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Thematic Analysis of CPOE Implementation in Inpatient Settings Using Fit and Subjective Usability in the DeLone Model

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Abstract

Computerized Order Entry Systems (CPOE) are transformational technologies: their successful implementation is a process of change within complex healthcare settings. This paper presents a practical thematic analysis of a sample of the CPOE implementation literature. By using the concepts of subjective usability and fit within the Information System (IS) success model of DeLone and McLean, we show that models can be used to both organize themes and explain the concepts themselves. The DeLone model does not address change, however, therefore we suggest a broader context for the model. This study begins to address Kaplan's concerns about gaps in implementation knowledge of user acceptance and changes in work. It also provides a practical tool for organizing themes for future research. Increasing awareness about the IS implementation context will ultimately improve the safety and effectiveness of these systems.

Keywords:

attitude to computers, Computerized Physician Order Entry System, qualitative research, thematic analysis

Introduction

The healthcare system is a complex adaptive system and successful Computerized Physician Order Entry (CPOE) implementation is a process of transformation within these complex healthcare settings [2]. Success is difficult to measure. One way of assessing success is to apply established models of system implementation success as sources of themes that lead to success or, conversely, failure. Kaplan [1] feels that reviewing implementation is important because it is often ignored, it does not often concern issues of user acceptance or changes in work and finally, it does not examine processes of actual system use during daily activities. We begin to address the gap in the literature identified by Kaplan [1] with a thematic analysis of CPOE system implementation in inpatient settings.

An "efficient technology" is referred to as the one which reinforces current ways of working and performing ongoing tasks, and a "transformational technology" as the one which changes the nature of the work, as differentiated by Sviokla [3]. Physician order entry (POE) systems are transformational technologies [3]. To transform work practices requires an awareness of collaboration in healthcare [4].

The process of implementation of CPOE in an inpatient setting is successful only when the system satisfies the human end-users of the system. Satisfaction is a perception following the implementation of the system in an organizational setting. We examine a sample of the CPOE implementation literature with the concepts of fit and subjective usability within the IS success model of DeLone and McLean (Figure 1) [5]. We hypothesize that successful CPOE implementation means that the system has good fit at the organizational level and satisfaction at the user level as defined by subjective usability. There are several advantages to placing themes in a model: first, this helps to organize themes; second, and conversely, the themes may also begin clarifying the abstract concepts of fit and subjective usability; and third, there is a practical purpose in describing our approach that others might find useful.

Concepts used in this study

Fit. Kaplan describes fit as *"there are a variety of dimensions to 'fit,' including the following: workflow, level of expertise, professional norms, values, institutional setting, communication patterns, organizational culture, technology and information needs. 'Fit,' then, is useful for understanding implementation issues surrounding a particular system, why the same system may be viewed differently by different users, and also why it may be implemented more successfully in one setting than in another. 'Fit' also links evaluation and design."* [6]. We shall apply Kaplan's dimensions to the CPOE implementation literature to categorize organizational themes.

Usability. We use Hornbæk's model of usability as it provides the ISO 9241 standard usability definition as the *"[e]xtent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction [7]."* We shall be concerned with the satisfaction element of usability. Satisfaction is also difficult to measure as there are subjective usability mea-

sures of users' perception of or attitudes towards the interface, the interaction, or the outcome; and, objective measures using standardized instruments [7]. We shall use subjective usability to categorize user satisfaction themes.

DeLone and McLean's IS success model: the link for usability and fit

The IS success model of DeLone and McLean is an established construct for evaluating information system (IS) success as a process of understanding of IS and their impacts. van der Meijden et al. have established the usefulness of this model for system evaluations [7]. They used the 1992 version of the DeLone model. IS success is multidimensional and interdependent [8]. We felt this trait would be helpful for this thematic analysis of implementation of CPOE systems into inpatient settings. We have placed fit within net benefits because this both captures the higher level organizational dimensions of Kaplan and includes the organizational impact element of the 1992 model. Information, system, and service quality are not discussed here. Figure 1 shows the model adapted to show subjective usability and fit.

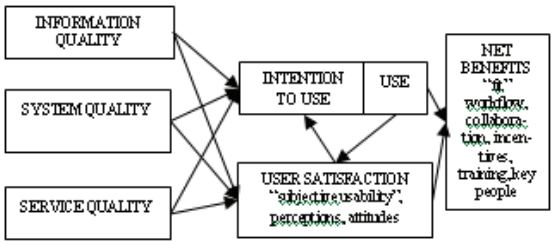

Figure 1 - Adapted from DeLone and Malone's updated D & M IS success model [5]

Methods

Literature Search

We performed a literature search using the terms "CPOE" OR "order entry" OR "e-prescribing" OR "electronic prescribing" or "electronic prescription" OR "computer prescription". This was to provide for the greatest search sensitivity. We interpreted CPOE for the purpose of this study broadly as a clinical information system [9]. The bibliographic databases PubMed. CINAHL, ISI Web of Science, and Compendex, were searched using the above search terms for the period ending November 1, 2005. Later a few articles were found incidentally. A start period was not specified. Since we found that the majority of the articles found in the other databases overlapped with those retrieved from PubMed, we used only the PubMed articles to maintain uniformity in the information and reduce redundancy of information. The bibliographies of the selected articles were not used to find additional references.

Study Criteria

The titles and abstracts of the articles were analyzed against the "inclusion" and "exclusion" criteria (Table 1) to obtain articles for the narrative review. The overall strategy was to review CPOE implementation in general within inpatient settings. A detailed reading of the included articles against the criteria allowed a further reduction in the study set to provide a final set that met the inclusion criteria.

Quality Assessment

The articles were then analyzed for their quality using assessment sheets based on the Critical Appraisal Skills Programme (CASP) appraisal tools [10] (The Quality

Assessment sheets for the selected articles can be provided on request to the authors).

Measure	Inclusion criteria	Exclusion criteria
Population	People: Physicians Inpatients Setting: Acute care	Outpatient, non-MD entry, primary care, ambulatory care, family practice, specific unit for eg. ICU, PICU, NICU
Intervention	CPOE implementation	CPOE specific manufacturers, design costing, cost/benefit, CPOE and: lab IT, radiology Information technology, health information system, decision support system, computerized information system, electronic health record, electronic medical record, guidelines, pharmacy information system, e-prescribing, specific drugs, dose calculators, barcoding
Outcomes	Human factors, usability	Changed behavior, test ordering, save time, benefit, medical error, safety, medication error, workload, nursing roles, education, training
Literature	Study type: evaluation, review, Medinfo proceedings, grey literature, expert opinion/consensus statement with evidence Language: English	Study type: editorial, opinion correspondence, commentary, interview

Table 1: Inclusion and exclusion criteria used for literature review for thematic analysis for CPOE implementation

Thematic anlysis

We undertook a simple qualitative narrative review that was concept-centric rather than an author summary [11]. This process is to identify and bring together the main, recurrent or most important issues or themes arising from a body of literature [12]. This technique was similar to the inductive approach described by Thomas [13]. This will be discussed further below. Nineteen articles met the inclusion criteria.

The quality assessment sheet had a section for themes: any comments or opinions about the CPOE implementation process were placed in this section. The sections were placed in a separate document. Re-reading of the comments and opinions permitted them to be grouped under concrete noun headings such as work, collaboration, barriers etc. Content analysis software was not used.

Results

Thematic analysis

"Fit" is a change of technology and workflow

Fit is a dynamic process [14]. Five articles describe fit as the relationship between technology and work practices or work flow [2, 4, 14, 15, 16, 17]. Fit is achieved through change or transformation of technology and work practices [14]. Some authors see only the technology as transforming work [3, 16], rather than a pure efficiency tool [3]. The organization's track record of making changes in the past influences these transformational changes as CPOE changes committee structures, member ship and accountabilities [17].

Encourage change: collaboration. This awareness can be fostered by educating all members of the healthcare team on the activities of other group members, so that each person understands what others do [16]. People work collaboratively when using clinical information systems and not recognizing this is a source of implementation failure [16]. Collaboration must also happen between administration and clinicians [18]. There must also be collaboration between problem solvers meeting regularly with users to work out procedural issues that cross boundaries [19].

Encourage change: training and support. Training and support are important tools to help staff change and accept CPOE. There must be extensive 24/7 support and a formalized training program before, during, and after implementation [18, 19, 20, 21]. Support must focus on problem solving to improve the system [19]. Problems will occur; they will be solved only if people focus upon how to make the system work better instead of being diverted by the question of whether the institution should be implementing CPOE [19]. Clinicians need to be educated about the potential long-term benefits of CPOE and remain open to the possibility of changes in their workflow [22].

Encourage change: incentives. These can include paid release-time fees to physicians to compensate them for time spent outside their clinical and administrative duties [16]. Incentive structures can also exist at the institutional level such as better access to care, better quality of care, lower cost of healthcare, lower administrative costs, improved patient management, and improved physician training incentives must be created to motivate each user

to adopt new medical technology [16]. Park et al. have attributed the high availability of CPOE systems to a combination of governmental encouragement, efforts and financial incentives and cultural characteristics in their study [23].

Encourage change: key people. Key people are identified as having universal attributes, including stability through adversity, steadfastness, initiative, and toughness [16]. These include: clinicians, top leadership, chiefs of staff, CEO, advisory groups, problem solvers [19, 21, 24, 25].

User Satisfaction is experienced as efficiency

Mekhjian et al. mention that they did not experience any significant negative results from CPOE implementation [21] though, others have experienced the opposite [22]. User satisfaction is increased when there is supportive administration and supportive heads of medical sections, direct involvement of physicians, mandatory implementation, adequate training, and sufficient hardware [25]. People who have *already changed and committed to a change* (emphasis added) focus more on issues surrounding actual implementation whereas those still contemplating the change are more concerned with the pros and cons [25].

The strongest correlates of CPOE satisfaction in the literature were efficiency characteristics such as productivity, ease of use, and speed. Van der Meijden et al. have a similar finding with a different reference set [8]: only our [4] was also discussed. The characteristics of CPOE that played a more significant role in changing the way the physicians made decisions about orders, such as reducing error and giving needed information were weaker correlates of satisfaction. In other words, although the technology itself was transformational, and patients and the hospital benefited substantively from improved quality and reduced costs, the users' satisfaction of the technology was primarily predicted by efficiency concerns [16, 21, 26]. Murff et al. suggest that the feedback of the physician's regarding satisfaction with the usage of information systems should be sought continuously and conclude that user satisfaction is a vital marker for usability of any information system [26].

Discussion

We reviewed a sample of the CPOE implementation literature that is based on inpatient settings use rather than experimental settings. The settings include the US, Holland and Korea. This points to the themes of CPOE implementation which cross boundaries. We see from the literature that fit is a key concept. Successful implementation means a good fit of technology and work practices. The literature suggests that change is necessary to achieve a good fit: some of the enablers of change are collaboration, training, support and incentives. These terms also help to define what fit is. User satisfaction also leads to fit. The users, primarily physicians in our literature, feel more efficient and are satisfied as a result.

Our thematic analysis showed that users who have changed focus on implementation and that there are enablers of change to enhance fit. The implementation process has been described as a "transformation" [2].The DeLone model does not address change. For convenience, we have placed the enablers of change within the context of organizational net benefit.

The difficulty in accommodating change into the DeLone model suggests that the DeLone model needs a broader context. Van der Meijden et al. state that the multidimensional construct of the model is appropriate for system evaluations [8]; however, change and transformation must also be captured.

Orlikowski and colleagues [27] discuss the implementation as change in a tripartite model (Figure 2): "first, the changes associated with technology implementation constitute an ongoing process rather than an event with an end point after which the organization can expect to return to a reasonably steady state; second, all the technological and organizational changes made during the ongoing process cannot, by definition, be anticipated ahead of time." They identify three types of change: *anticipated* or planned change; *emergent* or spontaneous change from local innovation; and *opportunity-based* or intentional change in response to an unexpected opportunity, event, or breakdown. The three parts of this model are interdependent.

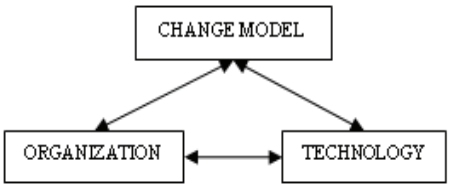

Figure 2 - Adapted from Orlikowski et al. [27; figure 3]

There is technology, or in our case, the CPOE system as described by the Delone model; the organizational context (culture, structure, roles and responsibilities); and the change model used to manage the three types of change listed above. The interaction among the three parts should be harmonious. Management can determine either a change model that is rigid with each step predefined and controlling events to fit the plan or flexible and responsive. This would require an explicit, ongoing examination and adjustment, where and when necessary, of the technology

and the organization [27]. In other words, there is constant change and feedback reacting with the system as our themes suggest.

Change and other themes could have been examined with a more rigorous method such as a general inductive approach [13]. This method uses detailed readings of raw data to derive concepts, themes, or a model through interpretations made from the raw data [13]. It is a tool used to describe the actual program effects, not just planned effects. The identification of any significant unplanned or unanticipated effects or side effects arising from program implementation can be seen as an important evaluation task [12]. The premise of evaluating effects in a structured manner would be very useful for implementation.

The outcome of an inductive analysis is the development of categories into a model or framework that summarizes the raw data and conveys key themes and processes. The category may also be linked to other categories in various relationships, such as a network, a hierarchy of categories, or a causal sequence [13]. This method is used to create models that might even show causation between satisfaction/efficiency and fit. For example, CPOE related adverse events [28] could be seen as a breakdown subjective usability and/or fit. It could also be used to examine the types of change identified by Orlikowski and colleagues [27].

Our method used an existing model, the DeLone and McLean's Information System (IS) success model to group themes, rather than creating a new model as in inductive analysis. This method is also useful to begin clarifying the concepts of subjective usability and fit themselves. This is a useful first step. Kaplan believes that because implementation is often ignored: implementation issues and barriers to system use are little different today from what has been reported over the past 50 years. This may be partly because post-implementation system evaluations often ignore issues concerning user acceptance or changes in work [1]. We find that there are limitations to the DeLone model because the change aspects identified in the literature and by Kaplan above are not easily accommodated in the model. We suggest the DeLone model addressing technology or systems be placed within a wider context of change model and organization. This would mean placing the DeLone IS success model in the "technology" construct of Orlikowski's model shown in
Figure 2.

Conclusion

We have addressed Kaplan's concern about user acceptance and changes in work by using subjective usability (user satisfaction) and fit respectively. We have used a sample of international CPOE implementation literature to find and organize some themes describing these concepts within an IS success model. Although the IS success model is useful for thematic analysis, more rigorous techniques of thematic analysis and a broader context for the IS model are needed to capture the transformational impact of implementation.

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