Scheduling] -.-> B[Onsite Consulting] </pre>	ISMP	

Another key action with ISMP is virtual healthcare consultation through which a patient and a physician share written conversations. Relatively the ISMP mobile consulting transactions are small portion (1.2% of all the events, 1,444 transactions completed). The

top variant related to the ISMP mobile consulting feature is variant 7 with 564 data of the initiation of the ISMP mobile consultation. Variant of the completion of the ISMP mobile consultation after initiation is variant 25, and variant of the completion of the ISMP mobile consultation after initiation and continue is variant 49. The activities with the ISMP mobile consulting feature, however, has been increasing over time, as shown in Figure 4, with 13,332 conversation texts at the end of the studied period. As the ISMP mobile consulting usage increases, the numbers of patients and healthcare providers using the ISMP also increased accordingly. The healthcare providers responded to patients' texts moderately quick (6 minutes in median terms). However, a third of the conversation texts (1,564 out of 4,728 texts) failed to continue written conversation with healthcare professionals. This pattern indicates the need of investigation on why interactive affordances are and are not actualized in the situation of both patients and physicians.

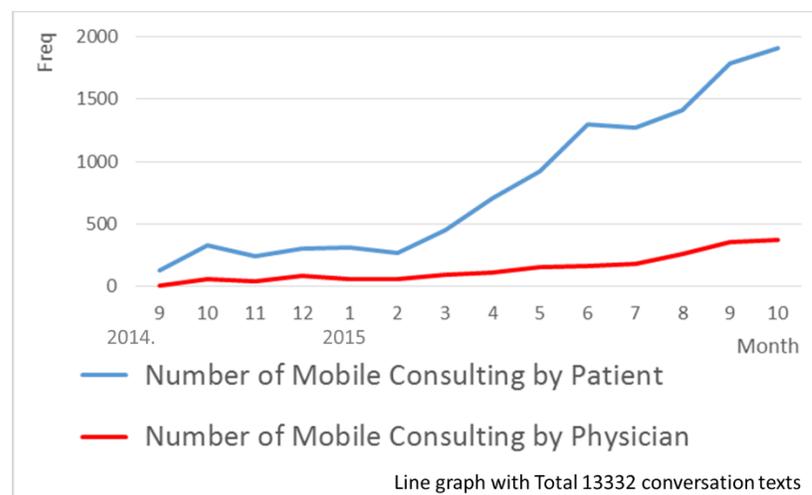


Figure 4. Trend of the ISMP Mobile Consulting Transactions

To analyze the conversation texts between patients and physicians archived in ISMP, I performed text mining techniques. Text clustering algorithm as one of text mining techniques was applied with 13,332 conversation text messages, treating each message

created as an analysis unit. The result of the text clustering analysis shown in Figure 5 gave me insights about the interactions between physicians and patients when they use the ISMP mobile consulting feature. A practice identified was using the ISMP mobile consulting feature for a patient and a physician to ask and respond to questions about test results and healthcare guidelines, which refers to virtual healthcare consultation. Physicians' texts are clustered around three themes, specifying what users do with the ISMP mobile consulting feature: to give guidelines (48%), to suggest to come to the hospital for an in-person visit (40%), and to discuss about test results (13%). Nearly half of the conversations (48%) show that physicians do medical consulting in ISMP, such as giving guidelines on pain management, dietary, or physical routines. The remaining half (53%) demonstrates that physicians do pre-diagnosis; physicians decide a disease or they recommend patients to visit a hospital next day after reading patients' test results. Those are main actions performed by physicians on ISMP, which are considered as virtual healthcare consultation in this study.

Patients' conversation texts show similar clusters as shown in Figure 5 (b). Patients ask physicians for professional opinions: asking physician's opinion about patients' test results (56%), asking guidelines (33%), and updating patients' conditions (12%). More than a half of the conversations (56%) are inquiries about test results that patients had viewed and that had made them worried. Below is a typical example of written conversations between a patient and a physician. A patient saw his or her test results and initiated a mobile consulting conversation by stating '*Dr. A, my test results came out. Is 125 high? Will it be no problem, right?*' Within 1 minute, the doctor responded to it with a simple answer, '*Not too high.*' They continued the conversation by exchanging follow-up questions and answers.

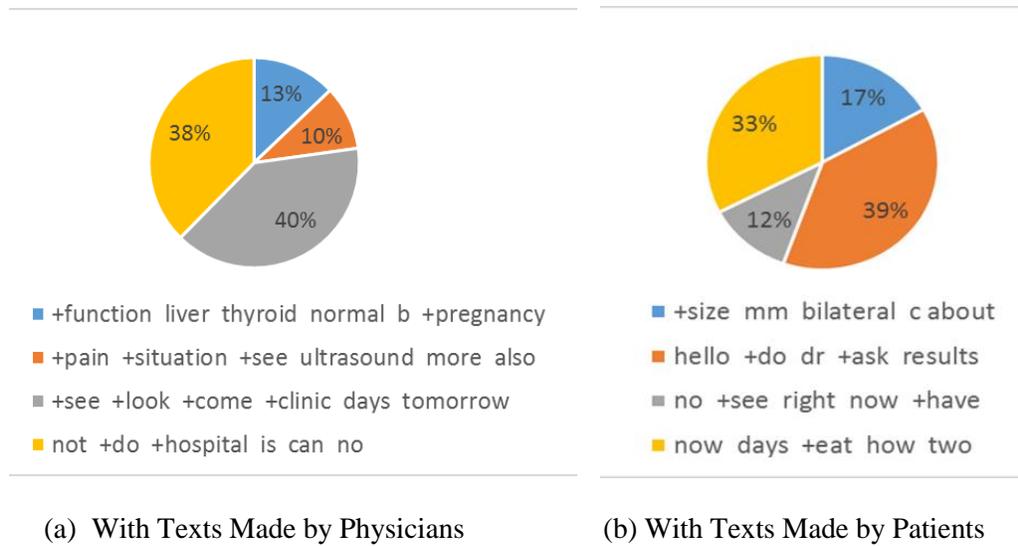


Figure 5. Results of Text Clustering of Texts Made by Physicians and Patients in the ISMP Mobile Consulting Feature (by SAS Text Miner)

Figure 6 is a conceptual map that expands links from the mostly used word. The analysis level of the data is the whole text pool. Words that many physicians actually wrote in the ISMP messaging feature is ‘is big problem,’ which indicates that physicians do diagnosis using ISMP. The next common expressions are ‘is normal’, ‘no problem’, ‘not worry/necessarily afraid,’ which indicate that physicians use ISMP to give his/her judgements on patients’ test results or descriptions of problems. This supports the same practice with ISMP, virtual healthcare consultation that I identified with information from the other sources.

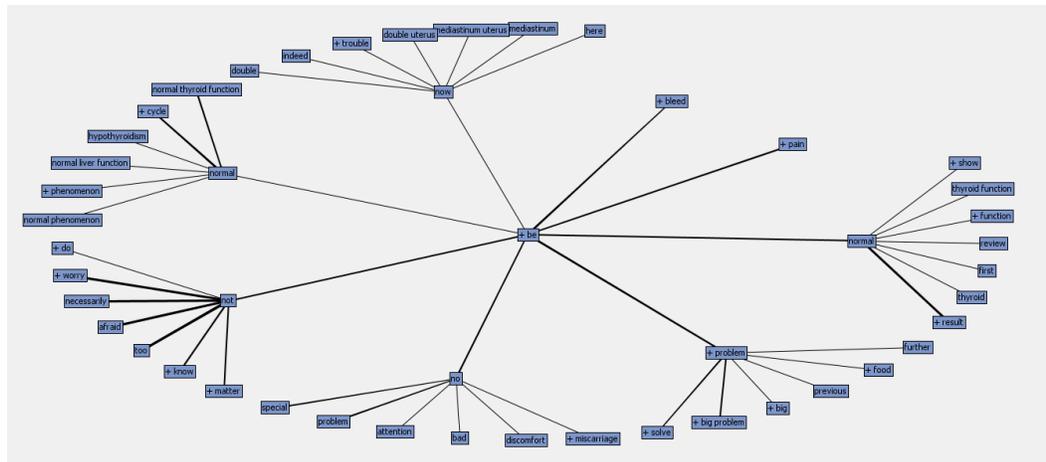


Figure 6. Results of Text Conceptual Map with Texts Made by Physicians in the ISMP Mobile Consulting Feature (by SAS Text Miner)

Table 1111 gives descriptions of the healthcare practices with ISMP that I identified according to the dimensions of affordances. Affordance theory suggests that affordances have core concepts including user, technology, goal, perception, actual use, which I titled as affordance dimensions. The affordance dimensions have important information about the affordance that emerges in a context with object properties and a user for a certain task (Stoffregen, 2003). Perceptions reflect perceived affordances and actual uses reflect actualized affordances.

Table 11. Description of Affordance Dimensions in the Healthcare Processes

Affordance Dimension	Healthcare Practice	Affordance Subdimension
Object	The ISMP technology features used by patients or physicians, such as the features of mobile consulting, scheduling, and payment	<ul style="list-style-type: none"> • Technological properties that may lead to emergence of affordance
User	A patient or a physician who use the ISMP technology features to perform healthcare processes	<ul style="list-style-type: none"> • Role, gender • User ability

Goal	The reasons that a user uses the ISMP technology features, such as scheduling, diagnosis, and follow-ups	<ul style="list-style-type: none"> • User’s purpose • Situation involved (e.g., when, where, what, and why)
Perception	Perception of action possibilities in the healthcare processes afforded by a patient or a physician’s uses of ISMP	<ul style="list-style-type: none"> • Perceived affordance • Expected net value of affordance
Actual use	The actual actions taken by a physician and a patient in the healthcare processes	<ul style="list-style-type: none"> • Actualized affordance

B. ISMP Affordances

Based on the analysis with the ISMP event log data, the conversation text data, the scripts of the interviews and the focus groups, I identified two key affordances in the healthcare context – ‘virtual healthcare consultation’ and ‘ubiquitous access’ – and the dimensions of affordances – goals, user characteristics, and technological properties – as summarized in Table 12. Since listing merely affordances and constraints has been previously criticized (Bloomfield et al., 2010), I described the specific circumstances that enact the affordances in order to see how they were perceived and actualized by the users (Strong, Volkoff, et al., 2014). In this section, I described a definition of an affordance, the evidence that supports the affordance perceived and actualized, the affordance dimensions that affect the emergence of the affordance, and the impacts of the actualized affordance on the healthcare processes.

Table 12. Overview of Identified Affordances and Their Dimensions

Affordance	Virtual Healthcare Consultation	Ubiquitous Access
User	A pair of a patient and a physician	An individual user as a patient
Object property	Asynchronized	Ubiquitous
Goal	Virtual healthcare consulting	Access information as soon as possible
Perception	Anytime and anywhere communication with a medical professional	Convenience

Patient's actual use	Access to care, Shared healthcare decision making	Access to care, Emotional comfort
Physician's actual use	Understanding the patient, Shared healthcare decision making	Efficiency
Type	Interactive affordance, Perceived affordance	Behavioral affordance, Perceived affordance

Affordance I: Virtual Healthcare Consultation

'Virtual healthcare consultation' affordance is recognized when both a patient and a physician use the mobile consulting feature provided by the ISMP technology in order to conduct a virtual healthcare consultation. With the scripts of the interviews and the focus groups with physicians and patients in the hospital with the documents about the ISMP development and release, I conducted a qualitative analysis to identify ISMP affordances. Participants of the interviews and focus groups mentioned about the use of ISMP and details related to affordance dimensions. Virtual consulting is one of the ISMP features that most interviewees highlighted, similar to what has been investigated in academia (Constantinides & Barrett, 2006; Thielst, 2011). Since virtual consulting is free of time and place limitations, patients can get medical professional services at anytime, even during off-operation hours, and from any place that is not necessarily at a hospital where patients normally go to get medical services in a traditional circumstance. Time of the consultation is related to a material property that enacts the affordance of 'virtual healthcare consultation.' There are two actors, a patient and a physician who are in the real world and the virtual world.

I found the 'virtual healthcare consultation' affordance as a perceived affordance in documents. Document 1 published by the hospital at the time of the ISMP release describes the hospital's explicit goal of the ISMP mobile consulting feature. It was designed for one-to-one communication between a patient and a healthcare provider, and

highlighted its ultimate goal is to offer healthcare services to patients. This new functionality itself enacts the new affordance of virtual healthcare consultation.

‘It is an online interaction between doctors and patients in the hospital. Healthcare providers give consulting virtually, and patients receive consulting. Patients provide healthcare providers with real-time information on the patients’ health status. They both receive healthcare information using the mobile technology.’

(Document 1)

Similar affordance is perceived by physicians as an expected net value of the ISMP consulting feature use. Some people value additional capability from ‘anytime and anywhere’ characteristic of the ISMP technology. The following quotation illustrates how Chief physician 1 perceives the ISMP technology use in the clinical process workflow of physicians. Physicians can get continuously patient’s information anytime and are able to give quicker feedbacks to the patients, enabling continuous care outside of the hospital. The physician envisions that they can be convenient doctors by becoming virtual physicians who offer virtual medical services. Physician 2, who worked for more than 10 years in surgical oncology and has the ability to seize opportunities to use health technologies for medical care in the Internet era, perceives the same benefits of the use of ISMP consulting feature; patients can get timely and inexpensive professional services regardless of time and place. The technological properties that enables anytime and anywhere plays a critical role in articulating the affordance of ‘virtual healthcare consultation’.

“[It] allows us [physicians] to anytime understand some of the causes or change of the patient. It is possible to solve some medical consultations, some difficult cases, after the diagnosis and treatment, outside the hospital, which provides a great convenience. It is said to just open the phone immediately, then it is a good

user experience, *we can be more convenient doctor.*” (Focus group, Chief Physician 1)

“It is really a great benefit to facilitate their *timely and inexpensive medical treatment* for them [patients]” (Focus group, Physician 2)

This affordance is actualized in the real healthcare processes. Figure 4 indicates that the use of the ISMP mobile consulting feature, as a measure of the interactive affordance of ‘virtual healthcare consultation,’ is significant. From the results of the process mining analysis with the real ISMP mobile consulting usage data, I found more variations in other affordance dimensions such as actor, place and time. Unlike the affordance of ‘ubiquitous access’, two groups of actors are involved: 2,492 patients and 109 physicians. Two-actor involvement necessitates a new type of affordance, an interactive affordance which is different from a behavioral affordance that involves only one actor. Some of the conversation texts were made by healthcare providers (13% of the 13,332 conversation texts), while most (87%) were made by patients. Nearly half of the conversation texts were made at off-work hours (46%).⁷ It clearly shows ‘anytime’ characteristics of the material plays a critical role in enacting the interactive affordance. Clinical department in which patients use the ISMP mobile consulting most is the OB/GYN department (50%), followed by internal medicine (12%). Detailed results of the process mining analysis are shown in Appendix 6.

From the results of the text mining analysis, I identified an actualized interactive affordance of ‘virtual healthcare consultation.’ The biggest cluster in Figure 5(b) describes the affordance of ‘virtual healthcare consultations’ that both a patient and a physician (as

⁷ The regular operation hours include 7 am – 12 pm and 3 – 5 pm. This hospital has lunch and nap time between 12 pm – 3 pm.

actors) discussed about the patient's test results (as what activity) using the ISMP mobile consulting feature (as a material) for a purpose of deciding healthcare plans (as a goal). The second biggest cluster represents patients' needs to get healthcare guidelines to improve patients' health conditions.⁸ This case also represents the same affordance of 'virtual healthcare consultation' in which case a physician (as an actor) transfers medical advice information (as activity and a goal) to a patient (as an actor) via the ISMP mobile consulting feature (as a technology).

I found more evidences that reconfirm the affordance of 'virtual healthcare consultation,' especially anytime and anywhere, in the conversation texts. Physicians answer patient's questions about test results and do diagnosis (e.g., a physician diagnosed an endometrial cancer via the ISMP). The mobile consulting feature is useful to patients who live far away from the hospital (*'I do not live [the city where the hospital is], but I will go down [the city where the hospital is] tonight,'* Conversation text, Patient 1). Virtual healthcare consultation is good to care-givers who want to talk with physicians on behalf of older seniors, pregnant women, or children who are discomfort to travel to the hospital. This service is provided, regardless of physicians' time (*'Oh, Dr. B sorry to disturb you so late,'* Conversation text, Patient 2), even when a physician is off (*'Today, I am out of clinic,'* Conversation text, Physician 3). As such, the mobile consulting feature with properties for anytime and anywhere affects the healthcare processes by improving the level of access to care.

So far, I identified interactive affordances of ISMP based on the actions demonstrated by peoples' actual usage of the ISMP mobile consultation feature. The affordance of 'virtual healthcare consultation' is reflected with the action itself and

⁸ Interestingly, not many patients ask about medication guidelines through the mobile consulting feature, because they are provided by other features like O₂O or alert in the ISMP technology.

measured by the ratio of the ISMP consulting use. A related affordance, ‘anytime virtual healthcare consultation’ is reflected with the ‘anytime’ characteristics of the action, and measured by the ratio of the ISMP mobile consulting completed during off-operation-hour. Initiation of a conversation text may indicate patient empowerment that can be measured by the number of patient-initiated conversations. Quick response can be measured by reciprocity, average of time period to get a first response. ISMP mobile consulting fee refunded, in this study, reflect the unmet requests or dissatisfactions of users. Patients can get refund if they get no response or a first response after 30 minutes. I collected data to represent the ‘virtual healthcare consultation’ affordance: event completed, event incomplete, time of event completed (grouped by operation-hour, off-operation-hour), and the number of event a patient initiated. According to the operational definitions defined in Table 13, the statistics of possible measures of the ‘virtual healthcare consultation’ affordance were calculated.

Table 13. Definitions of Possible Affordance Measures

Measure	Affordance	Operational Definition
Frequency of action (ISMP mobile consulting, ISMP mobile scheduling)	Virtual healthcare consultation, Ubiquitous access	The in-period cumulative number of action (ISMP mobile consulting or ISMP mobile scheduling) completed by a patient or a physician.
Ratio of action	Virtual healthcare consultation, Ubiquitous access	The in-period ratio of number of action using ISMP (ISMP mobile consulting or ISMP mobile scheduling) to total number of action regardless technologies completed by a patient or a physician.
Time of action	Anytime virtual healthcare consultation, Anytime ubiquitous access	Sum of the time code value of action (ISMP mobile consulting or ISMP mobile scheduling) completed: within operation hour = 0, off-operation hour = 1. Ratio can be considerable.
Initiation by patient	Initiation	The in-period cumulative number of mobile consulting initiated by a patient.

Incomplete action	Quick virtual healthcare consultation	The in-period cumulative number of mobile consulting refunded.
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Table 14 shows five measures of an interactive affordance of ‘virtual healthcare consultation.’ The OB/GYN and internal medicine departments show active usage of the ISMP mobile consulting (2,341 and 949 ISMP consultation completed, respectively), but there are still many incomplete ISMP consultation attempts. There are departments that show no use of ISMP consultation. The pediatric and surgery department show relatively lower percentages (1% and 8% respectively) of the ISMP mobile consultation usages, compared to those of other departments (a percentage between 12% - 14%). Instead, these departments show higher ratio of incomplete ISMP consultation (83% for pediatric department). In the interviews or focus groups, actually nobody in the pediatrics and surgery departments mentioned positive benefits from the use of the ISMP consulting feature. Besides, more ISMP consultation happens during off-operation-hours. As such, all the measures seem to relate each other, but each measure is slightly different. Each measure reflects a different affordance, and different affordances may produce different outcomes.

Participants in the interviews and the focus groups addressed the impacts of the ‘virtual healthcare consultation’ affordance on patient-centered care by sharing their real experiences with the ISMP mobile consultation. Physician 4 stated that the ISMP technology uses actually changed the real healthcare processes. Patients initiate a conversation text using the ISMP mobile consulting feature, which infers they become proactive patients. Physicians understand more about the patients, building common basis for relationships between them. The virtual interaction promotes shared understanding which plays a foundation role in shared decision making.

Table 14. Statistics of Measures of ‘Virtual healthcare consultation’ Affordance

Department	Frequency of ISMP consulting completed	Ratio of ISMP consulting completed	Ratio of Time ⁹ of ISMP consulting completed	Number of Initiation by patient	Number of Incomplete ISMP consulting
OB/GYN	2,341	12%	69%	5,502	3,263 (70%)
Internal medicine	949	13%	71%	2,257	1,402 (70%)
Pediatrics	120	1%	64%	576	456 (83%)
Men disease	274	14%	77%	699	447 (72%)
Surgery	478	8%	66%	926	648 (66%)
Dental	69	37%	28%	147	91 (68%)
etc	498	4%	56%	957	577 (66%)

- Etc include emergency, CT, MRI, Diagnostic radiology, Hospice, Medical Oncology, Outpatient Rehabilitation, Pain specialist, and so on.

“Patients sent the results of a number of check-ups through [ISMP technology]. I do give him answers to some personal questions. ... I recently discovered that communicating with a patient may be one side of a starting point, but it also increase the number of exchange communication with the patient. After we [physician and patient] communicate on the WeChat, I have a basic understanding of the patient.” (Focus group, Physician 4)

The mobile consulting feature offers a new type of the healthcare services by facilitating interactions between a patient and a physician. The displays of these simple words actually gave patients emotional reliefs. As a response of a doctor’s simple word, ‘normal,’ a patient expressed feeling in the mobile consulting feature like, ‘You say normal, which make me quite at ease.’ It illustrates the effect of the affordance of ‘virtual healthcare consultation’ on patient-centered care processes.

⁹ The ratio of off-operation hour code is applied.

Affordance II: Ubiquitous Access

An affordance of ‘ubiquitous access’ is identified through the data analyses. Material agents that enact this affordance are the ISMP scheduling feature and the eHealth data including lab results and summary reports that can be assessed through ISMP. A user’s goal regarding this affordance is convenience which is evident in the patient and the physician interviews (*‘It is convenient for patient when I get out, put all the results to see, including medical records’*, Interview, Physician 5) and (*‘I just want to know the results as soon as possible’*, Interview, Patient 3).

The affordance of ‘ubiquitous access’ is recognized as a perceived affordance from Document 2. The following statement describes the designers’ intentions to design the ISMP technology to make healthcare processes with less slack time. The need of ‘accessibility as soon as possible’ can be met with the affordance of ‘ubiquitous access’ enacted with ubiquitous technology property and the integration with hospital systems data.

“Patients access their lab results and medical records in no time... Patients make appointments with healthcare providers who they want and make payments for the healthcare services in no time” (Document 2)

The affordance of ‘ubiquitous access’ is actualized in the healthcare processes through the use of the scheduling, making payments, or querying medical records provided by ISMP. Like the ‘virtual healthcare consultation’ affordance, this affordance can also be assessed using derived measures from the actual action data. Intensity of mobile usage (e.g., scheduling) is measured by a ratio of the number of mobile activity (e.g., scheduling) over the total number of the activity completed regardless of technologies used. More importantly, that time measure accurately reflects the ‘anytime ubiquitous access’ affordance, and it assesses the availability of the health care. The detail definitions of each measure are described in Table 13.

Table 15 shows three measures of the behavioral affordance of ‘ubiquitous access.’ The OB/GYN and pediatric departments showed active usage of the ISMP scheduling feature (13,461 and 4,201 ISMP scheduling completed). Most of departments showed about even ratios of ISMP scheduling usages (41% - 49%), except for the OB/GYN department. The values of the ratio and frequency of the two different types of affordance, shown in Tables 14 and 15, are quite different, but the values in the time of the two affordances are not different.

Table 15. Statistics of Measures of ‘Ubiquitous Access’ Affordance across Departments

Department	Frequency of ISMP scheduling completed	Ratio of ISMP scheduling completed	Time of ISMP scheduling completed
OB/GYN	13,461	67%	56%
Internal medicine	3,477	47%	69%
Pediatrics	4,201	41%	66%
Men disease	879	46%	69%
Surgery	3,036	49%	69%
Dental	80	60%	63%
etc	3,098	82%	56%

- Etc include emergency, CT, MRI, Diagnostic radiology, Hospice, Medical Oncology, Outpatient Rehabilitation, Pain specialist, and so on.

In the process mining analysis results in Figure 3(b), Variants 1 and 3 show a combination with a patient (a social agent), onsite registration desk at the hospital (a material agent), to make an appointment (an activity) for a face-to-face consultation with a physician (a goal). Variants 2 and 4 show differences in a combination of the ISMP scheduling feature and more off-operation-hours. It clearly suggests that the main ISMP routines in the healthcare context is scheduling (as an activity) that a patient (as an actor) uses the mobile scheduling feature (as a technology) for the ease of scheduling (as a goal). The pattern with Variants 2 and 4 point to an instance of the actualized affordance of

‘ubiquitous access.’ The percentage of technologies used to schedule totally differ across the 4 Variants, $\chi^2(3, 12059) = 12,059, p = 0.00$. The percentage of hours and departments differ, $\chi^2(3, 12059) = 2,433, p = 0.00$ and $\chi^2(33, 12059) = 613, p = 0.00$, respectively. Therefore, I can say that technology, time, and department are significantly different depending upon patterns of activities. If we know the outcomes of the patterned activities derived based on the combination of these factors, such as behavior changes or satisfaction, then we can reveal how differences in the affordance dimensions, including technology and time in this case, contribute to certain outcomes¹⁰.

Patients and healthcare providers as users perceived two benefits of the ‘ubiquitous access’ affordance in the healthcare processes: emotional comfort and convenience. The following quotations reflect Patient 4’s perception of accessing eHealth data as soon as possible. Without the accessibility, the patient would keep worrying about the consequences due to possible diseases that are yet to be diagnosed or concluded. Chief Nurse 1 in the following quotation mentioned the values of information integrated in ISMP, such as registration, payment, and eHealth data, in improving convenience for patients. Interestingly, she added it is a visible benefit to everyone, which indicates it is obviously perceived by most users.

“I find it convenient. I just wanted to know the results as soon as possible, took a look at it, or some time I would be very worried.” (Interview, Patient 4)

“One is the information in the WeChat hospital app... began using the WeChat hospital app for registration, making an appointment, finding test results, and making payments, etc., The patient is very convenient, but also saves their time,

¹⁰ The numbers of the outcome data for each variants are not enough to perform statistics tests in this study.

and avoid their anxiety. This is visible benefit to everyone.” (Interview, Chief Nurse 1)

Patients interviewed discussed the impacts of the actualized affordance of ‘ubiquitous access.’ For example, Patient 5, a pregnant woman who thinks the hospital medical equipment is better, comes to the hospital for her regular check-ups, even though she lives outside of the city. However, to see the results of the check-ups, she uses ISMP instead of a physical visit to the hospital. As a result, she saves her time by not traveling to the hospital and lining up for registrations. Patient 6, who is a fairly busy teacher, also addressed that the ISMP use improves the healthcare processes, especially access to care. Integration with the hospital system data enables patients’ access to primary care with shorter waiting time and with ease in making appointments.

“I do not live in [the city where hospital is located], a little distance away from here... I try to come here for check-ups, but when the travel is relatively hard, because you never know when it [check-up reports] produced... You can arrange your time [with ISMP]. Then look at the result which is more convenient. They do not come to line up” (Interview, Patient 5)

“[Patient can make an appointment on] A same day can be. You make an appointment in advance, even for a full month and adjust the clock [in ISMP].”
(Interview, Patient 6)

C. Affordance Types

While I analyzed the data from the various sources of information to identify the affordances, I reconfirmed three types of affordance: perceived affordance, behavioral affordance, and interactive affordance. By defining three types of affordance, it becomes easier to study the relationships among affordance dimensions, outcomes, and affordances.

A perceived affordance emerges at the individual level. Action possibilities as perceived affordances are often related to the limitations (or expansions) of technology before a user's technology use. Perceived affordances are determined by a material's ability, an actor's capability, and a task's characteristics. Roles as a physician and a patient may be involved in enacting different perceived ISMP affordances. For example, a physician may think that the mobile screen is too small to carry image processing information, which perception limits the use of ISMP in certain work.

A behavioral affordance emerges at individual level, reflected by an actual action that a user uses a specific technology feature to perform a particular task. A user's skills, technology properties, task characteristics as well as situated context information are key factors involved in enacting a behavioral affordance. Patients' demographic information, as an example, may affect the creation of patients' behavioral affordances; some patient demographic factors have significant relations with the patient's behavioral affordance measures. Gender of patients is significantly related with the use of the ISMP scheduling feature. The male patient group scheduled less using ISMP ($M = 1.01$, $SD = 2.657$) than the female patient group ($M = 1.67$, $SD = 2.825$). This difference was significant, $t(482) = -3.485$, $p = 0.001$. Also an individual's perceived affordances influence his or her behavioral affordances. Physicians who complained about the small-size screen of ISMP, for example, actually showed almost no use of ISMP.

An interactive affordance emerges at pair level or group level, which indicates that an interactive affordance is subject to the influences due to more users. Influencing factors include users' perceived affordances (e.g., physician's perceived affordances and patient's perceived affordances), situations involving with more actors (e.g., the patient wants to use ISMP, but the surgeon is not available because he is working at an operation room), and

tasks that require collaboration (e.g., shared decision making). The ‘virtual healthcare consultation’ affordance is an interactive affordance because two actors were involved, a patient and a physician. Figure 7 shows two actors’ nodes (patients and physicians) and ties (their relationships in the ISMP consultation) in a social network analysis. Among 109 physicians who used the ISMP consulting feature, only 3 physicians appeared to extensively use it which boxes are colored dark in Figure 7 (422 texts, 186 texts, and 152 texts made by each of the three physicians). The 3 physicians do not share patients; there are clear clusters around each physician. The ties between a physician and a patients represent their interactions in the ISMP consultation. The relationships representing as ties in ISMP could be new or the same with the relationships between the patient and the physician in the physical world.

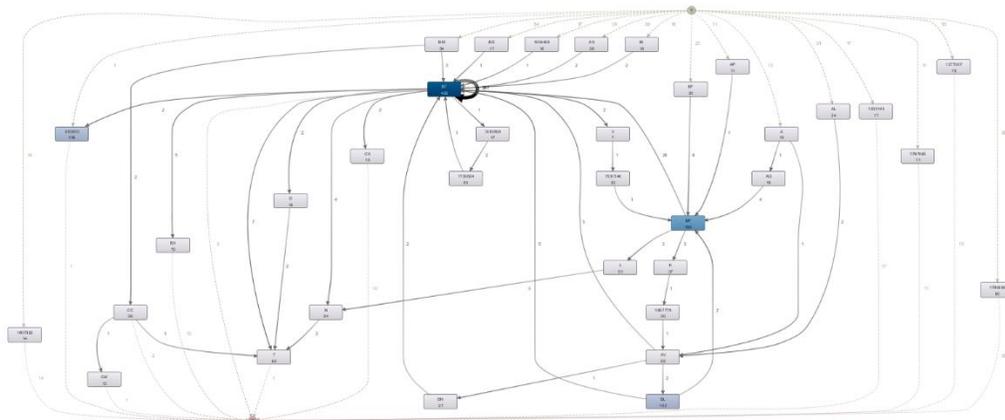


Figure 7. Result of Social Network Analysis for Interactions among Patients and Physician in the ISMP Mobile Consulting¹¹

¹¹ The letters in it represent doctors who wrote texts in ISMP, and the numbers represent patients who left messages to physicians. Patients and physicians who performed the ISMP mobile consultation less than 4 times are hidden, because they are too many patients and physicians who use only 1 – 2 times for the last 1 year.

An interviewee addressed an interactive affordance with a group chatting feature. The OB/GYN department offers clubs for patients by using a feature of group chatting in which usually at least a medical professional is involved. The club was created for the purpose of communicating among and educating a mass of patient groups. This group chatting feature enacts the interactive affordance at the group level, showing a new interactive affordance. Even though this study focuses on one-to-one level interactive affordances, one with the group chatting feature is also an instantiation of interactive affordances because the usage of the technology is for networked human interactions. Obstetrician 6 found benefits of the actual use of the clubs in the practices. It promotes patients to share relevant knowledge with each other and have medical professionals help them by sharing professional opinions and knowledge, thus makes it possible for the group of patients to learn and share knowledge. The impacts of the group-level interactive affordance would be a good future research topic because the impacts should be different than the individual level interactive affordance due to an additional layer of complexity with a mass of groups.

“We have a club, Obstetricians club or Mommy club, by the Obstetrician network that usually has obstetricians. We can communicate with each other, work each other, or send some things to learn like latest guidelines. What we do in Mommy club is to guide moms to enter the club. What we found there is a lot of knowledge, and communicating with each other so that they can educate themselves.”

(Interview, Physician 6)

D. Relationships of Affordance Types and Influencing Factors

As I mentioned before, some patient demographic factors significantly affect the emergence of behavioral affordances. Regression tests were used to see if length of a

patient's stay in ISMP significantly predicts the ratio of the ISMP scheduling over all scheduling events which is a measure of a patient's behavioral affordance. The regression analysis result indicated the predictor explained 10.4% of the variance ($R^2=0.104$, $F(1,1132) = 12.279$, $p = 0.00$). The length of patient's stay in ISMP significantly decreased the ratio of ISMP scheduling over all scheduling events, $\beta = -0.092$, $SE = 0.026$, $p = 0.000$. Patients who registered early used the ISMP scheduling less.

However, physician demographic factors appear to have insignificant effect on the physician's interactive affordances. Independent t-tests and regression tests were used to examine if some physician's information as affordance dimensions affected physician's interactive affordance measures. No physician's demographic information (i.e., age, work experience, period to use ISMP, gender, education, title, specialty) appeared significant in affecting physician's interactive affordance measures (i.e., the frequency of the ISMP consulting, the accumulative number of texts made by physicians, ratio of the number of texts at off-operation-hours over that of operation-hour).

The use situation plays a critical role in the actualization of interactive affordances. From the finding that a small number of physicians use the ISMP consultation in Figure 7, factors that affect the enactment of an interactive affordances relate more to the users than to the technology. That could come from individual situation difference. Social network is changed with new ties caused by the ISMP use with the new function to connect patients and physicians. I found this pattern from the real usage data of the ISMP consulting feature; some patients tried first to contact the same physicians they met at the physical hospital before, but the patients could not reach the physicians for some reasons (e.g., the physicians may be too busy to use or don't want to give their opinions based on part of information). As a result, the patients quickly switched to a new physician and got responses from the new physician, making a new tie. As such, the ISMP mobile consulting uses as an

interactive affordance could happen only if all users use the technology. Interactive affordances are affected by the situations of users that are two or more. If one of the users does not use the technology feature, then the interactive affordance failed to emerge, even though the technology gives possibilities to connect other users. This explains why the ISMP consultations showed lower percentage of the use (about 12%) rather than the use of the ISMP scheduling feature (about 47%).

The combination to users' situational factors affects the emergence of interactive affordances. The number of the ISMP consultations and the number of texts made at off-operation-hours as interactive affordance measures are positively associated with the ratio of the ISMP consultations with the same patient-physician user combination. Sobel test was applied and the results indicated that the ratio of the ISMP consultation with the same pair was a significant predictor of the number of the ISMP conversation texts made at off-operation-hours, $\beta = 1.05$, $SE = 0.49$, $p = 0.032$. The texts made at off-operation-hours was a significant predictor of the number of the ISMP consultations, $\beta = 0.30$, $SE = 0.02$, $p = 0.00$. However, when the off operation hour consultation conversation was added as a potential mediator, the ratio of same user combination was no longer a significant predictor of the number of the patient's ISMP consultation, $\beta = 0.46$, $SE = 0.34$, $p = 0.178$. These results suggest that the number of the ISMP consulting at off-operation-hours is considered as a full mediator, and the indirect coefficient was significant, $\beta = 0.32$, Sobel statistics = 2.12, $p = 0.034$. These relationships are illustrated in Figure 8. This finding, the same pair of a patient and a physician in both virtual consultation and face-to-face consultation promotes virtual healthcare consultations via ISMP, indicates it makes the relationship between patients and physicians stronger and it is an efficient way to perform a follow-up care.

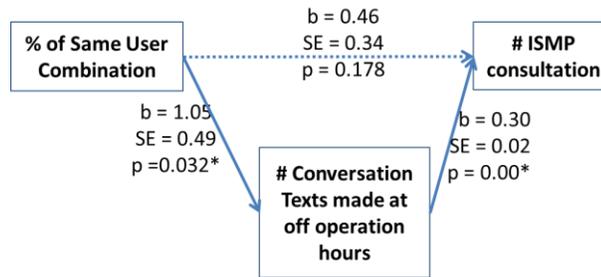


Figure 8. Relationships between User Combination and Interactive Affordances

Interestingly, I found that materials and situations induce the change of affordance types. In a situation that the information a patient wants is placed in the hospital systems even though the ISMP provides the patient with a function to view information, ISMP is useless to the patient. (“*I sometimes at home want to see the B-list, but sometimes it has been placed to the hospital. This is not very convenient*”, Interview, Patient 7). This case describes a failure to actualize a behavioral affordance. As a response to this situation, Patient 9 turned to the ISMP mobile consulting feature to ask a medical professional to access the data stored in hospital systems (‘*Because the advice is not in IMSP technology, so I come to you [through mobile consulting feature]*’, Conversation text, Patient 8). It shows that the absence of the information as a material technology capability led to no actualization of the behavioral affordance, but at the same time created an interactive affordance. I found an evidence to support the change of affordance types. Changes in technological properties enact a new affordance, discarding old affordances, which is consistent with the concept of imbrication proposed by Leonardi (2011). There are three methods to make doctor’s appointments: ISMP scheduling, Kiosk, or registration desk via staff at the hospital. Different technologies bring different types of affordances; ISMP scheduling and Kiosk are behavioral affordances, however, scheduling with registration staff is an interactive affordance. Later, the hospital made some changes in the technology

by adopting a typical social media's property, sharing contents in a large group. This change in technology might result in changes in the affordances and/or affordance types.

E. Relationship of Affordances and Outcomes

The 'ubiquitous access' affordance and the 'virtual healthcare consultation' affordance represent behavioral affordances and interactive affordances, respectively. Each type of the affordances generates certain outcomes. The 'ubiquitous access' affordance enhances convenience and emotional comfort with the technology's ability to access anytime anywhere. It is consistent with prior studies that show behavioral affordances promote engagement (Majchrzak et al., 2013), learning (Melhuish & Falloon, 2010; Cochrane & Bateman, 2010), regardless of time, places or devices. The 'virtual healthcare consultation' affordance brings associations between patients and physicians through access to virtual medial resources that improves access to care and easy sharing of information that facilitate shared decision makings and empower patients. Consistent with prior literature that shows similar patterns, this study found that interactive affordances bring social connection (Treem & Leonardi, 2012), continuous sharing of information, and collaboration (Cochrane & Bateman, 2010).

Besides the process outcomes, I analyzed the ISMP system data and patients' clinical data to see the impacts of the affordance types on healthcare processes. The outcome measure used is difference in the numbers of face-to-face consultations before and after the ISMP implementation.¹² To calculate the volume difference as an outcome

¹² First, I conducted regression analysis with volume difference in month as outcome data to check if there is a learning effect as time goes. However, it does not significantly affect the volume increase. Therefore, I made the variable accumulated, making the volume (before), which consist of the data between 2013.9 and 2014.5, and volume (after), which consist of the data between 2014.9 and 2015.5, to make comparisons easy.

measure, the data were collected for two periods (Sep. 2013 – May 2014 and Sep. 2014 – May 2015). Three months right after the implementation of ISMP, June 2014 to Aug. 2014, were excluded because the period is unstable because of the transition. Using data from the ISMP and the EMR systems, I tested the relationships between the affordances and the outcomes. The descriptive statistics of the outcome measure are shown in Table 16.

Table 16. Descriptive Statistics of Outcome Measures

Measure	Pre-ISMP (2013.9- 2014.5)			Post-ISMP (2014.9- 2015.5)			% change
	Mean	S.D	n	Mean	S.D	n	
Physician's productivity ¹³	137	282	378	137	280	417	100%
for Female physician	171	267	110	153	257	127	89%
for Male physician	123	288	267	130	290	289	106%
Patient's hospital visit ¹⁴	4.5	4.9	8,154	5.2	5.1	16,507	115%

Some patients' behavioral affordance measures are significantly related to the outcome measure. Regression analysis was used to test if the number of the ISMP scheduling significantly predicts the number of patient's physical visits to a doctor. The results of the regression analysis show that the number of the ISMP scheduling explained 37.5% of the variance ($R^2 = 0.375$, $F(1,13139) = 2145.28$, $p = 0.000$), and significantly predicted the ratio of the number of face-to-face consultations after ISMP implementation over that of before the implementation, $\beta = 0.024$, $SE = 0.001$, $p = 0.000$. Therefore, as the number of the ISMP scheduling increases, the volume of patients' visits increases after the ISMP implementation. This is a significant relationship only between patient's behavioral

¹³ Productivity is assessed by the number of face-to-face consultation of a physician per month.

¹⁴ Hospital visit is assessed by the number of face-to-face consultations a patient completed for the 9 months.

affordance measures and the outcome, not with interactive affordance measures and the outcome. It makes sense because interactive affordances do not affect the number of patient's visits.

I also checked the effects of affordance dimensions on the patient visit volume difference. Some patient factors (e.g., gender, same combination of users, and duration of stay in ISMP) appeared to be significant in affecting the volume of patients' visits (i.e., difference in volume of (after – before), ratio to increase volume). Regarding gender difference, the female patient group much more increased the volume of hospital visits compared to that of before the ISMP implementation, while the male patient group increased the volume, as Table 16 shows. This difference was significant, $t(425) = -2.209$, $p = 0.046$. With the ratio of combinations with same users, the results of the regression analysis indicated that the ratio of same user combinations for virtual and face-to-face consultations significantly predicted the volume difference of after and before of the ISMP implementation, $\beta = 0.197$, $SE = 0.098$, $p = 0.044$. Figure 9 illustrates a summary of the findings about the relationships around patient's affordances.

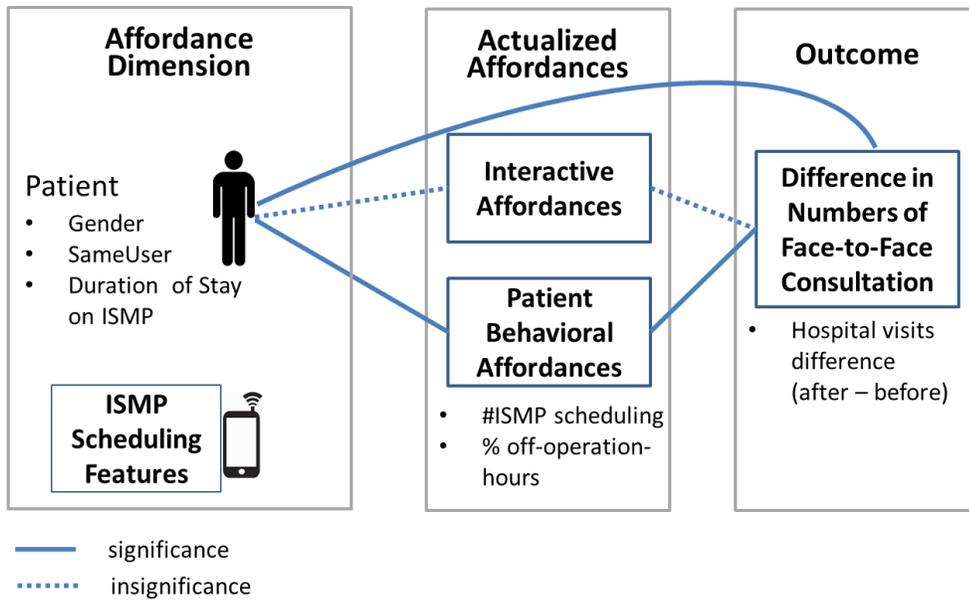


Figure 9. Relationships Related to Patient's Affordances

Physician demographic factors that may affect physician's interactive affordance were investigated. The outcome measure for physicians is difference in physician's productivity of (after – before) or ratio to increase work volume (after/before). Physician's gender, position, and specialty show relations with the outcome measure. No other physician information, such as age, work experience, duration of ISMP use, education, title, specialty, were found to be significant in affecting physicians' productivity difference. Regarding specialty, the physicians in the OB/GYN department show significantly smaller difference in productivity compared to that before the ISMP implementation ($M = 3.40$, $SD = 272$) than in general department ($M = 12.22$, $SD = 138$). The differences across departments were significant, $F(7,243) = 3.251$, $p = 0.003$. Regarding physician positions, the physician group had more increased work volume compared to that before the implementation of ISMP ($M = 112.1$, $SD = 641.37$) than the attending physician group ($M = 1.87$, $SD = 3.59$), the chief physician group ($M = 1.26$, $SD = 1.03$), the deputy chief physician group ($M = 3.09$, $SD = 17.56$). This difference was significant, $F(3,367) = 3.490$,

$p = 0.016$. Regarding gender difference, the female physician group shows higher increase ratio of work volume compared to that before the implementation of ISMP ($M = 42.16$, $SD = 387.33$) than the male physician group ($M = 2.15$, $SD = 11.86$)¹⁵. This difference was significant, $F(1,578) = 3.25$, $p = 0.072$. The results of regression analysis show that ages of physicians are significantly related to productivity difference compared to that before the implementation of ISMP, $\beta = 0.020$, $SE = 0.004$, $p = 0.000$. However, there are no significant relationships between these demographic information and interactive affordance measures. However, interactive affordance measures, such as number of ISMP consultation and sum of conversation texts, show no significant relationships with the outcome measures. Figure 10 illustrates a summary of the findings about the relationships around physician's affordances.

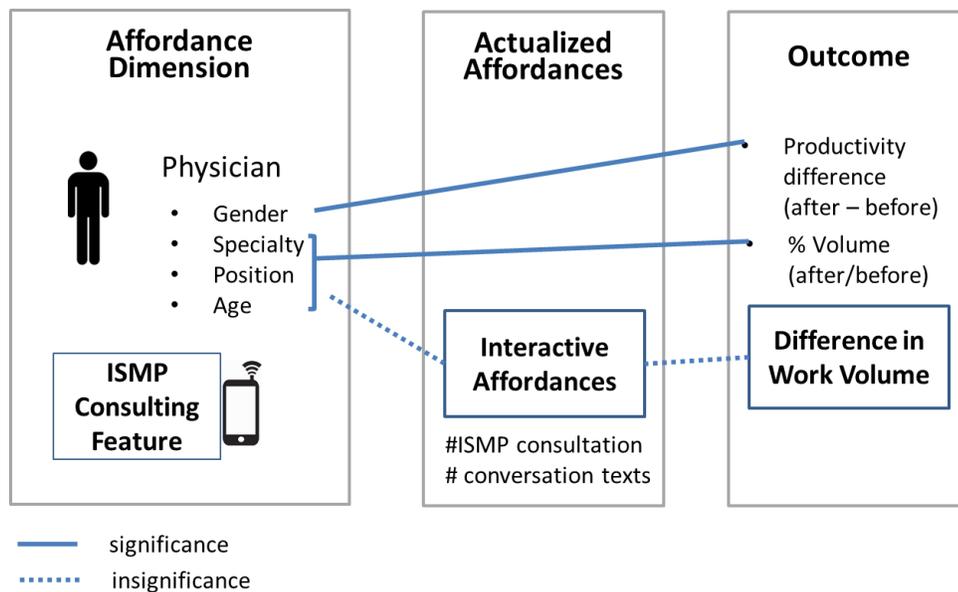


Figure 10. Relationships Related to Physician's Affordances

¹⁵ The data population is physicians who have worked in the hospital from the period of 'before,' Sep. 2013.

Based on the findings from the qualitative analysis results and statistics analysis results on the relationships of affordance types, affordance dimensions, and outcome. Figure 12 illustrates a synthesized summary of all the findings about the relationships around the ISMP affordances.

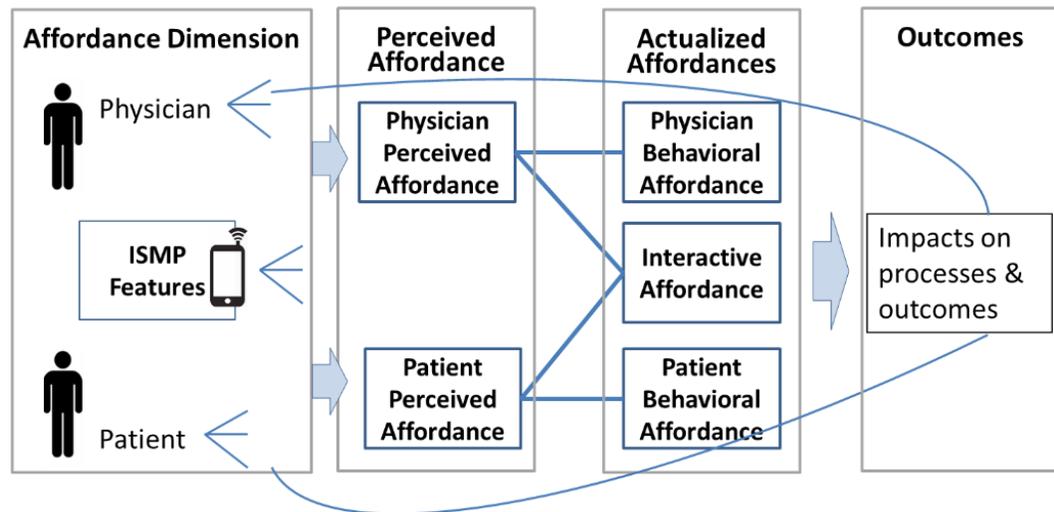


Figure 12. Relationships Related to Affordances in the Healthcare Context

F. Why Are Some Affordances Not Perceived or Actualized

Affordances are perceived (Shaw, Turvey, & Mace, 1982) and actualized (Strong, Volkoff, et al., 2014), but not all affordances do. The ISMP system data, the documents, and the interview and focus group data clearly show that not all the affordances are perceived or actualized. I found that the designers' intentions were not perceived by all users, often because of material agents and tasks. Perceived affordances are not actualized for reasons of material's properties and situations. Personal factors matter in enacting both perceived affordances and actualized affordances. I categorize the reasons as relating to task, people, and role factors with technology.

Task & Technology

I found that technology properties and task characteristics play a role in enacting perceived affordances of ISMP. ISMP is a simple and easy equipment rather than a perfect tool suitable for all kinds of medical practices. Some healthcare providers think ISMP usages are limited in the context of their medical practices. This point was evidenced in an interview with an Orthopedics physician. Orthopedics is a unique practice requiring image data processing and imaging technology. The orthopedics physician mentioned that his job requires a large amount of information (He described it as '*a little book*'). He complained about the lack of printing functionality in ISMP, which is critical for orthopedician's work. The current ISMP technology cannot afford the orthopedician's work to be completed, which resulted in a failure to enact even a perceived affordance.

However, some healthcare providers think that ISMP is very useful in the contexts of their practices. For example, OB/GYN physicians perceive possibilities of educating patients using ISMP. They created clubs for group education, which is more than what the designers expected. Patients also value the benefits of using ISMP in discussing about sensitive topic like their sexual life issues.

Role & Technology

Roles of users, technology features or information in the technology matter in affordance actualization. A material property of the mobile consulting feature, asynchronized characteristic, leads to the enactment of the affordance of 'ubiquitous virtual healthcare consultation' by enabling the use anytime and anywhere. The affordance is perceived by patients as a benefit and has been actualized by patients, as shown in Figures 3, 4, and Table 14. However, the same material property has a negative influence on physicians who get time pressure under a situation in which the hospital policy required them to quickly

response patients' inquires. Pediatrician 1, for example, addressed difficulties in answering in a timely manner (The rule here is that a physician is given at most 30 minutes to respond after a patient creates a new text conversation). Physicians or surgeons are too busy in the workplaces (e.g., operation rooms for surgeons) to take a look at alerts in ISMP. Therefore, many texts made by healthcare providers are during the off-work hours. Neurosurgeon 1 added that the ISMP use interrupts doctors' ponderation, which eventually lowers the satisfaction of patients. This interruption is a negative value of the ISMP technology use a doctor perceived.

“We [physicians] have to answer for half an hour, this is a very troublesome because we have to go to work and cannot always come up with a phone to see WeChat.” (Focus group, Pediatrician 1)

“I have tried to answer, and I found it hard. In fact, I think it depends on whether you are a physician or a surgeon. A lot of surgeons cannot go to work with a mobile device, and they cannot see WeChat all the time, because they focus on their thoughts in things around work. Looking at [ISMP technology] needs to take a break which is still influential, thus patients will feel bad.” (Interview, Surgeon 1)

Here is another case that both technology property and role both matter the actualization of affordances. A property of ISMP, not editable messages already sent, allows patients to keep all messages from physicians in patients' device. This persistent characteristics induces physicians to be hesitant in actively using the ISMP mobile consulting feature. Physicians transfer medical knowledge to patients as domain experts, and patients are receivers of knowledge services. Physician 8 in the internal medicine unit, for example, clearly mentioned that his judgment was based on the information a patient provided, which may not be accurate or correct. He understands the service of virtual consultation as a strategy of the hospital but also shows hopes for organizational moves for

changes to handle the limitations of ISMP. The organizational moves can be either material changes such as expansion of the technology's ability to edit messages or changes of social rules such as redefinition to access health data.

"I answered seven questions [before], no longer able to go. ... [when physicians give answer patients' questions], I emphasize that what I answer was only on my own behalf some of the points." (Focus group, Physician 8)

People

Personal factors influence the entanglement in perceived affordances and actualized affordances. Individual differences in gender, age, social economic status, absorptive ability, and attitude toward the technology play a role in the use of the ISMP technology. I just showed that user's gender affects a behavioral affordance in the healthcare process. Many old people cannot afford purchasing a smartphone, which results in no use of ISMP. It could be an explanation for why many chronic disease patients, most of whom are old, do not use ISMP.

People have different levels of absorptive capability when it comes to use new technology or adapting to a new routine. Not all patients are aware that healthcare is actually available through the ISMP uses. Some had no chance to get to know other health technologies, thus do not use them and miss the opportunity to access possible healthcare. Patients show differences in their abilities to understand health information and apply the information to their health situations. Some patients intuitively know how to use new technologies for achieving their healthcare goals. The following quotation demonstrates Patient 10's absorptive ability to use the ISMP mobile consulting feature to get second opinions from virtual medical professionals, which is novel and beyond the designer's intentions.

"Dr. A just replied with another opinion to the suggestion that Dr. B gave. Two drugs can help the problem... Then what do you think?" (Conversation text, Patient 10)

User's attitude towards a technology plays a role in technology use. The hospital designed communications between patients and physicians in an asynchronized way, but some patients still want to use it in a synchronized way like making phone calls, instead of written conversation in ISMP. The synchronized method may lead to lower probability to have conversation between them, as the following quotation shows. Patient 11 left a message with his phone number in the ISMP technology, and Physician 9 replied with his willingness to make a phone call, but not right away.

'Please call Tel [123456789]' 'Dr. C, I ask you not online?' (Conversation text, Patient 11)

'Yes, but it will be later' (Conversation text, Physician 9)

DISCUSSION

A. Summary

The main contribution of this study is the development of a comprehensive affordance theory using a mixed-method approach. I proposed three types of affordance: perceived affordance, behavioral affordance, and interactive affordance. I identified two affordances of an integrative social media platform (ISMP) from the analysis with objective actual technology usage data and subjective user perception data, which contributes to a small but growing stream of IS research that view technology use patterns as relationships among technologies, users, tasks, and situations.

From the real historical data, I found two main interactions related to the use of ISMP: scheduling and consulting with ISMP. From the point of sequences of activities, those two interactions are dominant showing certain patterns, but different combinations of activity sequences, technological features, and time distribution. Without the ISMP use activates happened usually in mornings. Activities involved with the ISMP use usually occur at night time. As such, the use of ISMP determines somehow where and when to use it. Much of scheduling were completed with the use of ISMP, instead of meeting staff at the hospital. Activities in ISMP as virtual healthcare consultations are more similar with face-to-face one in real world. However, the relationships between patients and physicians has been changed since the adoption of ISMP. I found that the use of the ISMP consulting feature not only supports relationships between patients and physicians established before in the real world, but it also provides with an opportunity to create a new association with a physician for a patient in the virtual world.

Among many possible ISMP affordances in the healthcare context, the 'ubiquitous access' and 'virtual healthcare consultation' affordances are recognized as key affordances

that make the patient-centered care process possible. The ubiquitous access affordance is enacted with anytime anyplace properties of the ISMP features. It enables patients' anytime access to information in the hospital systems from any locations, such as scheduling information and patient's medical data. This semi-automation information transferring provides patients with emotional comfort and convenience to make doctor's appointments. The virtual healthcare consultation affordance is enacted with a new function of ISMP that virtually connects patients and physicians. Interestingly, prior consultation experience between the same patient and same physician promotes the use of the ISMP mobile consulting feature. It indicates this affordance effectively supports follow-ups, making continuous care and shared healthcare decision-making possible. As such, the two affordances affect healthcare processes and promote patient-centered care process.

The three types of affordance (perceived affordance, behavioral affordance, interactive affordance) are related to each other but each of the affordance types has own characteristics. Perceived affordances are relatively simple, restricting or expanding possible affordances provided by the technology. It depends on a user's ability to understand technology's usage. Actualized affordances including behavioral affordances and interactive affordances are much more contextualized. Specific material elements and specific tasks limit some possibilities for actions. Actual choice out of the possible actions depends on a user's situation and perceived affordances. In contrast, interactive affordances are subject to being influenced by factors related to multiple users. If one of the users does not want to or cannot use the technology features, interactive affordances around the features fail to emerge. Therefore, a combination of those factors is required to provide answers on questions related to how to actualize affordances. Identification of a new category of affordances (interactive affordances) and categorization of affordance types provide a theoretical contribution to the conceptualization of affordances in literature.

Related to the research question 3, technology properties were identified to influence the enactment of affordances with other factors. One is tasks that affect the enactment of perceived affordance with the properties of ISMP. Roles are more involved with enactment of actualized affordance, such as the emergence of the virtual healthcare consultation affordance. In addition, I found individual differences such as absorptive capacity and attitude toward the technology affect both perceived and actualized affordances. Rather each factor itself, the relationship between the factors and ISMP technology elements together produce the enactment of affordances. Different factors show different effects on the enactment of perceived affordances and the enactment of actualized affordances.

One of the goals of this study is to understand and examine relationships among the affordance type, affordance dimension, and their outcomes, from a big picture perspective. I found that patient's and physician's factors have significant relationships with outcome. Behavioral affordances also show significant relationships with the outcome, but interactive affordances do not show significant relationships with the outcome that is volume difference of after and before of the ISMP implementation. ISMP scheduling usage may relate to the increase of patient's visit volume, while ISMP consulting usage may not influence on the volume increase. The outcome measure, volume increase, may be influenced by other business factors such as hospital promotion campaign or adoption of other health products, services, or systems. However, the text mining analysis result indicate the ISMP mobile consulting usage improves patient satisfaction. Having patient's health condition data or satisfaction data give additional measures for patient-centered care outcomes. Additionally, the analysis clearly showed that different affordance types due to users are related to users' differences in either user's demographic information or user's situations.

B. Implications for Research

The first theoretical contribution of this study is the investigation of an emerging technology which combines properties of social media technology and those of mobile technology, integrated with legacy hospital systems including an electronic medical records system, a scheduling, and a payment system. ISMP incorporates various technical features and information in other systems, especially, in a pervasive technology used by the majority of people. The presence of the ‘virtual healthcare consultation’ provides patients with a new method of communication, which encourages mutual trust between patients and physicians. This kind of technology has not been introduced or empirically investigated in academia; it is still a nascent concept.

Second, this study contributes to the affordance theory literature. I demonstrated that the affordance lens is suitable to provide rich insights into health IT-related phenomena. I also instantiated affordance types in the healthcare context, and developed an understanding about how they are perceived and actualized. Unlike many prior studies that recognize perception and actualization of affordance (e.g., Bernhard, Recker, & Burton-Jones, 2013; Strong, Volkoff, et al., 2014) or organization-level affordances (e.g., Leonardi, 2013; Strong, Johnson, et al., 2014), this study classifies three types of affordances, perceived affordance, behavioral affordance, and interactive affordance. The three types of affordance can be used as a foundation for organizational affordances, shared affordances, or collective affordances. For example, a set of affordances that I found can be considered as a collective affordance proposed by Leonardi (2013) (Leonardi, 2013). The ‘virtual healthcare consultation’ affordance appears often with the action of medical record requests which processes are supported by other departments, such as specific clinical departments, radiology, and several labs. An internal medicine physician mentioned and perceived the two activities as a complete process. However, it

does not happen all the time. Some patients view their lab results using ISMP, but do not value and use the ISMP consulting feature. As such, even the collective affordance should be understood in combination with lower-level affordances, such as an interactive affordance and a behavioral affordance. Especially one-to-one level affordances are a main topic of this study. These concepts are applicable to the affordances of technologies shared by many users. Understanding how each affordance contributes to and how different affordances interact with each other may suggest new mechanisms for changes.

Through the investigation using the mixed-method approach, the analysis results show that perceived affordances are related to a technology's material capability and the actor's attitude toward the technology in the context of the practices. However, actual usages are unpredictable and actualized affordances are not the same as perceived ones. Behavioral affordances and interactive affordances as actualized affordances are influenced more by specific situations including an actor's roles with elements of material including information in the technology than by other factors. These findings add to the extant affordance literature which will improve our understanding about what actually happens to the healthcare process when implementing such integrative technologies as the ISMP.

This study benefited from a robust methodology. A mixed-method approach was applied to understanding healthcare practices and to identifying ISMP affordances, starting with both objective real system usage data and subjective perception data on the technology use. It is vital that health IT research should use multiple methods and approaches in order to understand the complex healthcare problems (Carayon et al., 2015). My efforts in looking at the real life practices with various sources of information help me to understand the phenomenon through triangulation. In addition, it allows me to look at the problems with holistic views and to find better (optimal) explanations to the problems and solutions.

By examining the actual data without a priori hypothesized thoughts on the roles of technology or social actors, I have an unbiased view to find roles of other elements in this complete IT-related phenomenon which otherwise may have been ignored. I believe that affordances that highlights either anytime, anywhere (“how”), or anyone (“who”) have the power to provide generative mechanisms for either individuals or organizations to achieve desirable outcomes (Volkoff & Strong, 2013).

C. Implications for Practice

First, my dissertation study shows the complexity and explanation based on the concept of affordance about a new health IT phenomenon that closely reflects the actual healthcare processes, based on the real data. The introduction of a new ISMP technology has changed the healthcare processes, as people tend to make more doctor’s appointments via ISMP, because of the affordance of ‘ubiquitous access’ enabled by the anytime characteristic of the ISMP. The affordance of ‘virtual healthcare consultation’ promotes interactions and communications between patients and physicians. I found that patients use more the ISMP consultation to support the ties that the patients and the physicians keep in the physical world, with a mediator of conversation texts made at off-operation-hours. Furthermore, the ISMP uses change people’s perceptions about the healthcare service: “[ISMP technology] is a kind of subconscious transformation” (Interview, Physician 8). It offers the possibility to move to a virtual hospital consisting of virtual medical resources and virtual healthcare processes.

Second, by identifying the different types of affordances of ISMP, this study can guide healthcare organizations to offer solutions for the patient-centered care process. Organizations can improve the healthcare processes by inducing the actualization of the two affordances. Organizations face two choices, make changes either in the material or in

the social. Often situations can be controlled. For example, this case shows difficulties of the use of the ISMP consulting features for physicians who are too busy most of time. As an example of the hospital's efforts to solve the problem, the management made changes in the material by adopting the property of social media technology, sharing information with anybody in a group. This change puts more power to the 'quick' affordance from the 'desired specific users' affordance. This change produced an immediate outcome that almost all patients' consultation conversation request texts were answered by medical professionals. If we know what affordance leads to the ultimate outcomes like patient satisfaction or patient's health condition, healthcare organizations are able to devote appropriate attention and efforts to achieve their goals.

D. Limitations

First, the data set that was used to measure behavioral affordances (e.g., the number of the use of the scheduling feature) did not include all user data on all ISDP features. It would be more useful to analyze a complete data set with all user's activities which varied widely. I was not able to obtain every affordances-related activity data due to the restrictions of the healthcare institution's policy and vendor contract. Hopefully I can include the data of the action of health data query as measures of the behavioral affordances in a healthcare context, but was unable to obtain these in this study. In addition, I expect there are some affordances that may be actualized in the future (e.g., virtual organization), but that were not able to be actualized during the timespan of the data collection. The full examination of these affordances and influencing factors requires additional efforts, which I leave for future work.

I tried to apply a mixed-method approach for the analysis of information from various sources. One part is the conversational text using text mining techniques, which

provided me with a quick analysis of the results and rich information. However, the algorithm should be reconsidered due to the nuances involved in the language. For example, 'No problem' in Chinese has alternative meanings such as 'You are welcome/thank you' depending on the use situation, but the text mining technique considered it as only 'No problem.' In this study, I performed text mining with two subgroups, a patient group and a physician group. In the latter group the phrases mean 'no problems', whereas in the patient group it may mean an alternative meaning of 'thank you.' Thus, this is a need to clarify the specific meanings of texts depending on the particular contexts of their use.

Actualized affordances should be different across departments due to the uniqueness of each disease treatment. They may differ even within the same healthcare context. The examination of the impacts of each specific affordance improves generalization of the findings. As such, differentiating the three types of affordance might help to understand how IT affect clinical practices.

E. Future Research

I outline future research ideas that can build upon the foundation of this study's implications and limitations. Different levels of affordances were identified, such as individual-level affordances, group-level affordances, and organization-level affordances (Bélanger, Cefaratti, Carte, & Markham, 2014; Burton-Jones & Gallivan, 2007; Leonardi, 2013). This study fills a gap in the affordance theory literature with pair-level affordances which have been missing in the literature. Further theoretical categorization work can extend the affordance types I proposed: behavioral affordance and interactive affordance. For example, affordances around the use of the group-chat feature or discussion boards

may need further theorizing efforts. We should discuss different conceptualizations of multi-level affordances in a greater depth.

The analysis results indicate that perceived affordances change over time in terms of before, during, or after technology use. Not only functionality (Neisser, 1976) but also performance (Benbasat & Schroeder, 1977) matter in enacting affordances. For example, among different alternative ways of making doctor's appointments (e.g., the ISMP scheduling feature, the hospital kiosk, or the hospital registration desk), more patients have recently used the ISMP technology to make doctor's appointments. Changes in the usages may alter perceived affordances and the actualized affordances. The relationships among the affordances may in turn change clinical process and outcomes. It would be interesting to examine this change in real world practices.

The analysis explores how the ISMP affordances contribute to the patient-centered care. An important aspect of future research on affordances is to increase quantitative research. Therefore, I would quantitatively evaluate the impacts of ISMP affordances on the patient-centered care processes and its outcomes. The potential research space is defined by the avenues of replication, extension, and generation (Berthon, Pitt, Ewing, & Carr, 2002). I could extend this study by adding constructs and measures to reflect the healthcare practices with ISMP. Additionally, I would examine the mediating role of the patient-centered care processes in the relationships between the affordances of ISMP and their outcomes such as the satisfaction of patients and physicians.

CONCLUSIONS

A comprehensive focus on technologies to support patient's healthcare processes is surprisingly absent from health IT literature. ISMP, as a disruptive technology, threatens the traditional healthcare delivery method, showing the potentials to transform healthcare toward a more patient-centered care process. However, IT use-related phenomena are complex; the same technology is used differently by different users. In order to understand and study the complex IT phenomena, factors that induce an individual user to use specific features of a technology has become a focal point of interest.

I used the concept of affordances to explore ISMP affordances and their effects on patients' and physicians' activities through different uses of ISMP features. With mixed-method analyses results, I identified two forms of ISMP affordances that facilitate patient-centered care processes: ubiquitous access and virtual healthcare consultation. These affordances represent a behavioral affordance and an interactive affordance, respectively. Through the investigation on how those affordances were actualized, the study showed that some of affordance dimensions play an enabling role in the enactment of the affordances that lead to patient-centered care. The effects of the ISMP affordances depend on not only features that an individual user perceives to be afforded but also a user's situation such as roles of social actors in the healthcare context.

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APPENDICES

Appendix 1 – Affordance in Literature

Table A. Affordance of Social Media Technology

Technological Property	Affordance	Action	Study
<i>Social media</i>		<i>Use in organization</i>	(Treem & Leonardi, 2012)
Displays text, Status updates	Visibility	Work behavior, Metaknowledge, Organizational activity streams	
History of activity, Discussion recorded	Persistence	Sustaining knowledge over time, Creating robust forms of communication, Growing content	
Asynchronous text-based entries	Editability	Regulating personal expressions, Targeting content, Improving information quality	
Relations to others displayed (e.g., Friends), “Like” button	<u>Association</u>	Supporting social connection, Access to relevant information, Enabling emergent connection	
<i>Social media</i>		<i>Online communal knowledge sharing</i>	(Majchrzak et al., 2013)
Retweets	Metavoicing	Foster productive knowledge conversations when the mechanism of critical mass is invoked. But, inhibit productivity knowledge conversations when they promote biased and inaccurate information.	
Alerts	Triggered attending	Foster productive knowledge conversations by motivating more people to engage because of the minimal effort involved. But, inhibit productivity knowledge conversations when serendipity, contextualization, and trust are harmed.	
Display of connections	Network-informed <u>associating</u>	Foster productive knowledge conversations as knowledge workers strive to expand their social capital in pursuit of intellectual capital. But, inhibit productivity knowledge conversations as preferential attachment is activated.	
Custom-developed code	Generative role-taking	Foster productive knowledge conversations through reflectively	

		reframing the conversation to remove temporary barriers that have emerged in the conversation. But, inhibit productivity knowledge conversations when organizational memory is lost.	
<i>Social media</i>		<i>Chronic disease care process</i>	(Pousti et al., 2014)
Synchronous and asynchronous interactions, Store the history of interaction, Retrieve data	<u>Emotional support affordance</u>	Provide patients with emotional support	
Create information, Different formats such as text, video, audio	<u>Empowerment affordance</u>	Empower patient and cares	
<i>Social media</i>		<i>Chronic disease management</i>	(Merolli et al., 2013)
Self-presentation	Identity	Norms of patient identity protection and patient records ownership, less suitable for stigmatizing conditions	
Blogs, virtual worlds	Identity	More anonymous interaction	
Wall, board, message posting with asynchrony	Flexibility	Provides a sense of time-space freedom of communication, enhance engagement	
Ability to connect individuals	Structure	Enhance information sharing and collaboration, facilitate and guide chronic disease sufferers with their self-management and given online management more direction, but risk with poor quality and/or misleading information	
Professional input	Structure	Improve effectiveness, decrease attrition rates	
Storytelling, express emotions, share information in blogging	Narration	Believe blogs is a relatively reputable source of information but well suited as a way to problem solve and manage emotions	
YouTube	Narration	Increase emotional engagement	
Not addressed	Adaptation	Obtaining information, Consolidate existing relationships, Get supports	

Table B. Affordance of Mobile Technology

Technology / Feature	Affordance	Action	Study
<i>Mobile technology</i>		<i>Not addressed</i>	(Cousins & Robey, 2015)
Not addressed	Mobility	Flexibility and permeability of physical boundaries of place, psychological boundary	
Not addressed	Connectedness	Continuous communication at all times, multitasking for temporal boundary, manage relationships	
Not addressed	Interoperability	Various devices and applications, psychological boundary	
Not addressed	Identifiability	Self-presentation, distant mobile co-presence	
Not addressed	Personalization	Satisfy personal preferences or needs	
<i>iPad</i>		<i>Education</i>	(Melhuish & Falloon, 2010a)
Functionality and connectivity of a laptop, with the mobility of a smartphone	Portability, Affordable and <u>ubiquitous access</u> , Situated, 'just-in-time' learning opportunities, Connection and convergence, Individualised and personalised experiences	Better education	
<i>Smartphone</i>		<i>Not specific</i>	(Cochrane & Bateman, 2010)
Record and share live Events	Video streaming	Real time event, data and resource capturing and collaboration	
Geo-tag original photos, geo-locate events on Google Map	Geo-tagging	Enable rich data sharing	
Post short updates	Microblogging	Asynchronous communication, collaboration and support	
Notices for course and support	Text notifications	Scaffolding, learning and administrative Support	

Capture and upload images and video of ideas and events	Direct image and Video blogging	Student journals, eportfolios, presentations, peer and lecturer critique	
2D codes scanned by camera phone to reveal URL, text, etc	Mobile codes	Situated Learning – providing context Linking	
Remote recording of audio, tagged with GPS and images, etc	Enhanced student Podcasts	Situated and collaborative learning – providing context linking	
Social networking tools	Social networking	Formative peer and lecturer feedback Collaboration of groups	
<i>Hybrid Mobile</i>		<i>Education</i>	(Bai, 2010)
Narrative functions and existing Web 2.0 applications	<u>Ubiquitous learning</u>	More pervasive and equitable education	
<i>Mobile Technology</i>		<i>Use of healthcare record</i>	(Abouzahra & Tan, 2013)
Not addressed	<u>Ubiquitous connectivity</u> , Physical attachment, Viewing and authoring Capabilities, and Context awareness	Use of mobile personal health records	
<i>Mobile applications or Websites</i>		<i>Healthcare</i>	(Sundar et al., 2012)
Not addressed	Navigability, Interactivity, Customization	Enhance motivation for preventive care, change health-related behaviors	

Table C. Affordance of Healthcare Technology

Technology / Feature	Affordance	Action	Study
<i>EHR system</i>		<i>The use of EHR system in an organization</i>	(Strong, Volkoff, et al., 2014)
Common database for storing patient information Structured data entry forms	Capturing and archiving digital data about patients	Document everything	
Common database filled with patient information Technical infrastructure for anytime, anywhere access	Accessing and using patient information anytime from anywhere	Access other providers' patients, anytime, anywhere	
Messaging features Patient information stored and available real-time anywhere	Coordinating patient care across sites, facilities and providers	Collaboration among colleagues, coordination with urgent care staff	
Standard data entry forms Stored protocols and procedures for each role Restricted access to EHR features by role	Standardizing data, process, and roles	Ask standardized questions in an order	
Audit trail of what was done, by whom, and when Lists of tasks to do, by role and the current status of each	Monitoring organizational operations	Monitoring real time.	
Standardized data & functionality Audit trail Features for defining pools (e.g., the nursing pool) Message forwarding & messaging to pools	Substituting healthcare professional for each other	Coordination	

Decision support features (e.g., medication alerts based on patient data) Easy access to online clinical references	Incorporating rich information into clinical decision making	Basic pre-functionality for diagnosis	
Templates that can capture the decision rules of one role for use by another role	Shifting work across roles	Change roles	
<i>Virtual worlds</i>		<i>Healthcare for Obesity and Diabetes</i>	(Morie & Chance, 2011)
Not addressed	Accessibility, Social connectivity, Avatar usage	Not addressed	

Appendix 2 – Functionalities of the Integrative Social Media Platform



a. Homepage

b. Scheduling & Payment

c. Test Result Data



d. Human Connection

e. Conversation

Figure A. Screenshots of The Integrative Social Media Platform

Values added on healthcare processes:

- Access to healthcare: Patients provide healthcare providers with real-time data on the patients' health status. They receive healthcare services like mobile consulting and scheduling and healthcare information like education materials using the mobile technology.
- Access to medical records and test results: Patients access their lab results and medical records using the mobile technology, not waiting for them to see at the hospital.
- Personalized service: Patients are provided with medical treatment guidelines that are personalized using O₂O feature and mobile consulting patients.
- Medical alert: Patients receive appropriate and necessary information on medical treatments that doctors prescribed.
- Patient education: Patients receive educational and/or targeted information about population health on a regular basis.
- System Compatibility: The mobile technology has capability to integrate EMR system, patient portals, and other healthcare system used in the hospital.

Values added on management process:

- No waiting time: In no time, patients make appointments with healthcare providers who they want and make payments for the healthcare services.
- Instant reminders: The mobile technology alerts users a coming appointment that a patient made.
- Location-based real-time information: The mobile technology provides with real-time information about situations around parking lots, doctor offices, which offer transparency of the healthcare-related process, using Smart parking Wizard.
- Patient satisfaction survey: When treatment process is complete, the mobile technology automatically prompts patients to ask for a satisfaction survey to collect how patients feel about the hospital and healthcare services.

Appendix 3 – Guiding Questions for Interview and Focus Group

Table A. Questions for Interview

Construct	Interview Questions
Outcomes -Patient Satisfaction -Physician Satisfaction	<ul style="list-style-type: none"> • How did you assess the values of the use of WeChat hospital app, in terms of cost, time, profit, relationship with patients? • What are the unexpected effects of the WeChat hospital app usage? (e.g., stress) • Has the use of WeChat hospital app changed how consultations are conducted? How a clinician's work is organized?
Patient-Centered Care Process -Access to care -Patient Engagement -Focus on Patient -Shared Decision Making	<ul style="list-style-type: none"> • How would you define patient-centered care innovation? • How the technology or the information in it is used for administrative or clinical purpose?
Behavioral Affordance	<ul style="list-style-type: none"> • How often do you use the WeChat hospital app? • What do you do with the WeChat hospital app? • How and what technical features/characteristics has WeChat hospital app made the healthcare more patient-centered (e.g., changes in patients' engagement or patient's relationship with a physician)? • Why do you use WeChat hospital app?
Interactive Affordance	<ul style="list-style-type: none"> • How do you use it for communication between a patient and a physician?
Perceived Affordance	<ul style="list-style-type: none"> • What is meaning of your use of the WeChat hospital app?

Questions for Focus Group

Background information

Please provide the following background information to help us understand the context of your response.

1. Name of unit you have contacted : _____ (e.g., Pediatric department)
3. Years of your first experience in this hospital : _____
4. Months of your experience with using the WeChat hospital app : _____ months

5. Please indicate your gender: _____ Female _____ Male

6. Please indicate your age : _____

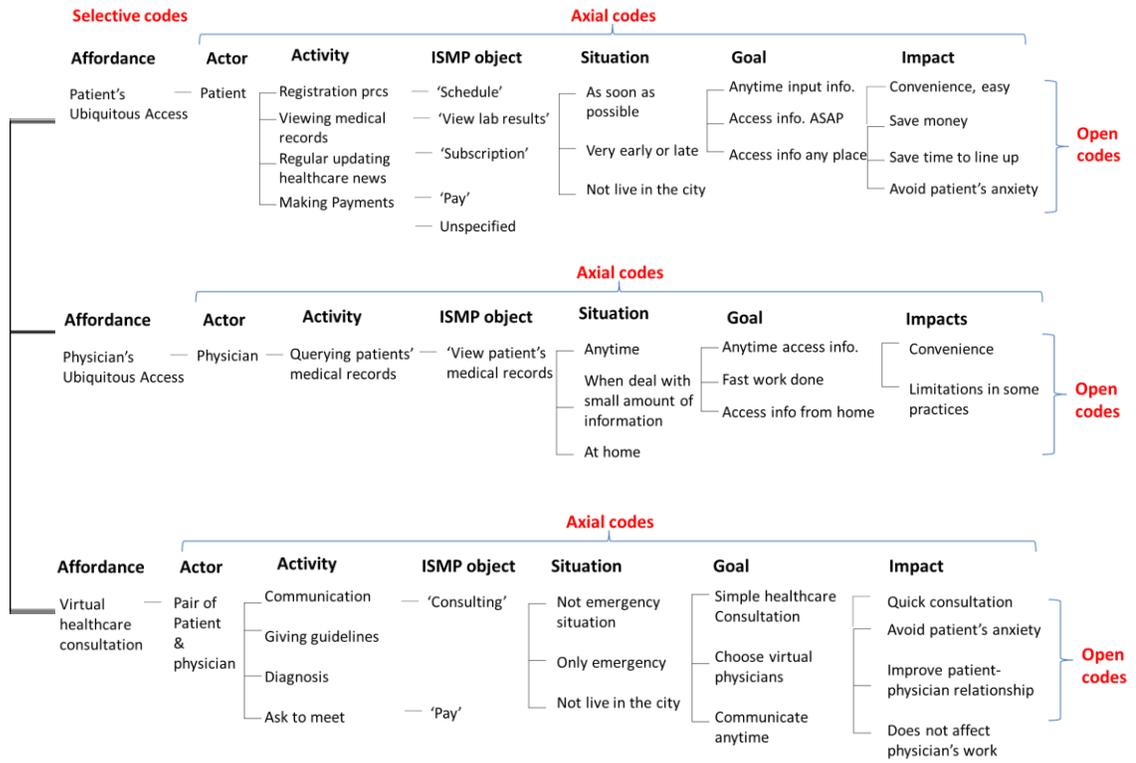
Construct	Discussion Questions
<p>Outcomes -Patient Satisfaction -Physician Satisfaction</p>	<ul style="list-style-type: none"> • How did you assess the values of the use of WeChat hospital app, in terms of cost, time, profit, relationship with patients? • What are the unexpected effects of the WeChat hospital app usage? • Has the use of WeChat hospital app changed how consultations are conducted? How a clinician's work (patient's administrative transaction) is organized?
<p>Patient-Centered Care Process -Patient's Access to care -Patient Engagement -Focus on Patient -Shared Decision Making</p>	<ul style="list-style-type: none"> • How do you know the hospital service is patient-centered care? • What technology helps to facilitate patient-centered care? • How technologies or information are used for administrative or clinical purpose?
<p>Behavioral Affordance</p>	<ul style="list-style-type: none"> • How often do you use the WeChat hospital app? • What do you do with the WeChat hospital app? • How and what technical features/characteristics has WeChat hospital app made the healthcare more patient-centered (e.g., changes in patients' engagement or patient's relationship with a physician)? • Why do you use WeChat hospital app?
<p>Interactive Affordance</p>	<ul style="list-style-type: none"> • How do you use it for communication between a patient and a physician?
<p>Perceived Affordance</p>	<ul style="list-style-type: none"> • What is meaning of your use of the WeChat hospital app? • How useful do you think the technology or information are? • How easy do you think the technology or information are?

Appendix 4 – Code Book

Coding scheme was adapted from the study of Gaskin et al. (J. Gaskin et al., 2014).

Dimension	Subdimension	Value	Instances
Actor	Role	Patient, Physician	
	individual/group	Individual, Pair, Group, Organization	
Technology	Feature	Mobile consulting, Query medical records, Scheduling, etc	Use of text/audio/video Use of optional elements
	Modality	Physical, Digital	This technology shows/represents This information is about
Situation	Process	Administration process, Clinical process	
	Location	Collocation, Local, Remote, Mixed	
	When		
Activity	Interaction	Behavior , Interaction	
	Type	Generate, Transfer information, Negotiate, Execute, Choose	I used I looked at I consulted Often, regularly
	Goal		I want My objective I am driven by
Perceived Affordance			I saw/ realized / found / thought The value/advantage is This is good/difficult I had to put in a lot of effort
Actualized Affordance			I was able to I successfully I performed I was supported in It enabled me
Impact on PCCP		Access to care, Patient engagement, Focus to patient, Shared decision making	The result/outcome/effect/consequence In the end / Overall It changed / added I learned What I would do differently

Below shows overall structure of codes for each affordance.



Appendix 5 – Healthcare Processes

Figure A. ISMP enabled healthcare process chart perceived (using MS Visio)

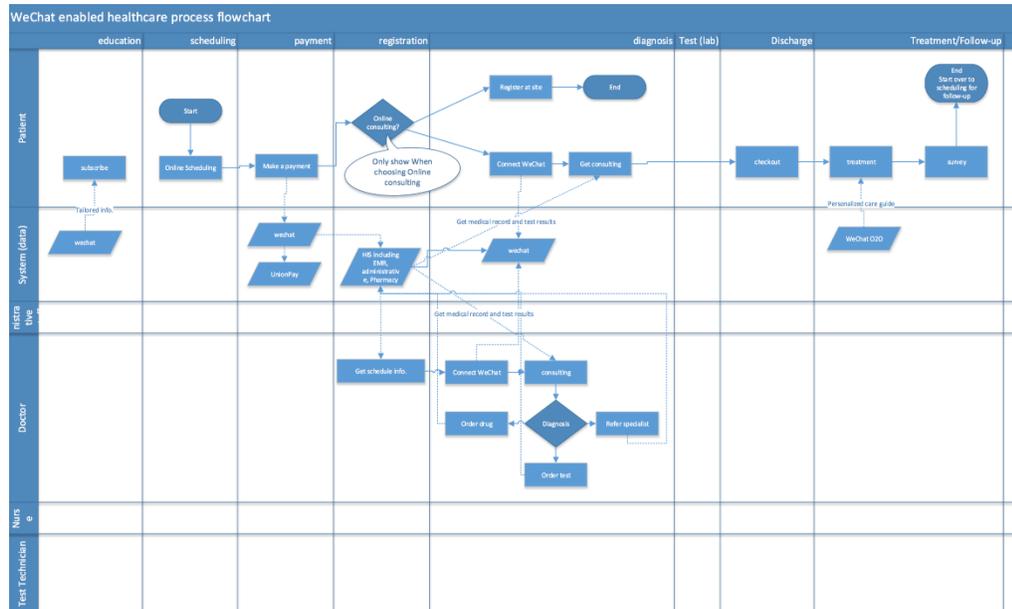
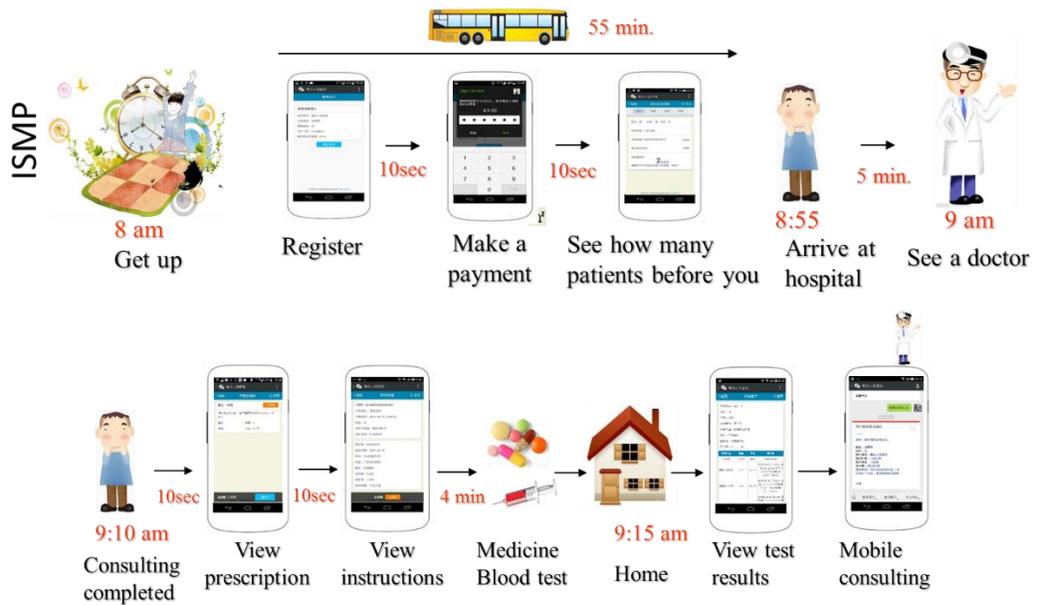


Figure B. ISMP enabled healthcare process illustrated in a hospital document, perceived by hospital



Appendix 6 – Process Mining Analysis Results

Figure A. Activity Flow (Regular Work Hour)

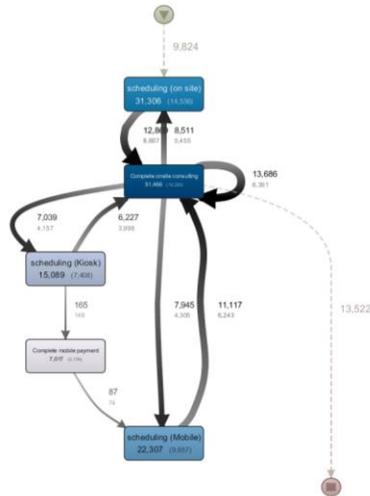
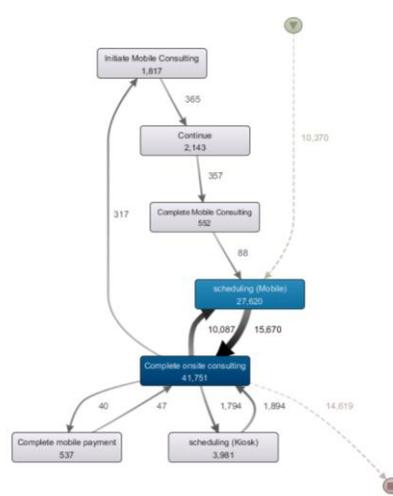
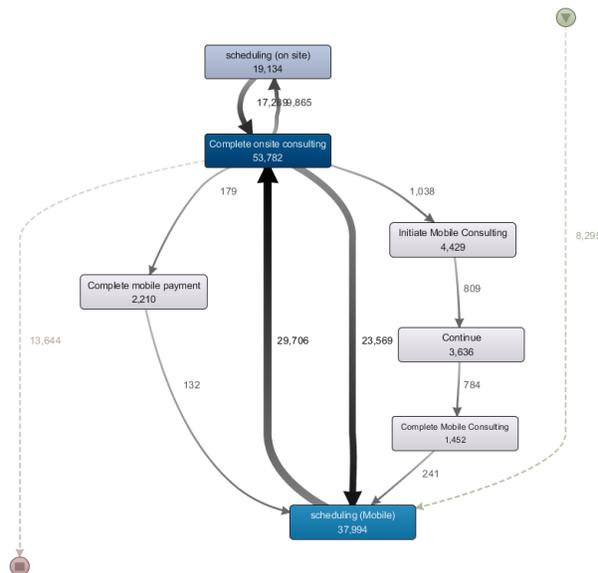


Figure B. Activity Flow (Off-Work Hour)



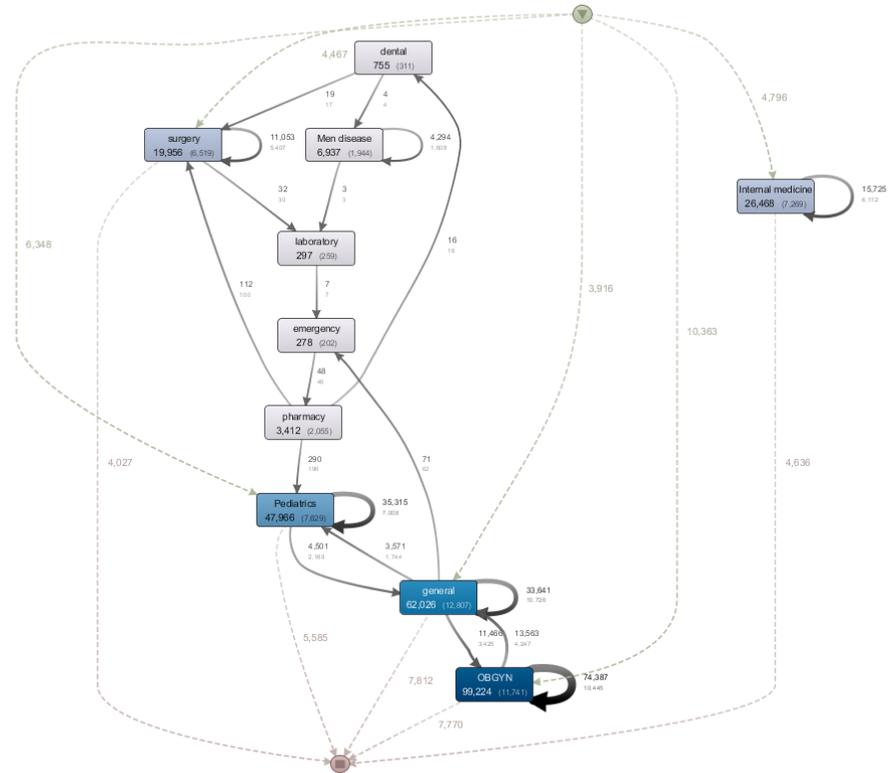
In Figure A, mobile consulting usage is barely seen during regular hour. Compared to the activity flow in the regular hour, mobile consulting usage is salient in Figure B. However, face-to-face onsite consultation is still large portion of all the activities, which indicate doctor's work.

Figure C. Activity Flow (in OB/GYN and Internal Medicine)



The data in only two units show clear activity patterns; scheduling with ISMP for onsite consulting and followed by mobile consulting.

Figure D. Patients Flow across Departments (Overall)



The department which patients use the ISMP mobile consulting feature most is OB/GYN (50%, 11,741 patients), next is internal medicine (15%, 7,269 patients).

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