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Communications of the Association for Information Systems



Understanding the Multidimensionality of Information Systems Use: A Study of Nurses' Use of a Mandated Electronic Medical Record System

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Abstract:

This study outlines the findings of a qualitative study designed to develop an understanding of nurses' experiences using an electronic medical record system (EMR) in a mandatory usage context. Drawing upon the Unified Theory of Acceptance and Use of Technology, a combined deductive/inductive research approach was adopted to study nurses working in an urban hospital system. This approach allowed for an in-depth study of the nature and structure of mandated information systems (IS) use in a healthcare context. We found that understanding the relationship between key technology acceptance constructs and system use required a multi-dimensional conceptualization of usage – something not commonly found in the IS literature. We identified three facets important to gaining a holistic understanding of nurses' use of EMR technology: time spent using the system, timing of use, and mode of use. We empirically demonstrate that the dimensions of IS use can be mandated and internalized to varying degrees even within the same organization, and that the predictors of use can be differentially associated with the dimensions of use given the degree of the mandate.

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I. INTRODUCTION

Information systems (IS) usage is one of the most prevalent behavioral constructs in IS research. For much of the construct's history, usage has been conceptualized in a unidimensional fashion, most commonly as duration or frequency of use. Advances in IS research have brought to light the multidimensional nature of information systems use and suggested that the particular dimensions of use that will be important in a given study are contextually dependent [Burton-Jones and Straub, 2006; Venkatesh et al., 2008]. In their paper arguing for the need to reconceptualize system use, Burton-Jones and Straub contended that "system usage is not the type of construct that can have a single conceptualization or measure. Unlike constructs that are strictly unidimensional or multidimensional with specific, known dimensions, we believe that relevant measures and dimensions of system usage will vary across contexts" (p. 231).

One of the most salient contextual factors is the degree of volition associated with system use. Whether research is conducted in a voluntary or mandatory setting has important implications for both theoretical development and the interpretation of research results. This is evidenced by the development and inclusion of the voluntariness of use construct in some technology acceptance research models [e.g., Venkatesh et al., 2003], as well as by the predominance of voluntary research contexts in both the technology acceptance and IS success research streams. Researchers have noted that the focus on voluntary contexts is limiting, especially given the likelihood that technology usage is mandated in many organizations [Chae and Poole, 2005; Rawstorne et al., 2000; Townsend et al., 2001]. It has long been suggested that usage is only an appropriate indicator of IS success in voluntary usage contexts because usage is not free to vary as a result of users attitudes in mandatory contexts [DeLone and McLean, 1992; Lucas, 1978; Seddon, 1997]. As such, system satisfaction measures are often used as an alternative to usage as a measure of systems success in mandatory usage contexts [e.g., Adamson and Shine, 2003; Doll and Torkzadeh, 1988; Downing, 1999; Etezadi-Amoli and Farhoomand, 1991; Franz and Robey, 1986; Gati, 2000; Goodhue et al., 2000; Igbaria and Tan, 1997; Ives et al., 1983; Seddon and Yip, 1992; Simon et al., 1996]. While this has led to a useful body of knowledge related to systems satisfaction, it has had the unfortunate side effect of drawing research attention away from the ways in which actual usage may vary in mandatory contexts.



Information systems research and practice would benefit greatly from developing a greater theoretical understanding of the nature of mandated technology use. In particular, they would benefit from a deeper exploration of the relevant dimensions of usage. The unidimensional conceptualization of usage that has dominated IS research assumes that there will be little variance in the duration or frequency of use in mandatory settings. Further, there may be other dimensions of use that are equally, if not more, important to the achievement of the organizational goals for which use was mandated, and those dimensions might have interesting and as-of-yet undiscovered relationships with existing predictors of IS use.

There are few places in which the pressure to mandate technology usage is more prevalent than in the healthcare industry. In 2000, the Institute of Medicine released a report entitled *To Err is Human: Building a Safer Health System*. This report found that medical errors occurring in hospitals accounted for over 98,000 deaths per year—a death rate greater than that of Acquired Immune Deficiency Syndrome (AIDS), motor vehicle accidents, or breast cancer [Kohn et al., 2000]. The report cited increased use of information technology as a key factor in reducing the rate of medical errors. Consequently, many healthcare systems now promote technology usage as a means of improving healthcare quality and reducing associated costs [e.g. Bates, 2002; Bates et al., 2001; Ortiz et al., 2002]. Moreover, practitioners and healthcare organizations are increasingly implementing information technology as a means of complying with government, insurance companies', and non-governmental accrediting bodies' mandates to improve patient safety [Baron et al., 2005; Berner et al., 2005; Hillestead et al., 2005; Leape and Berwick, 2005]. As such, the healthcare context offers an extremely useful environment in which to examine mandated technology use, and represents a growing field of IS research. Scholars have called for the development and diffusion of IS theory within the healthcare domain [Chiasson and Davidson, 2004] and explored the adoption and use of healthcare IS for a diverse array of healthcare practitioners, including physicians [e.g., Bhattacharjee and Hikmet, 2007; Blegind et al., 2007; Hennington and Janz, 2007], nurses [e.g., Mitsa et al., 2007], radiologists [e.g., Van Akkeren and Rowlands 2007], and paramedics [e.g., McLeod et al. 2008]. Unfortunately, healthcare research directly theorizing and measuring IS use is sparse. Most studies on the topic do not directly measure usage, using proxies such as satisfaction and behavioral intention instead [e.g., Bhattacharjee and Premkumar, 2004; Hu et al., 1999; Klein, 2007; O'Connell et al., 2004; Pendharkar et al., 2001; Wilson and Lankton, 2004, 2009]. In a rare exception, Devaraj and Kohli [2003] measured system use in terms of time spent using a strategic IT system (measured using system logs) in their study of the relationship between use and hospital performance, including revenue and quality of care. Their work found IS use to be positively related to both. Given the importance of the practical and theoretical implications of healthcare IS use, further research within this context is warranted.

The purpose of this research is to develop an understanding of nurses' experiences using an electronic medical record (EMR) system in a mandatory usage context. To accomplish this goal, we adopt a combined deductive/inductive approach to study nurses working in an urban hospital system. We draw upon the Unified Theory of Acceptance and Use of Technology (UTAUT) [Venkatesh et al., 2003] model to help construct a theoretical framework for our study (a deductive approach); however, we remain open to the possibility that new theoretical insights would emerge from the data as they were collected and analyzed (an inductive approach). Studying nurses' EMR use in this manner allows us to concurrently evaluate the influence of the UTAUT constructs and discover key influential factors external to the UTAUT model. Further, approaching the study of mandated use in this manner allows for the development of a richer conceptualization of use, which is typically narrowly represented as an expression of either how long or how often an individual uses a system. Many have acknowledged the limitations of this approach in aiding our understanding of the construct [DeLone and McLean, 2003; Doll and Torkzadeh, 1998; Gallivan et al., 2005; Goodhue et al., 2000; Kim and Malhotra, 2005; Savaya et al., 2006; Straub and Limayem, 1995], and have encouraged the development of context-specific measures of usage [Burton-Jones and Straub, 2006]. A particular shortcoming has been the inadequacy of survey designs to adequately capture the complex dynamics that characterize technology usage in a healthcare system. Thus, we adopt a qualitative approach that allows us to more adequately assess the nuanced understandings necessary for such a study. In doing so, we extend technology acceptance research and deepen our understanding of IS use in the healthcare context.

II. THE MULTIDIMENSIONALITY OF USE

Although systems use is a broad concept, its measurement in IS research is quite commonly limited to time spent using the system or other rudimentary measures. Doll and Torkzadeh [1998] argued that studies measuring usage in a unidimensional manner disregard the organizational context in which use takes place and assume that more use is necessarily better. They argued that employing usage as an indicator of system success when it might in fact only be a measure of compliance as an impediment to the development of multidimensional measures of effective system usage in mandatory environments. In their update of the IS Success Model, DeLone and McLean [2003] argued that time measures of usage are flawed because they do not adequately depict the relationship between usage and expected benefits. We agree and hold that there are widely acknowledged measurement limitations with these simplistic unidimensional measures [Gallivan et al., 2005; Goodhue et al., 2000; Kim and Malhotra, 2005; Savaya et al., 2006; Straub and Limayem, 1995].

Burton-Jones and Straub [2006] categorized unidimensional measures as “lean” measures, arguing that usage measures are often chosen in an atheoretical manner and are poorly validated, thus giving rise to mixed research results. In their research Burton-Jones and Straub [2006] identified 14 different usage measures that had been employed in 48 empirical studies between 1977 and 2005 (see Table 1). Although a single conceptualization of usage is impossible to derive, Burton-Jones and Straub argued that it is possible to have an accepted approach for how to develop conceptualizations of usage for specific contexts that allow for selecting measures of usage in a theoretically rigorous way. Building upon the work of Burton-Jones and Straub, researchers have begun to develop richer conceptualizations of the usage construct. Table 2 outlines the new conceptualizations of usage that have been put forth since 2006.

Given the importance of the research context in identifying the appropriate dimensions of use, it is unfortunate that we know so little about the various contexts in which the vast majority of usage research has taken place. In particular, we lack information about whether research was conducted in a voluntary or mandatory setting. A meta-analysis of the IS success model found that 74.2% of the studies comprising the sample failed to explicitly report whether the study was conducted in a voluntary or mandatory context [Sabherwal et al., 2006]. This is also a flaw of

Table 1: Usage Measures Employed in Prior Research 1977-2005

Broad Dimension	Individual Measures
System usage measured as the use of information from an IS	
• Extent of Use	• Number of reports or searches requested
• Nature of Use	• Types of reports requested, general versus specific use
• Frequency of Use	• Frequency of report requests, number of times discuss information
System usage measured as the use of an IS	
• Method of Use	• Direct versus indirect
• Extent of Use	• Number of systems, sessions, displays, functions, or messages; user's report of whether they are a light/medium/heavy user
• Proportion of use	• Percentage of times use the IS to perform a task
• Duration of use	• Connect time, hours per week
• Frequency of use	• Number of times use system (periods are: daily, weekly, etc.)
• Decision to use	• Binary variable (use or not use)
• Voluntariness of use	• Binary variable (voluntary or mandatory)
• Variety of use	• Number of business tasks supported by the IS
• Specificity of use	• Specific versus general use
• Appropriateness of use	• Appropriate versus inappropriate use
• Dependence on use	• Degree of dependence on use
Adapted from Burton-Jones and Straub [2006].	

much technology acceptance research. The technology acceptance model (TAM) [Davis, 1989; Davis et al., 1989] is based upon the theory of reasoned action [Fishbein and Ajzen, 1975], which explains behavioral intention and subsequent behavior as a function of individuals' attitudes toward that behavior and subjective norms (perceptions of whether or not important others think a behavior should be performed). Although the 'subjective norm' concept does not capture the usage context explicitly, it does reflect the extent to which individuals feel social pressure to adopt and use a technology, which is indicative of the extent to which they perceive usage to be mandatory. However the subjective norm concept was initially excluded from the TAM. Davis et al. [1989] opted to leave it out, arguing that the construct was not well understood and that computer usage was thought to be mostly voluntary. As a consequence of excluding 'subjective norm', much of the subsequent TAM-based research has also failed to capture data pertaining to social influences on technology adoption with little known about the adoption context. Further, many studies do not make the context explicit, which has been acknowledged as a limitation of technology acceptance research [Lee et al., 2003].

Table 2: Conceptualizations of Usage Identified in the IS Literature 2006-2009	
Dimensions/Sub-Dimensions	Definition
<ul style="list-style-type: none"> • Exploitive system usage [Burton-Jones and Straub, 2006] 	<ul style="list-style-type: none"> • The extent to which the user exploits the features of a system to perform a task
<ul style="list-style-type: none"> - Cognitive absorption 	<ul style="list-style-type: none"> • The extent to which a user is absorbed when using the system
<ul style="list-style-type: none"> - Deep structure usage 	<ul style="list-style-type: none"> • The extent to which features in the system that relate to the core aspects of the task are used
<ul style="list-style-type: none"> • IS use-related activity [Barki et al., 2007] 	<ul style="list-style-type: none"> • The set of behaviors individuals undertake concerning a specific task-technology-individual context
<ul style="list-style-type: none"> • Telemedicine use quality [LeRouge et al., 2007] 	<ul style="list-style-type: none"> • The effective convergence of technological aptitude and ability, communication skill, and encounter orchestration to provide suitable patient care

Thus, existing research suggests we may need to alter the ways in which we study systems use in organizations. In line with prior research, we contend that usage is a rich, highly contextualized behavior. Just because users *have* to use the system does not mean there will not be variations in *how* they use the system: the *how* questions are the ones that remain interesting and under-examined. Perhaps more importantly, the *how* questions may also bring our understanding of usage in closer alignment with the accomplishment of organizational goals, thus providing a means to establish the elusive link between systems use and organizational benefits. In the following section, we discuss the design of our research and the methods that we used to collect and analyze our data.

III. RESEARCH DESIGN

A qualitative approach was utilized to provide a richer picture of the dynamics of mandated IS usage from the perspectives of those actively engaged in the behavior. Recognizing that no researcher approaches research with a completely blank theoretical slate, we drew upon our own research experiences in selecting a theory base to structure the data collection process. Some of the researchers involved in this study have published research on technology adoption in healthcare using Venkatesh et al.'s [2003] UTAUT model, and that model was deemed an appropriate starting point given the purposes of the study. At the same time, we recognized the importance of letting new theoretical insights emerge from the data as it was collected and analyzed, and thus we adopted a combined deductive and inductive approach to arrive at a representation of mandatory usage.

Research Context

This research was conducted in a large urban hospital system (hereafter referred to as UHS) that operates five geographically dispersed hospitals within a single metropolitan area in the United States. In 2003, UHS implemented a vendor-supplied EMR system across all five hospitals. The EMR automated and integrated several clinical functions, including patient care documentation (charting), radiology, and laboratory work. Use of the EMR was mandated for nurses working in medical/surgical units (those caring for patients on the hospital floor), as well as most other direct care staff. Nurses were required to use it in order to document the care they provided and to retrieve patient data from other functional areas. At the time data collection was initiated for this study, the system had been in place for three years.

Participant Selection

Research participants were purposively selected based upon several factors. First, we wanted to interview nurses from all of the UHS hospitals. Nurses at all hospitals accessed the system via the same intranet and used the same interfaces once logged into the EMR; however, a great deal of variety existed in terms of how and where they accessed the system. Each hospital was different in terms of its architecture and physical surroundings, which made the location, availability, and performance of the hardware and software potentially different in each setting. Further, a wide variety of equipment, such as tablets, laptops, desktops, and rolling carts (referred to as 'COWs' for 'computer on wheels') was used within each hospital, which also made for variation in practice. We felt that the collection of data reflecting this diversity was critical to our practical and theoretical understanding of EMR usage.

There were also practical concerns relating to participant selection. We needed units with cooperative nurse managers who could facilitate the data collection process by granting us on-site access during nurses' normal working hours. We also wanted to investigate direct care nurses working on units that served a general purpose

patient population, as opposed to a specialty unit, in order to allow us to compare findings across the hospitals. Doing so gave us a large pool of potential units, and thus a large number of nurses from which study participants could be selected. Further, we deemed that interviewing nurses working in general, as opposed to specialized, care would offer greater generalizability of our findings. Once the units were selected, the research team interviewed as many nurses as were available and willing to participate. In some cases, follow-up trips were arranged to interview personnel unavailable on the original visit. In all, 23 nurses and 4 nurse managers were interviewed. Of the 23 nurses interviewed, 19 were responsible for direct patient care on a daily basis. The other four nurses served in supervisory or compliance positions. The interviews lasted between 20 and 60 minutes.

Data Collection and Analysis

Data collection was comprised primarily of in-depth, semi-structured interviews and direct non-participant observation. When units were selected for inclusion in the study, the corresponding nurse managers were contacted and initial site visits were made during May and June 2006. These site visits included a guided tour of the specific hospital unit, as well as independent observation of work going on in the unit. Initial site visits lasted between one and two hours in duration. Field notes were taken by the research team during the visits. The researchers returned to each of the sites to interview members of the nursing staff during September and October 2006. The research team was comprised of four individuals experienced in qualitative methods. All interviews were conducted with no less than two members of the team present. The majority of the interviews were recorded and transcribed for data analysis. When recording could not take place, we followed Eisenhardt [1989] in writing-up field notes into narratives, whenever possible, within 24 hours of data collection. The interview protocol is presented in Appendix A.

The semi-structured interviews were conducted using an interview protocol derived from Venkatesh et al.'s [2003] UTAUT survey instrument. These questions helped to frame our initial understanding of the nurses' use of technology around the UTAUT model's core constructs—behavioral intention, performance expectancy, effort expectancy, social influences, and facilitating conditions. Table 3 provides an overview of these constructs and their definitions. In addition to the UTAUT questions, each nurse was asked to describe his/her typical workday. As the nurse described his/her day, we probed for information about the EMR system use and asked how it might be different on an atypical day, as well as what may have motivated the change. Data were collected regarding the nurses interaction with the system itself, as well as how that interaction integrated with their other work activities, medical personnel, and patients.



Table 3: UTAUT Constructs and Definitions [Venkatesh et al., 2003]

Construct	Definition
Behavioral Intention	The strength of one's intention to perform a specified behavior.
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
Effort Expectancy	The degree of ease associated with the use of the system.
Social Influences	The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.

Throughout the study, we concurrently analyzed and collected data, using themes emerging from the data to modify and improve our instruments [Miles and Huberman, 1994; Yin, 2003]. Initial data analysis started during the interviewing process, and led to the modification of interview protocols as insights into EMR usage, practitioner beliefs, and managerial requirements emerged. This analysis became more extensive following the completion of data collection, leading to several rounds of coding, categorizing and thematic development. Following Miles and Huberman [1994], we developed a “start list” of codes based on the constructs associated with the UTAUT model. We also inductively generated new codes based upon words and phrases emerging from the data. In line with Strauss and Corbin [1990], we analyzed the data line-by-line, generating codes alongside the text as they emerged. As the codes were developed, they were entered into a master code list. The master list included not only the codes, but also a brief definition of what each code meant in order to maintain consistency in their application to the data. Remarks or “memos” [Charmaz, 2006] were also made in the margins during the analysis process to capture reflective thinking by the researcher. “Memoing” is encouraged as a means of avoiding the tedium of coding, as well as capturing important insights as they occur to the researcher.

When an iteration of data analysis was complete, the master code list was reviewed and modified in order to reduce redundancy among the codes and to eliminate codes that were idiosyncratic. In early iterations, the codes were largely descriptive, but they began to take on more of a theoretical tone as we developed a more holistic understanding of the nature of nurses’ experiences. The coding process concluded when it was felt that a satisfactory master code list had been generated and rigorously applied to the data. This list, in combination with the marginal remarks and frequent references back to the original data, forms the basis of the findings to be

reported. Following Corley and Gioia [2004] and Pratt, Rockman and Kaufmann [2006], among others, Figure 1 provides an overview of how the theoretical dimensions were derived from the initial descriptive codes.

In order to establish the trustworthiness of our qualitative data, we followed the criteria established by Lincoln and Guba [1985] for data collection and analysis. To establish *credibility*, we spent an extensive amount of time in the field, collecting data from many participants at multiple sites. We discussed our interpretations with employees of UHS both formally during interactive presentations made to leadership groups and informally during one-on-one conversations with employees at varying hierarchical levels of the organization. Further, by using observations, field notes, and multiple interviews as a means of triangulating our findings and conclusions, we gained significant confidence in the robustness of our findings. The *dependability* of our findings was increased by engaging in a process of peer debriefing, whereby the data and analyses were exposed to an uninvolved colleague who was able to question the logic of the interpretations and conclusions being drawn. We also presented our findings to UHS insiders, both in the form of oral presentations and written reports, in order to ensure that our conclusions 'rang true'. The criterion of *confirmability* was addressed by the triangulation of data noted above, and also by continually reviewing our emergent understandings against any potential biases of the research team. This was achieved primarily by having numerous meetings in which we challenged each others' assumptions, queried findings, and revised conclusions until we were all comfortable with the veracity of the constructed narrative. Finally, in order to facilitate *transferability* of our results, we have sought to provide as much information as possible pertaining to how we carried out the research and what we found in order to allow readers to determine the applicability of our findings to other research contexts.

IV. FINDINGS

The findings from our data analyses reveal new insights relating to the dimensions of IS usage. In addition to our deductive insights related to the UTAUT model, we also introduce caseload as a determinant of usage that inductively emerged from our data as important to understanding EMR use by nurses at UHS. This section contains a detailed presentation of our results related to these areas.

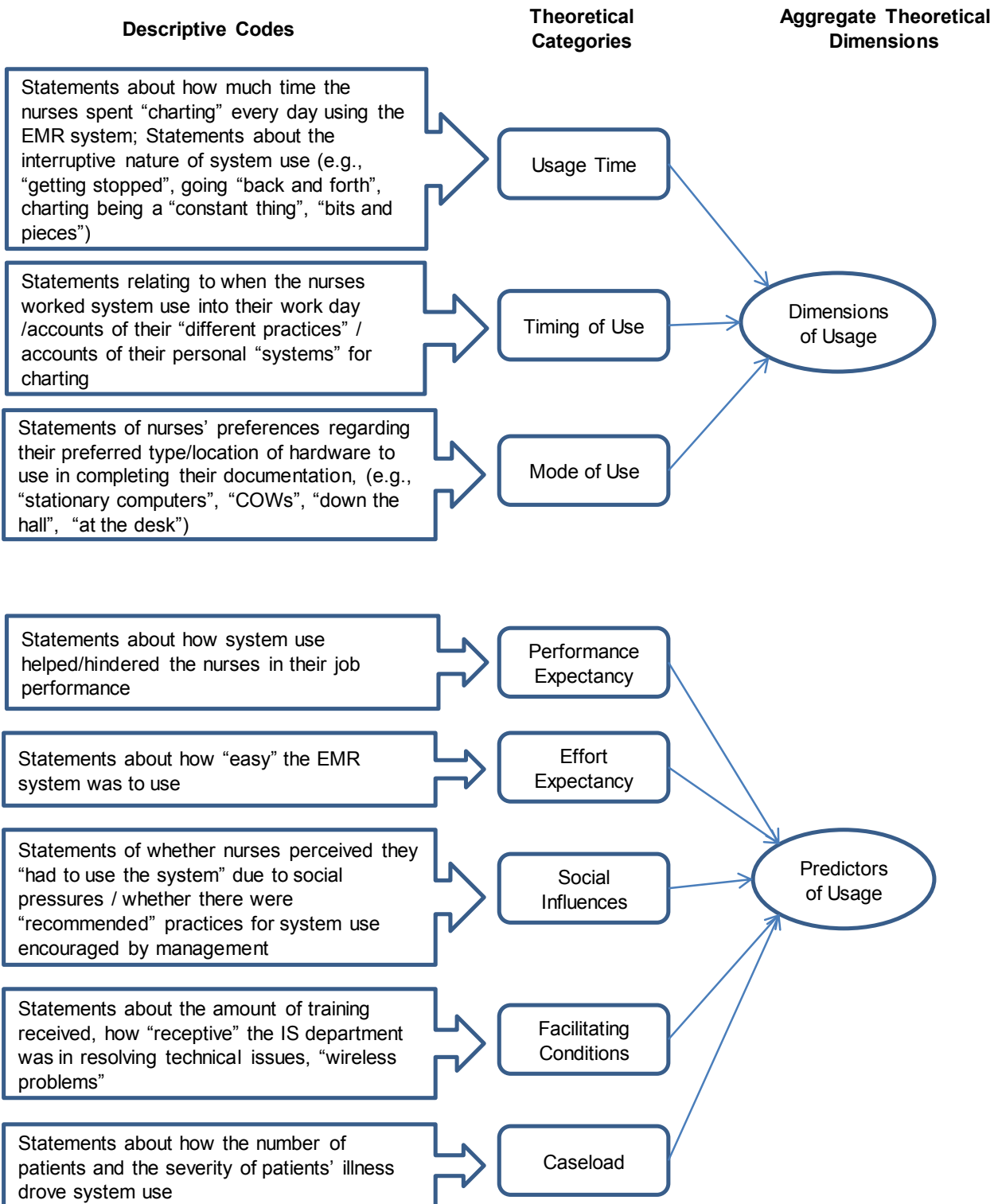


Figure 1: Overview of Data Structure

Dimensions of Usage

In order to discuss the predictors and outcomes of usage, it is first necessary to outline our findings related to the multidimensionality of usage. As previously discussed, usage is commonly conceptualized in the IS literature in terms of time spent using the system and/or the frequency with which the system is accessed [e.g., Davis, 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003]. Although the time spent using the system did emerge from our data as an important aspect of use, our findings suggest that there are other dimensions of usage in need of exploration. In particular, two dimensions emerged from the data as being important to understanding usage at UHS: the timing and the mode of use, neither of which have been previously employed in IS research (see Tables 4 and 5). We believe we have identified two important, albeit previously overlooked, facets of usage. When organizational goals can only be attained via real-time data entry, the timing of use may be as important as the length of time spent using the system. In addition, as systems become more sophisticated, the ways in which the system can be accessed has increased. Most usage research to date has overlooked the physical aspects of gaining access, including the type of hardware used and its physical location. In the following sections, we discuss our findings related to usage time, the timing of use, and the mode of use.

Usage Time

Within UHS, the tasks requiring EMR use included documentation of patient care and retrieval of patient information. The typical workday was structured in such a way that nurses performed rounds - visiting each of their patients to assess their condition and provide necessary care and then accessing the EMR system in order to document the care they provided. This process of rounding and documenting activities occurred three or four times a day. Periodically, nurses would also access the EMR system to look up patient information such as vital signs, laboratory reports, x-rays, and physicians' orders.

Institutionalized policies prevented nurses from creating workarounds to avoid system use. For example, auditing/accrediting bodies hold that any activity that is not documented is not actually done. Thus, complete and accurate documentation is critical from a compliance, as well as patient care, standpoint. Further, the care provided by a nurse had to be documented by that nurse; no other nurse was allowed to do it, even if they had witnessed the care taking place. Based on our interviews, estimates of the time spent "charting" (i.e., using the EMR system to document patient care) represented 25-70 percent of a nurse's workday. As will be discussed in greater detail in the section related to determinants of use, we found this difference to be largely due to variation in nurses' patient care responsibilities. As such, we found usage time to be representative of the proportion of the day dedicated to accomplishing those tasks requiring system use.



One important insight that emerged from the interview data was the interruptive nature of EMR use at UHS. When asked to estimate how much time she spent documenting over the course of the day, one nurse provided the following response:

Charting, oh good Lord... I wish I could [tell you precisely]....because it's in just bits and pieces because you do a little something, you chart a little something, you do a little something, you chart a little something.....ummm....probably 25-30%, more so, yeah.

This nurse's statement is representative of the responses we received pertaining to usage time (see Table 4) and reveals another important insight: The number of times a system is accessed throughout the course of a workday can represent the degree to which an individual is being called away prior to completing, or prevented from even starting, the work tasks requiring EMR use. As such, higher frequency of use might not necessarily be better in all cases. These findings highlight the importance of understanding the context of use in interpreting representations of frequency.

Timing of Use

Up-to-date information enables better decision making, which, in healthcare, can literally be a matter of life-or-death. The UHS leadership implemented the EMR system with the goal of real-time charting. Initially, it was intended that nurses would take a computer into the patients' rooms during rounds, performing the electronic documentation as they went. However, several obstacles— behavioral and technical—prevented this from becoming common practice. Although a lengthy discussion of those obstacles is beyond the scope of the present work, it is important to note that the success of the EMR system in meeting the organizational goal relied not only upon the system being used, but also upon it being used in a timely manner. As a nurse manager explained:

Our goal is to provide the care, have the computer at the bedside, and enter your documentation, you know, as you do your care. Unfortunately, we are not able to do that because most of our computers have to stay stationary, so we have to still go in and do our care, come back to the computer, and then enter our documentation from that standpoint. So, you have different practices. Some people will go do the care and then enter it directly after performing the care before going to the next patient. Then some people will do all their patient care and then come and sit down and document everything in the computer.

Our findings from interviews with frontline nurses were consistent with the description provided by the nurse manager (see Table 4). Most of the nurses interviewed performed their patient assessment first, making notes on something that they could keep in their pockets, and would then document all of their care at one time. For most nurses, this “batch” process occurred multiple times throughout the day. Further, it was not uncommon to hear of

cases in which complications with patients prevented nurses from completing their documentation until the very end of the shift—sometimes many hours after the care had been provided.

Mode of Use

Although UHS mandated that all documentation be completed using the same IS, there was considerable variance in where and how nurses accessed the system within and across the different wards that we studied. Due to the differing architecture of each of the hospitals, there was variation in where the computers were located and in the hardware employed. This can be attributed to a number of factors, including hospital management’s decision to delegate equipment purchase decisions to the units, the technical performance of the various forms of equipment once in use (e.g., wireless connectivity), regulatory issues (e.g., fire codes preventing equipment from being left in the halls) that impacted where hardware could be located and stored, and the personal preferences of nurses. Collectively, we refer to these as variations in the mode of use.

Table 4: Dimensions of Usage

Theme	Representative Quotations
Usage Time	<p>“It takes me about an hour [to chart the first round of patient assessments] because along the way I’m getting stopped.” - RN</p> <p>“Umm man that is hard to say because I mean you are back and forth so much, actual charting itself, like the assessments and what not doesn’t really take that long umm it’s going back and looking at labs and orders and is this ordered, have they done this and umm that varies” - RN</p> <p>“Off and on all day, I mean that is a constant thing. You know I mean you never really just get away from the computer because by the time you have charted on this patient, you have to do another assessment” - RN</p>
Timing of Use	<p>“If I have six [patients] I will get the first three, see everybody, go chart then I do the next three and go chart. You know I do a little system like that but I don’t patient, chart, patient, chart. Oh my God that seems like it would take forever.” - RN</p> <p>“the nurses are going to see the patients, providing the treatment, and then documenting and they’ll probably document about every four hours. They’re probably seeing all their patients, generalizing, seeing their patients and then sitting down every four hours to document.” – Nurse Manager</p> <p>“depending on how my day is going... I will do a couple of assessments, chart, do a couple of assessments, chart, for the majority of the time I end up doing all of my assessments and then charting and stuff when I get an opportunity to sit still and do some.” - RN</p>
Mode of Use	<p>“if you chart at the computers down the hall, every time a patient or a family member walks out of the room, you have to do something or take them something and you occasionally stop and you never get to your chart.” - RN</p> <p>“No, I prefer to use the computers at the desk because I don’t like the ones down the hall, I don’t use the COWs and stuff” - RN</p> <p>“I can’t [chart] at the nurses’ desk, it’s too busy and it’s distracting.” – RN</p>



Issues relating to the mode of use are an often-overlooked aspect of overall IS usage, yet the data collected in this study illustrate just how important they can be to the achievement of organizational goals. In making real-time charting at the patient bedside a reality, the type of hardware selected and its physical location are as important as the availability and performance of the software. The UHS nurses used a combination of stationary desktops, laptops, COWs, and portable tablet computers. The various forms of hardware were used in a wide variety of physical locations including patients' rooms, halls, spare rooms, and nurses' stations. In explaining why most of the nurses she supervised chose to chart at the stationary computers in the nurses' station, one nurse manager explained the practical limitations relating to modes of use:

Even the carts with wheels, they don't tend to lose connection like these tablets do, but nurses won't use those up and down the halls because they're big, bulky, heavy...and they can't be left in the halls. So it's like every time you go, take it into a patient's room and come back out you've got to go bring it back into this nurses' station. It's not like we can kind of strategically place them out and about to where it's easy for them to just grab one and go.

Predictors of Usage

We are now in a position to discuss those factors theorized to be predictive of our broader conceptualization of IS use. An important theme that emerged was that predictors can be differentially associated with the various dimensions of use. To our knowledge, this is the first time that research has empirically demonstrated this phenomenon. In this section we present our findings related to each of the determinants of usage behavior found in the UTAUT model. We also discuss caseload as a determinant of usage that inductively emerged from the data.

Behavioral Intention

Initially, we did not expect behavioral intention to be an important factor in understanding nurses' use of the EMR system. So long as a nurse had intentions to remain employed with the organization, there was no choice but to continue use of the system; everyone would intend to use the system because there was no other alternative, thus negating the construct's explanatory power. We found, however, that some dimensions of use remained volitional. At UHS, decisions regarding the timing and mode of use were left to individual nurses. Although there was an initial expectation that nurses would electronically chart at the bedside, in practice nurses were able to exercise considerable discretion about when, where, and how they charted. The freedom to make these choices allowed for

usage to vary as a result of their behavioral intentions. Consistent with technology acceptance theory, we found evidence of the impact of behavioral intention on the timing and mode of usage.

In an example illustrative of behavioral intention's impact on the mode of use, one nurse, vocal in her dislike of the tablet computers, said she thought that UHS would mandate their use at some point. She stated that she had no intention of using the tablets until required to do so, saying, "...if I have to use [the tablets], then I'm going to have to use them, but for now, when I don't have to, I don't want to." This statement and others like it contained in the interview data led us to conclude that behavioral intention can be differentially related to usage dimensions based on the degree of volition associated with each dimension.

Performance Expectancy

Performance expectancy is theorized to impact usage indirectly via behavioral intention [Venkatesh et al., 2003]. A wide amount of variance in nurses' performance expectancy beliefs emerged from the interview data. We did not, however, find evidence of a direct association between performance expectancy beliefs and time spent using the system. This seems logical in that nurses were required to use the system regardless of their personal beliefs relating to the system. Behavioral intention and subsequent usage were not free to vary as a result of performance expectancy beliefs. Rather, the time spent using the system was more a function of the job activities that required system use.

Our data did point to a strong connection between performance expectancy and those dimensions of use that were volitional. In regard to timing, we found that lower performance expectancy was sometimes associated with nurses consistently choosing to batch chart late in the day. There was a perception among some of the nurses' interviewed that use of the system took away from their ability to provide timely patient care. In essence, they felt time spent using the system was time not spent caring for the patient, thus putting the two behaviors at odds with one another. One nurse stated, "If there is something going on that I need to tend to that's more important to me... like taking care of that patient, that's where my focus is and I'll get to that computer when I get to the computer." In terms of her overall job performance, she held that providing direct patient care was more important than timely documentation of that care. Given this mindset and the freedom to dictate when she charted, her performance expectancy beliefs influenced the timing of her system use via her behavioral intention to not let documentation activities interfere with direct patient care activities.



Table 5: Predictors of Usage

Theme	Representative Quotations
Performance Expectancy	<p>“I mean [the tablets] were kicking us out so much that it was just, it was wasting so much of our time, it was just not benefiting us to use them.” [mode of usage] – RN</p> <p>“I prefer using the desktop just, um, they seem to function a little quicker.” [mode of usage] – RN</p> <p>“Well, we don’t get a good connection and every time we unplug [the COWs] they go down. So it makes it a little difficult so we just do an assessment at the bedside and then go chart it.” [mode of usage] – RN</p>
Effort Expectancy	<p>“It’s just much easier for me to go see my patients and then come back and chart because I have my little sheet that I write on that I know eventually we’re supposed to go to bedside charting, but now we’re not, so...” [timing of usage] - RN</p>
Social Influences	<p>“[Leadership] want[s] you to do [charting] the right way: down the hall with it and really at the bedside.” [timing and mode of usage] - RN</p> <p>“I do have a few people who really work hard to try to do it like we suggest they do it, which is take the computer in the room with you, do your care and document. So, I do have a few people who really work to do that.” [timing and mode of usage] – Nurse Manager</p>
Facilitating Conditions	<p>“So, [the nurses] just kind of have been burned from it, I guess, and now they just won’t deal with [the tablets]. And then people are like, “So, have the wireless issues gotten better?” And we’re like, “I can’t tell you because they’re not using it now.” [mode of use] – Nurse Manager</p>
Caseload	<p>“If I have six I will get the first three, see everybody, go chart then I do the next three and go chart.” [timing of use] – RN</p> <p>“...you may have a patient that doesn’t have hardly anything ordered and you are not looking very often and you may have a patient with a ton of stuff and you are on there again and again.” [time spent using] - RN</p>

Our findings also suggest an association between performance expectancy and the mode of usage. Primarily due to their previous experiences with the different modes of use, nurses had formed performance expectancy beliefs for each mode of use available to them. When asked, they had clearly stated preferences as to which mode of use they found to be most beneficial. These preferences were so strong in some nurses as to preclude their use of particular modes altogether, most usually the portable modes (COWs, laptops, or tablets). As can be seen by reviewing the interview excerpts in Table 5, these beliefs influenced the means by which nurses accessed the system, thus demonstrating a link between performance expectancy and the mode of usage via nurses’ behavioral intentions. In

reading Table 5, the bracketed phrases at the end of quotes (e.g., [mode of usage], [timing of usage]) indicates the dimension of usage that the interview data secondarily support.

Effort Expectancy

Effort expectancy is also theorized to impact usage via behavioral intention. When faced with this question participants reflected on such application characteristics as navigability and ease of data input, but also upon other issues relating to the ease of access. These included nurses traveling to a location where charting would occur, (e.g., nurses' station) or moving a computer into a patient room, as well as the double-login process necessary to access the EMR system. There were reflections on wireless network performance and the increased effort that resulted from slow system performance or, in extreme cases, information loss that necessitated re-entry of data. Indeed, it was largely in exploring these network performance issues that we found an association between effort expectancy and both the timing and mode of usage via nurses' behavioral intentions. Consider the following description of a nurse's experience with the tablet computers:

Like you'll be in the middle of charting and it'll get out of it and you'll have to go back and re-chart all what you charted and that is so frustrating and it did it to me a couple of times and I just gave up on the tablet. I am so frustrated with that tablet...every time I go to do it, I'm like, 'Ok, I'm gonna' try this', and then it just irritates me. It's just much easier for me to go see my patients and then come back [to the nurses' station] and chart.

This excerpt is indicative of not only how effort expectancy impacts the timing and mode of use, but also the interrelatedness of the two usage dimensions. UHS acquired the COWs and the tablet computers in order to facilitate real-time charting at the patient bedside. When UHS experienced wireless connectivity problems, nurses developed negative perceptions of the effort associated with usage modes dependent upon the wireless network. As a result, nurses resorted to workstations they deemed to be more dependable and, thus, easier to use. These included stationary computers located in the nurses' stations and COW's that were plugged into the wall (in essence converting them into stationary computers). As a consequence, they would typically visit all of their patients and then chart, thus turning documentation into a cyclical batch process. Of the 19 nurses we interviewed whose primary job responsibility was direct patient care, 18 reported that they batch charted throughout the day. Only one nurse reported using a tablet computer to chart as she visited her patients and even she reported difficulty in using the mobile device.



Social Influences

Social influences are theorized to impact usage via behavioral intention. This relationship is theorized to be contingent upon users' perceptions of the degree to which the behavior is voluntary. That is, the relationship between social influences and behavioral intention is expected to be stronger in those instances where users perceive their behavior is being mandated. At UHS, the incorporation of required work activities into the IS made use a foregone conclusion. However, social influences were being exerted in terms of the timing and mode of use. In general, the nurses and nurse managers who participated in our study were aware of executive management's desire to implement real-time charting at the patient bedside, understood the rationale behind it, and were supportive of it. One nurse manager explained:

[Leadership] recommends that we do it bedside just as, you know, we want to. They understand that we're not; they are aware and understand that, the issues that cause us not to be able to do it that way. But the recommendation from administration is to take the computer in and document as you go.

However, she also noted that there were no negative consequences to not following the recommendation. Overall, the data reveal that leadership had initially strongly encouraged those modes of usage that facilitated bedside charting, but the early connectivity issues and the resulting reluctance on the part of nurses to use those modes had led to a non-existent enforcement policy by the time our data collection occurred.

In terms of timing, it was widely acknowledged that leadership wanted nurses to chart in a timely manner, yet, again, there were no consequences for failing to comply. The primary requirement was that any care provided by a particular nurse during a given shift must be documented in the EMR system by that nurse prior to the end of the shift. Consistent with technology acceptance theory, there did not appear to be a strong relationship between these social influences and nurses' behavioral intention to document in a timely manner using recommended modes of use because nurses' did not perceive the behavior to be mandatory. Table 5 contains selected interview excerpts related to social influences.

Facilitating Conditions

Facilitating conditions are theorized to impact directly on usage behavior. Wilson and Lankton [2009] described facilitating conditions as the situational factors outside users' direct control that influence their system use. We found that the situational factors directly influencing system use fell into three categories: training, ongoing IS support, and system performance. Participants were largely positive about the amount and quality of the training they received, as well as with the responsiveness of the IS function to their needs. There were, however, some negative perceptions relating to the system's performance and the ability of the IS department to solve performance problems. These

issues included the previously mentioned wireless network problems, as well as limited reports of performance slowdowns when many people were attempting to access the network at once. When asked about the IS function's responsiveness to reports of such problems, one nurse manager said:

I think [the IS department is] receptive, that's not the problem. I really believe that they want to help you and that they're receptive; I don't believe they understand how to fix it and I don't believe they understand what it's like to be a nurse on the unit.

This manager's lack of faith in the IS department's ability to adequately address the problem speaks to her perception that UHS lacks the technical infrastructure to support use of the system, at least in the recommended manner. As illustrated in Table 5, the data revealed that some nurses abandoned use of the tablets, laptops, and in some cases the COWs, due to negative experiences resulting from wireless network problems. Despite assurances from the IS function that the problems had been corrected, some nurses expressed reluctance to give those modes of usage another try. They had lost faith in the technology and the organization's ability to support their use it. Given these findings, the data support an association between facilitating conditions and the mode of usage.

We did not find evidence that nurses' perceptions of facilitating conditions impacted time estimates of system use, nor did we find evidence of a relationship between facilitating conditions and the timing of use, other than what could be argued to exist due to previously mentioned interrelationship of the timing and mode of use.

Caseload

Beyond the UTAUT constructs that we used to structure our exploration of nurses' experiences using the EMR system at UHS, an additional determinant of usage emerged from our data. We found that caseload, or the volume of work activities necessitating system use, was critical to our understanding of variations in usage. At UHS, documentation via the EMR system was required for all patient care activities. As one nurse manager explained, "Anything that they do physically for the patient, any treatment that they provide, they need to document." The amount to be documented was determined primarily by two factors: the number of patients assigned to a nurse and the nature of the patients' illnesses.

We found caseload to be the primary driver of time spent using the system. The more patients a nurse cared for, the more care there was to document; the less stable and/or more ill patients were, the more there was to document. We also found caseload to impact the timing of use. When nurses were asked to describe system use, it was common for them to qualify their responses based upon how "busy" a given day was. The relative "business" of the day was driven by the caseload and the specifics of what was going on with the patient. Examples include whether a



patient was going to surgery, leaving the floor to have tests, or being admitted or discharged. In the worst case scenario, a day might also be made “busy” by the death of a patient. Combinations of these events could occur at any time, so there was a degree of unpredictability to the day. On busy days, it was not uncommon for nurses to report that they would not chart until the end of their shift, often working overtime to complete the required documentation. As such, the timing of their system use was greatly delayed. We also found that caseload dictated the mode of use in some cases. Even nurses who reported their dislike of the portable computers (COWs, laptops, and tablets) would use them when they needed to be in a patient’s room for an extended period of time, such as when admitting a patient or administering blood tests. An admission, for example, could take anywhere from 45-minutes to an hour and required extensive use of the EMR system as nurses gathered information on the patient’s medical history. The volume of information to be documented at one time made it impossible for nurses to record it all on paper and enter it in the system at a later time – the amount of duplicate charting would have been too time consuming and the process too open to errors of omission. Thus, in these instances, issues specific to their patient dictated the mode of usage, despite the preferences of some nurses toward the stationary, hard-wired computers.

V. CONCLUSION

This study contributes to the IS literature by introducing new dimensions of IS usage, by demonstrating that dimensions of usage can be mandates to varying degrees within the same organization, and also by highlighting that some dimensions of use are more important than others in the realization of organizational goals. We structured our exploration of this phenomenon by using a combined deductive-inductive research method that allowed us to extend existing technology acceptance theory. The data collected for this investigation depicted nurses’ system use as a multi-dimensional phenomenon. Time spent using the system, the timing of use, and the mode of use all emerged as important aspects of use at UHS. Burton-Jones and Straub [2006] argued against the use of “lean” measures of use (such as time spent using the system) and for the use of context-specific measures that place usage within the appropriate nomological net. Although we agree with their assertion that context-specific measures of use should be employed, our findings suggest that lean measures might sometimes be an appropriate choice of measurement. Within the context of this study, time spent using the system was found to be the only usage dimension representative of mandated use, as the other two facets of use (timing and mode) were found to be voluntary. While our findings support Burton-Jones and Straub’s contention that context-specific measures should be used, our findings also suggest that caution should be exercised in the wholesale dismissal of lean measures, as they can sometimes be the most appropriate measurement alternative.

Our findings also suggest that two additional usage measures, timing and mode of use, should be considered in developing future context-specific measures. As previously mentioned, these two aspects of usage were absent from the list of usage measures identified by Burton-Jones and Straub [2006] from the literature. Thus, their identification makes an important theoretical contribution. Although EMR system use was mandated in the sense that documentation responsibilities could only be met via use of the system, UHS allowed nurses to exercise discretion in terms of the timing and mode of usage. These particular dimensions proved to be of great import in understanding the dynamics of usage at UHS, however we do not argue that they will be of primary significance to every organization, nor do we imply that we have provided a definitive list of usage dimensions. We do suggest that timing and mode of use should be included in future work attempting to develop a comprehensive taxonomy of usage. More importantly, though, we hope that our identification of these two dimensions as playing a critical role at UHS underscores the importance of *looking for* the dimensions at play in a given organization. Had we limited our analysis of the data to just nurses' responses regarding the amount of time they spent using the system, insights important to our understanding of IS use would have been lost.

Further, had we ignored the timing and mode of usage, we would not have come to understand that the dimensions of usage can be mandated to differing degrees. To our knowledge, this is the first time this phenomenon has been empirically demonstrated and this finding thus constitutes an important extension to the technology acceptance literature. Technology acceptance research has long been concerned with developing a comprehensive list of the predictors of usage. Indeed, the UTAUT model developed by Venkatesh et al. [2003] and employed in our interview protocol was designed to combine eight different technology acceptance research streams into one integrated model. While research developing new predictors of usage might well be reaching the point of saturation, our findings suggest that there is still much work to be done in understanding the complex and dynamic nature of system usage. Had we limited our analysis of the data to focus only on time estimates of system usage, we would have missed one of the most important insights coming from this study: that technology acceptance constructs can be differentially associated with the different dimensions of system use. We found little evidence that any of the technology acceptance constructs impacted the amount of time nurses spent using the system. Due to the EMR system's integration into the work system, caseload was found to be the primary driver of usage time. Technology acceptance constructs were, however, useful in explaining those usage dimensions that were left to nurses' discretion, namely timing and mode of usage. Consistent with Burton-Jones and Straub [2006], this speaks to the need for researchers to both expand and justify the particular dimensions of use they explore in a given investigation. Further, it supports those who have acknowledged that failure to make the context explicit is a limitation of technology acceptance research [Lee et al., 2003].



Another important insight emerging from this research is the possibility that causal relationships exist among the dimensions of usage. The language used by the nurses implied a causal relationship between the mode and timing of system use constructs. Causal relationships are often theorized among the different dimensions of multidimensional constructs. One IS example of this is Karahanna et al's [2006] development of the IS compatibility construct. In their work, they identified four distinct dimensions of IS compatibility and empirically demonstrated that IS compatibility with values acted as a determinant of the other three compatibility dimensions. In our work, the data suggest such a causal relationship exists between mode and timing of use. Within the context of this research, the mode of usage acted as a determinant of the timing of use in that the type of hardware used (stationary/wired vs. mobile/wireless) drove the timing of use (real time vs. batch data entry). To our knowledge, this is the first time that such a causal relationship between the dimensions of usage has been suggested and strongly suggests the need for future research in this area.

As with all studies, this one is not without its limitations. First, in consideration of space limitations we did not discuss the impact of the moderators associated with the UTAUT model in great detail, although there was some evidence in support of them. Second, although our combined deductive-inductive qualitative approach allowed for an extended analysis of the day-to-day experiences of the nurses, it is limited in its ability to establish the prevalence of any of the relationships found. Future empirical research could further examine the existence and strength of the relationships between the dimensions of system use and individual outcomes such as role conflict and role ambiguity.

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1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
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APPENDIX

UHS Interview Protocol

Observation Protocol

- Observation will be conducted using more than one person
- Observation will be conducted in multiple two-hour increments
- Field notes to be written up immediately following each observation

Interview Questions

General

1. Why do you think the hospital is using this system?
2. How many hours a day do you use the system?
3. How many days a week do you use the system?

Performance Expectancy

Perceived Usefulness

1. How useful do you find the EMR to be in doing your job?
 - Productivity
 - Effectiveness

Job-fit

1. Overall, how helpful do you find the EMR to be in performing your job?
 - Time
 - Quality

Relative Advantage

1. Do you prefer electronic or paper charting? Why?

Outcome Expectations

1. Do your coworkers perceive you as more competent based on your use of the EMR?
2. What's rewarded around here?
 - Promotion
 - Raises

Effort Expectancy

Perceived Ease of Use

1. How easy is the system to use?
 - a. Data entry
 - b. Flexibility
 - c. Distracts from patient care
2. How easy was learning to operate the system?
 - a. How long did it take?
3. Are there any problems with the system?
4. Where do you typically interact with the system?
 - a. Desktop
 - b. COW
 - c. Tablet
5. With a given patient, when do you use the system?
 - a. Where
 - b. How often
6. Do you consider yourself skillful at using the system?

Social Influences

Subjective Norm/Social Factors

1. Which people influence you most in your day to day work?
 - Supervisors
 - Peers
 - Patients
 - Senior Management
2. How do they feel about the system?
3. How do they feel about you using the system?
4. Did you see other people using the system? (observability)

Image

1. Is your use of the system tied to your identity as a nurse/doctor?
 - Reputation
 - Prestige
 - Profile
 - Status symbol

Facilitating Conditions

Perceived Behavioral Control

1. To what extent does this system dictate how you do your job?
2. How has this system altered the way you do your job?
3. Do you have the time necessary to use the system?

Facilitating Conditions

1. What kind of specialized instruction was available to you concerning the system?
2. Is a specific person (or group) available for assistance with system difficulties?

Compatibility

1. How compatible is the system with other aspects of your work?
2. How well does the system fit with the way you like to work?

Moderators

1. Gender
2. Age
3. Experience

- i. How long have you been using the system?
 - ii. How long have you worked at UHS?
 - iii. How long have you been a nurse?
 - iv. How have you used computers in the course of your work/education in the past?
 - v. Do you use PCs at home? How much time do you spend?
4. Voluntariness - Are you required to use the system?

