# INFORMATION TECHNOLOGY IMPLEMENTATION:

# WHAT WORKS AND WHAT DOES NOT

By

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To my beloved and infinitely supportive husband, Alexander

and

to my mother, Ludmila Morozjuk and Grandmother Irena Mikheeva

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# CHAPTER I

## INTRODUCTION

It is a necessity, not an option, for organizations to continuously adopt new information technologies (IT) if they want to sustain competitiveness and improve productivity in current markets (Dewett and Jones, 2001; Grover et al., 1998; Ives and Learmonth, 1984; Lucas and Baroudi, 1994; Porter and Millar, 1985). Attempts at implementing information technologies have resulted in widespread failures because of: behavioral problems involving users, organizational characteristics and, as well as technological features of a particular technology (Alavi and Joachimsthaler, 1992; Davis et al., 1992; Edmondson et al., 2001; Ewusi-Mensah and Przasnyski, 1991; Keil, 1995; Kumar et al., 1998; McCauley and Ala, 1992). Implementation of Information Systems (IS) has long been a topic of great interest and still is one of the major challenges facing the IS field (Larsen, 2003; Marble, 2000; Moore and Benbasat, 1991).

This tenet leads to the research question: *How and at what point do: organizational, user, project and technology factors affect the IS implementation outcome?*

The Kwon and Zmud's (1987) six-stage model of Information Technology (IT) implementation was used as a framework for the model to study the process of IS implementation (Cooper and Zmud, 1990). We reviewed prior research on IS implementation and identified specific organizational, individual, technology, project contextual factors that previous research on IS implementation demonstrated to have an influence on the successful IS implementation outcome (Larsen, 2003).

In the qualitative part of our study, we collected data in a field study of the computerized Clinic Documentation System (CDS) implementation in an ambulatory neurology clinic of a

large teaching hospital. The case of CDS implementation in a healthcare organization was an exemplary subject to study what factors may contribute to the system acceptance or rejection by users because healthcare organizations are among the least experienced in applying computer technologies to improve its practices (Raghupathi and Tan, 1999; Bates, 2002). As a result, they continue to experience multiple problems with their implementation of these technologies, ranging from the cost increase associated with the troubled projects, to making users and developers skeptical about whether computer technologies can substitute already established practices (Connolly, 2005).

Quantitative and qualitative approaches were used to collect data for the study. Participants were initially surveyed and these data were analyzed by non-parametric statistical test as well as calculating the means for the responses. Next all participants were interviewed and qualitative. Based on the results of the study we found that the implementation is not merely a technology deployment but most importantly an organizational change. This study supports prior research findings that organization context do has an influence on the IS acceptance by users. Such factors as organizational climate, work group characteristics, job characteristics and technology context of the organization affects user's ability and motivation to successfully adopt and use new IS. A careful evaluation of the organizational context must be completed during the initiation of the IS implementation before embarking on an actual system implementation. It is also important to analyze user characteristics: attitude toward computers and innovation, computer experience, and employment history with the organization. As implementation translates into the next stage - adoption phase, management commitment, user's commitment to the change, and proactive project championship are necessary attributes of a successful implementation project. When commitment is present, the sufficient resources are allocated to

the project and users' get involved. For the adaptation stage we found that a plan that elicits every participant feedback, address strategies of how users will be supported, motivated, rewarded, as well as how current practices will be restructured to best fit the use of new technology are paramount to the successful implementation. Management support at this stage was shown to be an integral element to keep users dedicated to reshaping the organization context to facilitate successful implementation. Finally, for the acceptance stage, users framed their final acceptance decision based on the characteristics of technology, how well it fits their workflow, and whether it gives relative advantage compared to the old system. If users are satisfied with its quality and information, and if it affects their environment in a positive way, then users become committed and willing to work with the new system. Two factors were identified by the study as important for inclusion in the proposed model: shared vision for the objectives of the IS implementation and proactive championship of the project.

A number of factors were found to be less explanatory of the IS acceptance by users. These are IS department power, computer literacy, project uncertainty, education about the project, technology trialability, personal innovativeness, facilitating conditions, and technology results demonstrability. The results of the study not only add to the literature on IS implementation by providing a comprehensive model that incorporates critical factors for the successful IS implementation outcome, but also helps to guide implementers through the process of IS implementation and emphasizing their attention to the aspects of organizational, user, technology and project environment that have to be accounted for during before and during the IS implementation.

The study is organized as follows. The next section develops the research model and explains why the Kwon and Zmud's (1987) staged model of the IT implementation activities

was used as a foundation for the proposed model. A detailed description of each of the stages and an introduction to specific factors and concepts that are theorized to have an importance at a particular stage are presented in the following section. The process of identifying factors for model inclusion was guided by the Kwon and Zmud's (1987) definition of each stage and what key activities take place during each phase (Cooper and Zmud, 1990). Case analysis methods and techniques used to test the model are described next. Case study results are then presented and the study concludes with the discussion of theoretical and practical implications.

# CHAPTER II

# INFORMATION SYSTEM IMPLEMENTATION

## IS Implementation

Implementation is a critical gateway between the decision to adopt innovation and the routine use of the innovation within an organization (Klein and Sorra, 1996). For implementation to be a success, the application should be no longer perceived as something new, and the "targeted employees use a given innovation consistently and well" (Klein and Sorra, 1996). To understand what are the important steps that take place during this critical gateway, and to know what issues should be raised and resolved throughout implementation process, would allow for better control over the outcome of IS implementation, thus increasing odds of success of the innovation.

## IS Implementation in the Health Care Organizations

Implementing IS successfully is especially important in health care organizations (HCO). The use of IT in healthcare is ten to fifteen years behind such industries as banking, manufacturing, and the airline industry (Raghupathi and Tan, 1999). However, today the health care delivery industry is on the verge of applying various information technologies to assist with everyday activities (Healthcare Information and Management Systems Society, 2003). This change is characterized by a highly competitive environment in which HCO find themselves and the hope is that new technologies will increase efficiency, reduce costs, reengineer work processes, and most importantly improve quality of care (Pare and Elam, 1995, McDonald,

1997). As IT starts to penetrate more departments and business functions of the HCO, IT spending also increases. In 2004, for instance, aggregated US provider and payer healthcare information and communication technology spending was around $26 billion in 2004 and estimated to grow over $34 billion by 2008 as estimated by Datamonitor group in the report "US healthcare ICT spending opportunities," (Datamonitor, 2004). Further growth is expected, as in 2004, President G.W. Bush called on doctors and hospitals to move their medical records from paper to electronic files, and set an agenda for the Department of Health and Human Services on the process of automating medical records within ten years (Brailer, 2004; Fletcher, 2005).

**Healthcare IS Technologies**

Having Electronic Medical Records (EMR) will influence various aspects of health care activities. The challenge is not only to design systems that will integrate a range of technologies to support execution of diverse array of tasks such as scheduling, communication, clinic documentation systems, labs management, reporting, databases (McDonald, 1997), but also to make them fit and be used by a number of different user group – administrators, physicians, nurses, ancillary services specialists from areas such as labs, radiology, pharmacy, materials management, etc. Among the technologies that are going to facilitate transition to an EMR, computerized Clinical Documentation Systems (CDS) are especially important. CDS are designed to replace written or dictated notes that physicians, nurses, and other healthcare specialists generate and use to report their findings and document procedures. The value of CDS to HCO is high, because these systems have the potential to assist caregivers in decision making by enhanced reporting that is more complete, has less errors and thus may improve quality of

patient care, reduce insurance denials, and accelerate reimbursement for the care delivered (Retchin and Wenzel, 1999).

However, developing and implementing CDS may bring its additional problems to health care organizations (HCO). Since the process of patient care may involve multidisciplinary teams, the findings in the field of IS research may not account for some of the specifics of the healthcare setting. For example, a treatment process of a patient who suffers from epilepsy would involve a primary care provider, a neurology specialist, possibly a neurology surgeon if operation is required, a radiologist that performs and gives an impression of the image studies as well as a nurse personal that assists during the treatment period. All of these individuals have unique needs that a new system has to account for. Next, the introduction of these computer tools can mean that users will have to either possess or develop a completely new dimension of computer skills and attitudes towards using technologies. CDS may change how and what information is captured, shared, and stored in databases. In addition, it may force health care providers to interact with each other in a manner that is not customary. Therefore, finding implementation methods that reduce disruption to established practices, without jeopardizing the value of new technologies, is becoming an important priority to health care organizations.

**Motivation for the IS Implementation Model Development**

While the topic of IS implementation success has been the focal point of a considerable research, the literature varies regarding how to study implementation process and what variables are necessary for implementation success, or are responsible for its failure (Larsen, 2003). The process of change has been identified as a general approach when studying the IS implementation phenomena (Ginzberg, 1981). Researchers have studied the implementation of

the new systems as a process of change with a general conclusion that implementation can succeed if it falls into the model of change (Ginzberg, 1981). Among the most prominent models that look at implementation as a process of change are Lewin (1952), Kolb and Frohman (1970), Kwon and Zmud (1987), Roger(1995), Joshi (1991).

Another area of IS research consists of theories, models that are more oriented towards the content of IS implementation and use. This research stream produced an assortment of factors that seem to influence IS acceptance and utilization through study of *IS Success*, *IS Effectiveness* and *User Satisfaction* (Bailey and Pearson, 1983; Delone and McLean, 1992; Seddon, 1997; Moore and Benbasa, 1991). In addition, a number of models and theories of individual acceptance have been developed. They are listed in Table 1 below.

**Table 1: Models and Theories on Individual IS Acceptance**

| Model | Author/Adopter | Description |
|---|---|---|
| *Theory of Reasoned Action* | Azjen 1975 | Explains individual's intention to adopt technology |
| *Theory of Planned Behavior* | Azjen 1975 | Is used to predict intention and behavior of individual acceptance and usage of technology |
| *Technology Acceptance Model* | Davis 1989 | Helps to predict user intention to accept IS |
| *Model of PC Utilization* | Thompson et al. 1991 | Used to predict usage rather then intention |
| *Motivational Model* | Davis 1992 | Has been used to study the nature of motivation that explains user behavior towards technology |
| *Social Cognitive Theory* | Bandura 1986; Compeu and Higgins 1995 | Studies how outcome expectations, self-efficacy expectations guide individual behavior in the context of adopting technology |
| *Innovation Diffusion Theory* | Rogers 1995 | Postulates that characteristics of adopters and innovation have an influence on the spread of innovation |
| *Task Technology Fit Model* | Goodhue 1995 | Showed that success of adopting technology may be explained by compatibility of its characteristics with the characteristics of the task |

These models provide an important theoretical foundation for studying how various users, and technological and environmental influences, can predict, explain and determine the use of IS. However, due to its rich content and various research approaches taken, this part of the IS research has been challenging to describe (Benbasat and Zmud, 1999). Merging the factor research and the process research streams and applying a combined vision to study the IS implementation permits my research to address broad issues that an IS implementation process might have and allows for consideration of more specific factors that are crucial throughout the course of implementation.

Our work creates an encompassing framework for studying the implementation process by building on the results of research in IS. First, a number of models that explain process of implementation were reviewed to identify which ones would provide "capabilities to more throughout examine the dynamics of individual, organizational, and technological adaptations during implementation" (Cooper and Zmud, 1990). Next, to enrich the model that was selected as a framework, a set of constructs were identified from prior research on IS Success, IS effectiveness (Bailey and Pearson, 1983; DeLone and McLean, 1992; Seddon, 1997; Moore and Benbasat, 1991) and theories of individual acceptance that explain IS usage (see Table 1).

**IS Implementation Model Description**

The six-stage model of IT implementation developed by Kwon and Zmud (1987) was selected to serve as a foundation because it allows to comprehensively explore the process of IS implementation. Any implementation has to be accepted by the target users in order to be a success is. Therefore, this study intent is to explore the implementation process to the point when routine use of the innovation should occur within an organization. Thus, only the first four

phases out of Kwon and Zmud's (1987) six-stage model are adopted and examined in this study. They are: 1) initiation, 2) adoption, 3) adaptation, and 4) acceptance.

There are several reasons that justify the use of the Kwon and Zmud (1987) stage model as a framework for studying process of implementing new technology. First, this model is based on the Lewin's (1952) change model (Cooper and Zmud, 1990). The Lewin's view on the change process made many researchers recognize "system implementation as a change process and system designers as a change agents" as noted by Ginzberg (1979) and Zmud and Cox (1979). Therefore, the model that reflects on the change process would be appropriate for describing the organizational change associated with introducing new technology. Next, this model incorporates innovation and diffusion literature philosophy. Diffusion of innovation literature states that the diffusion of innovation does not happen at once, but rather, it happens over an extended period of time that begins with learning about the technology, adapting to it and the new procedures that are enforced with its introduction. It ends successfully only after all benefits are realized and organization effectiveness increases as a consequence of using it (Rogers, 1995). Kwon and Zmud's (1987) IT implementation model supports this view of innovation diffusion by containing a sequence of stages, where each stage is composed of a number of activities that take place during implementation (Cooper and Zmud, 1990).

A number of other researchers (Cooper and Zmud, 1990; Premkumar et al., 1994; Rajagopal, 2002) used this six-stage model and its variation as their framework to analyze technology implementations process. Cooper and Zmud (1990) looked at the adoption and infusion stage of this model to examine the implementation of a Material Requirement Planning (MRP) information system. Premkumar et al. (1994) described the model as one that "essentially captures the organizational learning process where adopters go over the learning curve,

understand the potential of the innovation, identify and develop sophisticated uses for innovation, modify their work practices to suit innovation, and develop suitable organizational control procedures to manage the innovation and new work environment." Studying the technology implementation through the stages may significantly enhance an understanding of this process and allow us to explore the impact of multiple contextual factors at multiple implementation stages (Cooper and Zmud, 1990). Therefore, to expand the limited prospective on IS implementation, our research adopts the multi-stage view of IS implementation.

Kwon and Zmud (1987) identified five major contextual categories of factors that have impact on technology: user community, organization, technology, task, and organizational environment. They also stated that these factors would be associated with each stage of implementation (Cooper and Zmud, 1990), but they did not emphasize at what stage in particular they are most significant. Cooper and Zmud (1990) studied the influence only of compatibility and task fit factors at adoption and infusion stages and suggested, "Adopting a comprehensive research framework that would allow to examine a set of constructs from this framework a substantial progress can be made in prescribing which issues should dominate for each of the IT implementation stage (p. 136)". Therefore, our study assigns factors to the particular implementation stage, to investigate what impact they possess during the particular implementation stage on the IS implementation outcome.

Figure 1 below presents our model of IS Implementation. In this model, a set of factors that describe organizational, user, and technology and project context are assigned to specific phases of the implementation process according to their level of importance. These factors represent aspects that need to be addressed at the particular phase of the implementation process. It is important to note, that while some factors may be relevant to more than one stage of the

implementation, they were assigned to a specific phase according to how significant they are expected to be at that particular phase of the implementation. In the next section of the paper, each stage of the model is discussed and rationale for why specific constructs were added is given.

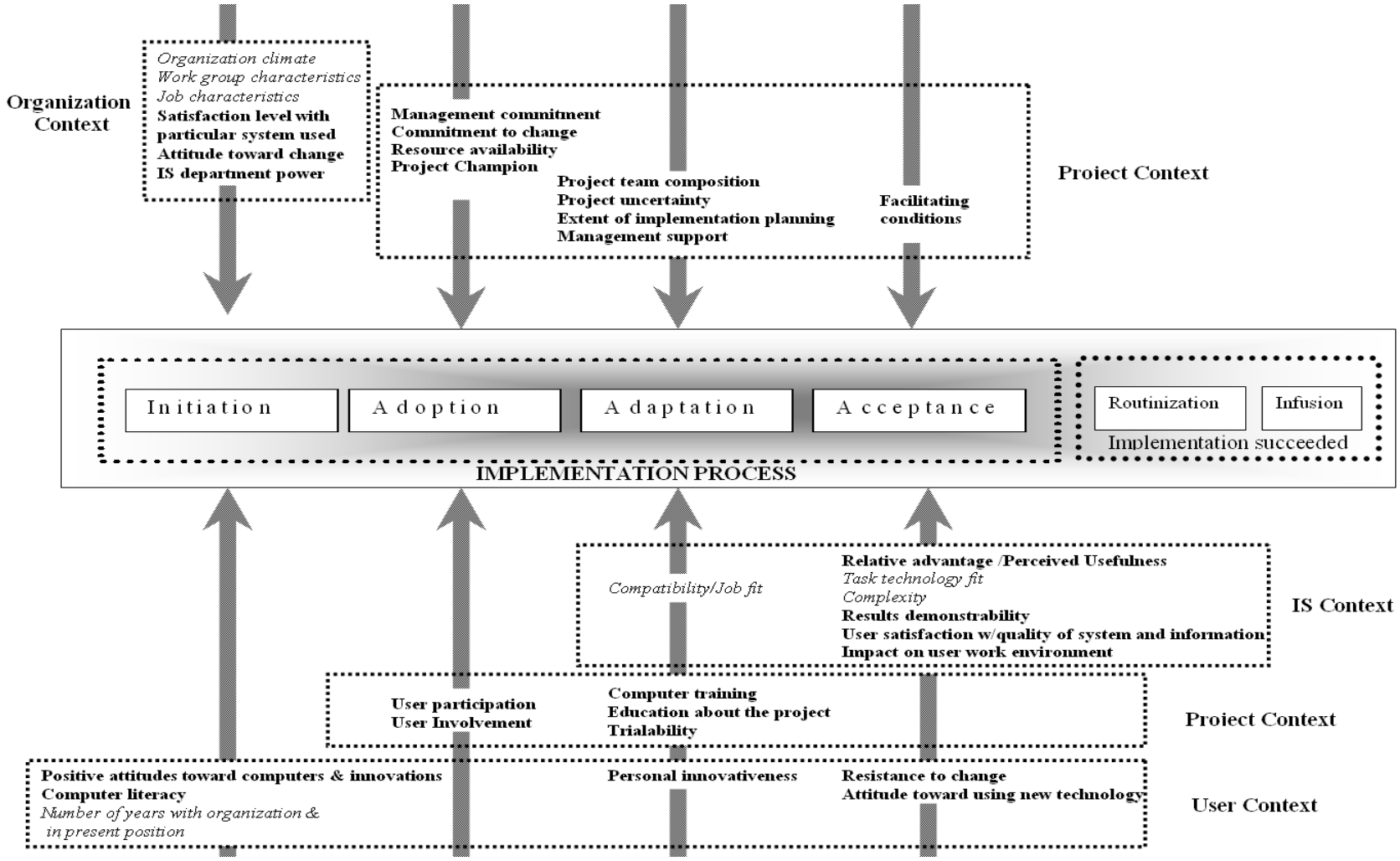


**Figure 4: IS Implementation Model**

***Initiation Stage***

Initiation phase is the first phase of the implementation process. During this phase, through examination by the organization uncovers a problem or an opportunity for improvement (Cooper and Zmud, 1990). Whether the demand for change comes from an organizational need, technological innovation push, or both, the major emphasis of this phase is to fully understand organization's internal and external settings. Through the analysis of organizational context and user context, an implementer will ensure that there will be a strong match between the innovation and its possible application in the organization. The variables that we believe have to be considered at the initiation phase are described next.

While identifying possible opportunities for improvement, it is important for an organization to fully understand the internal and external settings in which it operates. Among the contextual factors that Kwon and Zmud (1987) identified as important to consider are characteristics of the user community (job tenure, education, resistance to change), characteristics of the organization (specialization, centralization, and formalization), characteristics of the task (task uncertainty, autonomy, and responsibility of person performing the task, task variety), and characteristics of the organizational environment (uncertainty, inter-organizational dependence). Reviewing past research on individual adjustment to information technologies, Nelson (1990) also suggested incorporating factors that describe organizational, work group and job characteristics when analyzing IT acceptance by users. Understanding of personal and situational factors, as well as the environment where the new system is to be introduced, at the beginning of the implementation project would help managers create an environment that is conductive to implementation. Different from Kwon and Zmud (1987) we recommend that addressing organization and user characteristics most heavily at the very first

stage would yield the most success of an implementation. Next, we will describe what these factors constitute and why previous research pointed them out as an important to IS implementation.

*Organizational climate* (Nelson, 1990) can be defined through organizational politics, institutional leadership, confidence of employees with their management, the reward systems, and organization size and goals. There are no organizations that would possess identical organizational environments, simply because they would have different people working for them. Thus, a deeper understanding of an organization's climate would aid in shaping the right implementation plan and creating a conductive environment for implementation.

Investigating what the unique *characteristics of the work group* are, such as the nature of collaboration among workers, job tenure (Nelson, 1990) and education, (Kwon and Zmud, 1987) would help to shape an implementation process that would best fit the group. For instance, it was shown that if groups are collaborative in the way they interact, it is easier to encourage innovative behavior among them (Nelson, 1990).

Careful consideration of the current *job characteristics* (Nelson 1990), or as Kwon and Zmud (1987) name it *characteristics of the task* that include the level of autonomy, control over work quality, and responsibility for the outcome, would give better guidance toward what job changes may occur due to the new IS implementation, and would help managers to prepare users for changes as well as anticipate possible source of resistance later in the implementation (Nelson, 1990)

Before embarking on a change, managers should analyze what concerns target users have with systems and procedures already in place. Understanding satisfaction level with *particular system already in use* (Goodhue, 1995; Chau and Tam, 1997) would facilitate the understanding

of required attributes in the new system. Thus, adding this factor into the initiation stage of the model would help assess whether a new change can resolve a present problem. A low satisfaction level with existing system generally referred to as performance gap, will provide the impetus to find ways to improve performance (Roger, 1983). Failure to take into the level of user satisfaction with the existing systems may result in an inadequate assessment of the situation, the framing of a wrong solution and that can result in ineffective implementation.

As soon as the organizational problem is identified, and an understanding as to why the change should be made is reached, users start to frame their *attitude toward the change* (Davis et al., 1989b; Taylor and Todd, 1995b; Ginsberg, 1981a). We include attitude toward the change in the initiation stage because knowing whether a users' attitude towards the change is negative or positive can give a strategic advantage to the implementers. This attitude can be later accounted for as implementation plan is developed.

The assessment of the *computer literacy* of targeted users is also significant to consider during initiation stage, thus it is added here as well. Reviewing what exposure to various technologies the users had in the past, and how confident they are in their computer capabilities, can help define what additional computing support or computer training should be provided (Hiltz and Johnson, 1990; Johnson et al., 1998). It was shown that users with more intense computer background were prone to experience higher level of satisfaction with and appreciation of new IS (Montazemi, 1988). Also, knowing the *users' attitude toward computers and innovations* can give an extra key to successful implementation as it would help to recognize how users will feel about the new system (Webster and Martoocchino, 1992; Hiltz and Johnson, 1990).

One more candidate for inclusion into the initiation stage of this model is *IS department power and its direction* (Ein-Dor and Segev, 1982; Hunton and Price, 1997). The implementation process outcome may vary depending on the level of IS department involvement in the decision to adopt the IS. For instance, if a particular technology is important to the organization, then the IS department can allocate required resources necessary to success.

In summary, during the initiation stage, an organization identifies an opportunity for change and evaluates specific IS solution to engage in. However no commitment from either potential users or the IS department is made during initiation stage.

***Adoption Stage***

The main intent of the adoption stage is to ensure organizational backing. This is usually reached through negotiations that aim at achieving the decision necessary for sufficient resources to be available for the implementation effort (Cooper and Zmud, 1990).

To increase the odds of successful implementation, it is crucial to gain early support from key participants including potential IS users and their management. Research suggests that *user involvement* increases user IS acceptance (Baronas and Louis, 1988; Ives and Olsen 1984; Lucas, 1978; Mann and Watson, 1984; Markus, 1983). Over the course of the implementation, the adoption stage is when the process of buy-in from the key participants begins. This is because the introduction of an IS typically means that employees who are targeted to be system users as well as mangers will need to go through a period of significant changes. Baronas and Louis (1988) noted that implementation of a new system is likely to represent a threat to user's perceptions of how much control they have over their work. They propose that developers and those who implement the system should involve users in the implementation process.

Hartwick and Barki (1994) made a distinction between user participation and user involvement. They suggest that the term "user participation" be used instead of "user involvement" when describing users behaviors, and activities that are performed during the system development process. The term "user involvement" is used to refer to a psychological state of the individual, which is defined as the importance and personal relevance of a system to a user. When users view the system as being good, important, and personally relevant to them they are more prone to be engaged in the participative activities (Hartwick and Barki, 1994).

The *user participation* is integral in the implementation process that it is almost plays the role of catalyst in the implementation reaction. Implementation of the new technology often poses a threat to the users sense of control because of the change that implementation brings. However, by getting users to participate in the decision making process, and building ownership by making users accountable for results on the tasks necessary for the implementation to succeed, may lessen user's feeling of uncertainty.

McKean et. al., (1994) emphasized the influence of user participation on the user satisfaction with IS. The strength of participation-satisfaction relationship was investigated by looking at the effects of four contingency factors - task complexity, system complexity, user influence, and user developer communication. It was concluded that the more the task is unstructured or ambiguous, and the more complex the system, the more essential the user's participation is in user satisfaction and consequently to system success (McKeen et. al., 1994). Therefore, placing *user involvement* and *user participation* into the adoption phase of the implementation model gives a tactical lead to the implementers at establishing strategies that would first seize user involvement and then transform it into active user participation throughout

implementation process, thus ensure full backing for implementation from those who might potentially resist the project.

User participation does not happen on its own; management plays a critical role in facilitating and influencing user's participation in the implementation (Hartwick and Barki, 1994). Previous studies have recognized management support as one of the key reoccurring factors affecting system success (Ewusi-Mensah and Przasnyski, 1991; Ginsberg, 1981a; Gottschalk, 1999; Jarvenpaa and Ives, 1991; Marble, 2003). Management that can ensure sufficient resources to the implementation effort, that is willing to accept risks, and that acts as a change agent to create more conducting environment through encouraging and promoting IS use, is associated with greater system success. The lack of management commitment can become a serious barrier that can hinder a successful outcome of IS implementation (Ginsberg, 1981b). Gaining the *management commitment to the IS implementation project* translates into taking all necessary actions to assure that the new system is a good one, and also provides a solution to the organization's problem. Gaining management commitment also increases the odds that appropriate actions will take place at each stage of the implementation (Ginsberg, 1981b).

Another commitment concern is *commitment to the change*. An organization where its members are unwilling to accommodate to the change is unlikely to have a successful implementation (Ginsberg, 1981b). Both commitment to the project and commitment to the change requires attention from management and users. Securing management commitment and support right after the decision is made to proceed with the change is the objective of the adoption phase. It is logical to do this earlier in the implementation process, because management that is not committed and does not believe that system is good one will do a poor job of securing necessary resources to satisfy the implementation demand. Similarly, users who

are reluctant to make the changes in behavior and work procedures will not create a setting that is necessary for the new system to work (Ginsberg, 1981b).

The *allocation of sufficient resources* has been sited as affecting IS success (Ein-Dor and Segev, 1978; Iacovou et al, 1995; Marble, 2003). Whether a particular project has enough resources or not is a direct result of how committed and supportive management and the organization are, and therefore an allowance needs to be made for this stage as well. Types of resources that are common to support implementation effort are personnel, equipment, time, and implementer's skills. However, the project must not only have sufficient resources but also the quality of the resources needs to be adequate to assure that the needs of implementation effort are met. The quality of resources that put forward implementation such as technical support, assistance, quality of staff highly correlates with the user satisfaction during the implementation (Essex et al., 1998).

One more factor that was shown to have a positive effect on the implementation success and thus included in the model is *project champion presence*. A champion is an individual in the organization that has a previous experience with the technology; possesses a great level of confidence in the new system and its potential benefits; and is enthusiastic about the technology and change it represents (Beath, 1991). The champion can be an opinion leader and change agent that inspires others to adopt innovation and accept the change. It has been show that having a champion is a key to successful implementation (Beath, 1991). This leads us to argue that adoption phase represent exact time when the project champion should come on board of the implementation.

In the adoption phase of the project, it is necessary to lock-in user interest in the new system as. Getting users involved in the decision-making, and creating an environment where

they are encouraged and are given opportunities to be active participants, will help to build project ownership and help gain support from those who otherwise can resist the change. At the same time committed management will emphasize organization interest in the new IS, devote time, establish an environment benevolent to the change, and finally, make certain that proper resources are available.

Even though, the constructs that were added to the adoption stage of the model above were recognized by prior research as crucial to consider throughout the implementation process, they were not specifically assigned to a particular order of concern in the implementation process. Therefore, by identifying these factors and assigning them to the adoption phase we extend Kwon and Zmud (1987) model of IT implementation.

### *Adaptation Stage*

The next stage of the implementation progression is adaptation. During this phase, organizational procedures are revised and new business processes are introduced. Therefore, current practices need to be well understood and new ones need to be structured in a way that will exploit the full potential of the new technology. First, the required changes that facilitate appropriate use of technology need to be established and then users need to be trained both in new procedures and in the IT application. The outcome of this phase is that new application becomes available for full use in the organization (Cooper and Zmud, 1990).

The emphasis of this stage is on preparing the organization and its users for the use of the new system. This is a time when management commitment to the project, users' involvement and user participation established during the adoption phase, needs to be effectively utilized. To do so, the implementation project should be carefully planned. Cooper and Zmud (1990)

summarized that issues associated with managing the project are often addressed during the adaptation stage. We add to the model by including a number of factors that are significant to organizing the implementation effort: *extent of project definition and planning* (Ginzberg 1981b), *project uncertainty* (Nidumolu, 1995), and *implementation team composition* (Baronas and Louis, 1988).

In identifying issues in the IS implementation, Ginsberg (1981) demonstrated that *the extent of project definition and planning* are factors that should be viewed as a placing demand on both management and users. Having a project plan will decrease *project uncertainty* (Nidumolu, 1995) by assessing organizational needs, system fit into work practices, training requirements, evaluation criteria and specifying the roles of project team members. "The more thorough the planning effort, the less likely are unforeseen circumstances which could endanger the project" (Ginzberg, 1981b). Developing a comprehensive implementation plan with strategies and tactics helps to direct and utilize users' participation and management support to the fullest potential.

To carry out the implementation plan, an *implementation team* should be comprised of members with the right skill-sets and knowledge-sets within the interpersonal, computer systems, and organizational areas (Baronas and Louis, 1988). The skills and experience of the implementation team as well as ability to build strong relationship between the user and the provider of the new IS represents a significant factor in the success of failure of an implementation effort (Bailey and Pearson, 1983; Baronas and Louis, 1988) and thus needs to be added to the model.

With every new technological adaptation there is a period of adjustment and change of a new system within a given organizational setting (Hong and Kim, 2002). The more compatible

the innovation with the existing values, past experience, and needs of adopters, the more likely it is to be adopted (Agarwal and Prasad, 1997; Cooper and Zmud, 1990; Hong and Kim 2002; Moore and Benbasat, 1991; Rogers 1983; Taylor and Todd, 1995). Moore and Benbasat (1991) confirmed *compatibility* to be a good predictor of usage behavior.

Similar to compatibility, the concept of *job fit* which describes the extent to which innovation is compatible with individual's job responsibilities, is capable of supporting one's tasks and the extent to which users believe that the system can increase performance of his or her job (Davis et al. 1989; Tompson et al., 1991; Tornatzky and Klein, 1982). Cooper and Zmud (1990) concluded that compatibility is a factor affecting adoption. However, we expect that since adaptation stage is where the users start to learn about new technology characteristics and functionalities, they will gain a better understanding of how compatible the technology is with their tasks and workflow content during this stage. Therefore, we add this construct to the adaptation stage of the model, which differs from Cooper and Zmud (1990) view.

An interesting result of the Agarwal and Prasad (1998) study suggests that user perception can play a different role in information technology adoption for different individuals. It was found that *personal innovativeness* positively moderates the relationship between the perception of compatibility and the decision to adopt an innovation (Agarwal and Prasad, 1998). More innovative individuals may develop stronger intention to use the innovation at the same level of perceived complexity and congruence with work style as a less innovative individual. Thus knowing the level of users' personal innovativeness management can create a different support structure to motivate those who are less innovative, and utilize those who are more enthusiastic about innovation-as champions for instance.

The introduction of a new IS can lead to changes in already established organizational routines and, consequently, routines themselves can be a source of resistance to organizational change (Edmondson et. al., 2001). Sharma and Yetton (2003) completed an overview of the studies that focused on the role of institutional context in successful implementations (Majchrzak et al. 2000; Orlikowski, 1992; Oriklowski et al., 1995; Purvis et al., 2001). The main observation made is that the institutional context - key aspects of which are workflow patterns, work procedures, routines, reward systems, control and coordination mechanisms - affects the end users' ability and motivation to successfully adopt and use IS innovations. The institutional context needs to be shaped in ways that facilitate an appropriate use of technology to accomplish work. The actions that can be undertaken to ensure successful implementations are: instituting new structures, new performance control systems, new coordination mechanisms, and changes to performance goals (Sharma and Yetton, 2003). Drawing on this research Sharma and Yetton (2003) examined the role of *management support* on implementation success in undertaking actions to reshape institutional context and their findings showed that in high task interdependence context – when several people take part in performing a task - management support has a significant impact on implementation success. Thus, management support is of paramount of importance during the adaptation stage and as a result was added to the model.

Another factor that plays an important role in new system implementation is *user training and education about new system* (Zmud and Cox, 1979). Careful planning and implementation of a training program may facilitate acceptance of the system by users. Training influences system usage by building confidence in the new system use, thus increasing users' satisfaction (Torkzadeh and Dwyer, 1994). While preparing for implementation users need to understand why the particular IS is being introduced and how the project will affect them both during and

after its implementation. Without such knowledge, ignorance and uncertainty will lead to: project resistance, a lack of participation and eventual disassociation from the IS. Therefore, training programs should not only provide exposure to technical aspect of the system, but also resolve whatever concerns and question users might have about proposed implementation. According to the Kwon and Zmud (1987) training starts at the adaptation stage, thus it was added to the model.

Another factor that is important to consider is whether the user will have a chance to experiment with the new system before committing to its use. *Trailability* has been generally considered positively related to innovation (Rogers, 1983; Rogers, 1995). Having an option for trying out the new system offline for a period of time can give the potential user an opportunity to become familiar and proficient with it without worrying that it may cause downtimes at work. Trialability of a system is important in reducing risk and uncertainty about the expected consequences of using the innovation. It provides adopters a risk-free way to explore and experiment with technology, to increase their comfort level and consequently the likelihood of adoption (Karahanna, et. al, 1999)

In summary, the center of adaptation stage is the process of mutual adaptation of technology and organization environment. During this phase the existing institutional context is revised; IS innovation functions and features are evaluated in terms of fit for a particular setting; new systems and support mechanism are established to promote long-term acceptance and usage of the technology; and training programs are designed to satisfy the needs of different groups are carried out. Strong management support and user participation are critical at this stage.

### *Acceptance Stage*

After all preparation for the IS implementation is done, organizational members are induced to commit to the new IS application. By starting to use technology for the first time, users evaluate its characteristics, how it affects their performance, and ultimately make decisions about whether to continue its use (Copper and Zmud, 1990).

We give an overview of the constructs that were added to the acceptance stage of the mode that describe how characteristics of particular technology may influence user acceptance. However, contrary to Kwon and Zmud (1987), we consider these factors to be significant not at every stage, but primarily during the acceptance stage. It is during the acceptance stage when users really begin to use the new system, gain more concrete knowledge about the system, become more experienced with it, and start to recognize what value it can add. Therefore, during the acceptance stage users will assess the characteristics of the technology and decide whether it fulfils their expectations.

Goodhue (1995) studied user evaluation of the IS through applying the *task technology fit* construct as a measure of IS success. He argued that users give evaluations based not only on inherent system characteristics, but also on the extent to which that system meets their task needs and their individual abilities. Usually users with different task needs and abilities might give different evaluations to the same system (Goodhue, 1995). The value of technology appears to differ depending on the tasks of the user; users view their systems as tools that assist or hinder them in the performance of their tasks (Goodhue, 1995). The more closely the system meets users' needs and abilities, the higher the performance level users can reach.

Seddon (1997) defined "the degree to which the stakeholder believes that using particular system has enhanced his or her job performance, or his or her group's or organization's

performance" as a *Perceived Usefulness* (Seddon, 1997). He developed the Perceived Usefulness concept when extending McLean and DeLone (1992) IS Success model, which uses the Individual Impact category as a measure of realized benefits from system use.

Similar to Perceived Usefulness, the concept of *Relative Advantage* has been one of the innovation characteristics that were shown to have an affect on individual's opinion of the innovation prior to adoption and affect on the rate at which innovation is adopted (Karahanna et al 1999; Moore and Benbasat, 1991; Rogers, 1995). Rai et al. (2002) assessed the validity of both DeLone and McLean (1992) and Seddon (1997) models and concluded that Perceived Usefulness affects *User Satisfaction*, which influences expectations about future benefits, thereby influencing IS use. While using the new system, users evaluate it based on how well the system's features meet their task demands. They develop a perception of what benefits they can realize from its use, and as a result, users' beliefs about how useful and advantageous the system would shape their level of satisfaction.

To evaluate the level user satisfaction with the new IS, *System Quality* and *Information Quality* are the most studied dimension in the IS research along which users evaluate IS (Bailey and Pearson, 1983; Rai et al., 2002; Seddon, 1997). System Quality is usually represented by *ease of use,* defined by Doll and Torkzadeh (1988) as the degree to which a system is "user friendly". Davis et al. (1989a) and Moore and Benbasat (1991) defined ease of use as a degree to which potential adopters view usage of target technology to be relatively free of effort. They found it to be a significant predictor of innovation adoption. Analogous to ease of use, the *complexity* of the system was shown to have negative relationship with the utilization (Tompson et al., 1991; Tornatzky and Klein, 1982). The more the system was perceived as relatively difficult to understand and use, the less the probability that it would be used.

The most extensively studied attributes of *Information Quality* are content, accuracy and format (Rai et al., 2002). Table 2 summarizes the characteristics that users are looking for in the new system.

**Table 2: IS Information Quality Characteristics**

| Characteristic (Bailey and Pearson 1983) | Why is important? |
|---|---|
| *Content* | Users require that information system contain precise and complete/comprehensive data |
| *Accurate* | Data supplied by the system must be accurate so that users are able to interpret it correctly |
| *Errors* | If system has errors, users will have to find ways around them. If not rapidly corrected, the errors will eventually frustrate users. |
| *Output* | The output of the information on the screens and report format is important. The format of presenting the data must be sufficient for use and easy to understand |
| *Flexibility* | Users will be discouraged if the system lack flexibility to meet their changing data needs |
| *Access* | Users might be frustrated if the access to the system is not convenient |
| *Confidence* | Feeling assured, confident with the system and in control when executing the system affects user satisfaction working with it |
| *Integration* | How integrated the new IS is with other system users use is also a significant characteristics that shapes user satisfaction |

Accordingly, through evaluating system characteristics, users identify how using the new system is better than its precursor (Moore and Benbasat, 1991; Karahanna et al., 1999; Rogers, 1995). If they see that using the new IS increases their productivity, effectiveness or makes the job easier, the more satisfied they are and more certain they are about future system use. Moore and Benbasat (1991) and Rogers (1983) showed that the greater the degree to which the effects of an innovation *are visible* is generally thought to have a positive impact on the innovation adoption.

The implementation of the new IS may result in changes on the ways in which users perform their job. Understanding how introduction of the new IS *impacts users work environment and psychological aspects of work* should be measured (Guimaraes et al., 1996; Joshi and Lauer, 1998; Turner, 1984). Particularly important factors are satisfaction with the work itself, and satisfaction with interpersonal relationships such as communication and relationships with fellow employees. IS researchers showed that the IS impact on the user's jobs is an important factor in successful IS implementation (Guimaraes et al., 1996; Joshi and Lauer, 1998; Nelson, 1990; Turner, 1984).

Implementation of the new technology affects business functions and influences users directly. Due to changes in the job content and uncertainty of the new system target, users may become *resistance to an implemented change* (Hong and Kim, 2002). Markus (1983) explained resistance to the IS implementation as a power distribution misfit of IS that can lead to different power and resource allocations. Copper and Zmud (1990) also suggested that organizational resistance and lack of technology understanding had more explanatory power of inhibiting new system infusion within its work environment then the task technology fit.

Venkatesh et al. (2003), in their research on individual acceptance of information technology found facilitating conditions to be a direct determinant of usage behavior. *The facilitating conditions* are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Tompson et al., 1991). However, the effect of facilitating conditions on usage was found to be only significant when examined in conjunction with the moderating effects of the user age and experience. Thus, this factor is expected to be only important for older workers in the experience with technology in later stages of the implementation. (Venkatesh et al., 2003).

**Classification of Factors in the Implementation Model**

In the previous sections, factors that have been shown by prior research findings to be significant during the process of IS implementation were identified and discussed. Also, earlier in this paper a definition of the implementation process was adopted from the Klein and Sorra (1996) study which defines it as "the process of gaining targeted employee's appropriate and committed use of innovation." Therefore, the outcome of the implementation is influenced by four major contexts: project, user, technology, and organization. The project context defines how the process of implementing new technology is carried out, user contexts explores the characteristics of targeted users, technology investigates the characteristics of the technology being implemented, and finally organizational context that describes the organization environment where technology is going to be implemented.

In conclusion, this section presented an overview of the model that was developed explore the process of IS implementation in the organization and understand what influenced users to use, or not use, an information technology implementation. After an extensive literature review of a number of theories and models, Kwon and Zmud, (1987) stage model of IT implementation that utilizes technological diffusion perspective was concluded to be the most appropriate for answering research question described in this paper (Cooper and Zmud, 1990). Finally, based on the literature review results, factors of significant influence on IS implementation process were identified and embedded into the model. In the Figure 1 of the model, each cluster of factors is directly linked to the stage of implementation process model where they are theorized to have an impact. The new factors that were included into the model are highlighted in bold and factors that simply reassigned are italicized.

# CHAPTER III

# METHOD

## Research Setting

To answer the research proposition of this study - what various contextual factors (and when during the course of IS implementation) have potential to influence its outcome - this work investigates a case of IS implementation in the healthcare delivery environment. In recent years, the role of IT as a tool to increase efficiency, reduce cost, and improve quality has been widely recognized and many Health Care Organizations (HCO) consider IT to be central to achieving desired changes in health care practices (Lorenzi and Riley, 2003). However, implementing such systems remains a difficult task, (Dixon, 1999) and many new systems "experience some type of failure" (Lorenzi and Riley, 2003). Therefore, studying IS implementation failure in the healthcare setting can add to the understanding of how organizational implementation of new systems.

### *Medical Center*

This study was carried out in the outpatient neurology clinic of a large teaching medical center that is ranked among the premier health care facilities in the United States. This center is a leading academic medical center with 800 licensed beds and a major referral center for the southeastern region of the country. The primary operative units of this center include a medical school, nursing school, outpatient clinic, adult hospital, children's hospital, cancer center, heart institute, and transplant center. There are a number of unique programs to the region such as a

Level 1 trauma center, a burn unit, an air emergency transport, and an organ transplant program. During 2004 this medical center had about 39,000 hospital admissions; 219,000 inpatient days; 824,000 outpatient days; and 76, 831 emergency room visits (Vanderbilt University Medical Center [VUMC], 2005a and VUMC, 2005b).

### *Neurology Clinic*

The Department of Neurology consists of twelve divisions: Consulting Practice, Epilepsy, Headache, Movement Disorders, Neuroimmunology, Neuromuscular Disease, Neruo-oncology, Neuroophthalmology, Pain and Neuromagnetics, Pediatric Neurology, Sleep Disorders, and Stroke. The department employs 41 faculty members out of which only 23 see patients in the clinic full-time. At the time of the studied IS implementation, there were six full time nurses and three technicians working in the clinic (VUMC Department of Neurology, 2005).

## Research Design

To study the process of IS implementation we use the case study methodology developed by Yin (1994). The case study research method is the most widely used qualitative research method in the field of IS research (Klein and Myers, 1999). It has been shown to be relevant to situations where understanding the relations between information related technologies and organizational contexts are important, (Orlikowski and Baroudi, 1991) and where "the focus is on understanding the dynamics present in single settings" (Eisenhardt, 1989). Case study is "an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident and it

relies on multiple source of evidence" (Yin, 1994, p. 13). Therefore, the case strategy in this study is justified because the focus of the work is on the process of healthcare IS implementation that is only possible in the real life context where boundaries between IS system and the context of implementation are quite complex. Moreover, case study research has been recommended as a valid method for testing theory within information systems research (Benbasat et al., 1987; Lee, 1989), thus results of the case study analysis will be used to compare case findings with the expected outcomes predicted by theoretical propositions.

This implementation of a medical informatics application in proved to be an ideal case to study. First, it was a case of failed implementation; the project failed, because only three out of six physicians from the neurology clinic accepted this technology. The researcher had a chance to be an observer during the implementation process and was able to collect extensive documentation about project progression. Key participants could be located for interviewing.

To begin the data gathering process the researcher was required to obtained approval from the Vanderbilt University Internal Review Board (IRB). The study was approved by the IRB on March 10, 2004 (IRB number is 040199). The complete IRB form can be seen in the Appendix A.

**Data Collection**

After the study was approved by IRB, the identified participants were contacted via e-mail to get their approval for participating in the study. The study recruitment letter (Appendix B) described to the participants the context of the study, its objectives, the proposed nature of the participants' involvement, and a description of the strategies that the study will take to preserve confidentiality rights of the participants. The group of participants consisted of five nurses, five

physicians, one IT representative, who was a project manager for the implementation, one clinic director, who was a physician champion of the project, and one charge nurse as a representative from the nursing management side. Only five out of six physicians implemented on the system were included in the study. One physician was not selected to be a participant, because during the implementation, he did not have full clinic and saw only one or two patients per week, therefore, he did not have a chance to participate in the implementation project.

Both qualitative and quantitative data were collected in this study in three different ways. The process of data collection included surveying and interviewing thirteen key participants twelve months after IS implementation was completed, as well as collecting secondary source documents during the implementation project.

Before conducting face-to-face interviews, participants were asked to complete a questionnaire (see Table 3).

**Table 3: Participants Questionnaire Administration**

| Participants | Number of Participants | Number of Questions Asked and Answered |
|---|---|---|
| Physicians * | 5 | 59 |
| Nurses | 5 | 56 |
| Clinic Management | 2 | 60 |
| Project Manager/IS Representative | 1 | 60 |

* One physician did not complete questionnaire, therefore the questionnaire topics were addressed during the interview.

Having participants to complete questionnaires prior to interviews allowed the researcher to not only have a quantitative assessment of their views and experience with implementation process, but to better structure the interview process and follow-up questions. Since the proposed model is comprised of thirty-three constructs, the number of questions that the interviewees would have to answer during the interview would be difficult to manage within the interview time frame. Therefore, having an insight into participant opinion on a certain aspect prior to the interview would allow interview time to be used for obtaining significant information.

The process of questionnaire development started by reviewing prior research on how model constructs were measured. Thus, items used to operationalizate the constructs where adopted from the relevant prior research and previously developed instruments. All questions were modified to make the items meaningful to the particular IS implementation context. In addition, a number of questions that were aimed at capturing opinions about similar concepts were tailored to suit different groups of participants such as nurses, physicians, and clinic management and a project managers. Finally, questions were assigned in the order that most logically represented the process of a new system implementation. A seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) was used to measure the items (Trochim, 2001).

As reviewed previously, thirty-three key factors that help to evaluate how characteristics of a new IS, users, organization and implementation project itself affect the IS implementation outcome, were included in the research model. Metrics for the particular system used and "task-technology fit" items were obtained from the work of Goodhue (1995). Moore and Benbasat (1991) scale to measure compatibility, relative advantage, and complexity through ease of use and easy to learn was found to be acceptable for this study. The user satisfaction with the quality

of information and the system were measured using Bailey and Pearson (1983) measures. Finally, questions about the impact of a new IS on the user work environment (including changes with work satisfaction and interpersonal relationships) were developed based on results of the studies by Guimaraes et al., (1996), Joshi and Lauer (1998), and Turner (1984).

The next set of questions measured the participant's opinion about how well the implementation project was carried out as well as their experience during the time of implementation. The questions to measure user participation and involvement were adopted from the study by Hartwick and Barki (1994). From the instrument used in that study, questions about "how interested users were in the new system implementation" and "whether they felt that using the new system would be important to them" were used to assess user involvement. In order to evaluate the level of user participation, questions looking into whether users took part in helping with the implementation and system development processes were adopted.

The metrics of project definition and planning, commitment to change and commitment to the project were obtained from the Ginzberg (1981b).

To understand how supportive and committed management was during the implementation project, a number of questions were developed by analyzing results of the studies that showed how crucial the role of management is to promote the system use (Ewusi-Mensah and Przasnyski, 1991; Ginzberg, 1981a, Gottschalk, 1999; Jarvenpaa and Ives, 1991; Marble, 2003).

A question on how adequate users find their training in the system was included and was adopted from Sanders and Courtney (1985).

Trialability was measured by inquiring whether users had a chance to experiment with the new system before committing to its use. This question was developed based on the Rogers (1995) statement that trialability is positively related to innovation adoption.

Questions concerning how well users were educated about the implementation project were created based on the studies by Torkzadeh and Dwyer (1994) and Zmud and Cox (1979).

Questions regarding user's resistance to change were adopted from Hong and Kim (2002) study.

Finally, all respondents were asked about number of years of their experience as computer-based system users, number of years of in the present position, and number of years they have been with the organization.

A complete list with of items included into the questionnaire for testing the constructs of the proposed model as well as their sources is displayed in the Appendix C.

**Questionnaire Testing**

The questionnaire was a pilot tested by a group of eight graduate students. Based on their feedback, minor modifications were made. The modifications included grammar revision, wording of the instruction section, moving the order of the questions, and eliminating redundant questions. The time required to complete the questionnaire was estimated to be 15 minutes.

In May 2004, the questionnaire was administered to thirteen participants. Ten participant completed paper form questionnaire. Two participants completed the questionnaire in the electronic format. One participant was unable to complete the questionnaire; therefore, the majority of questions were addressed during the interview. It took from two to seven days for participants to return a completed questionnaire. For the participant's convenience, complete

questionnaires were picked up at their work place. Next, an in-depth, issue-focused and semi-structured interviews with thirteen implementation participants were undertaken in order to capture a rich set of subjective experiences of organization members during the IS implementation process. Before conducting interviews with participants, a mock interview was conducted to practice authors' interviewing skills, to test how long it takes to answer the questions, and to test the questions' content and order.

The key participants were members of one of the following four groups: physicians, nurses, clinic management represented by clinic director, and nursing management, represented by charge nurse, or IS representative that was responsible for the implementation of the new system. All thirteen participants were involved in the implementation project and thus were selected for an interview. Table 4 below presents a summary of the key participants.

**Table 4: Study Participants Description**

| Participants | Group (N) | Years w/organization | | | Years in present position | | | Years as experienced computer user | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min |
| Physicians | Epilepsy (2)<br>General Neurology (1)<br>Stroke (2) | 11.6 | 26 | 3 | 10 | 26 | 2 | 7.9 | 16 | 1.5 |
| Clinic Management | Clinic Director and General Neurology Physician (1) | | 7 | | | 2 | | | 7 | |
| Nursing Management | Charge Nurse (1) | Did not provide | | | Did not provide | | | Did not provide | | |
| Nurses | Licensed Practice Nurse (4)<br>Registered Nurse (1) | 11 | 31 | 1 | 8.6 | 30 | 1 | 2.8 | 4 | 2 |
| Project Manager | IS Representative with nursing background (1) | | 4 | | | 3 | | Number of years as experienced project manager =4 | | |

All interviews were conducted in a private environment. The privacy allowed interviewees to freely express their personal opinions about the implementation process and reflect on the events that took place. The interviews lasted anywhere from 30 to 45 minutes and were semi-structured. All interviews were completed between June 2004 and August of 2004, one year after the IS implementation process was finished. Since the interviews were conducted one year after the implementation, the interviewees were less sensitive when talking about the failing aspects of the project and were more open to share their experiences. All interviews were prearranged and each interviewee was interviewed once. With the participants' prior permission, all interviews were tape recorded and later transcribed. Since the author who interviewed all participants was an active observer of the implementation process and had a chance to get to know key individuals involved in the implementation it was only required to give interviewees a brief introduction about the study goals.

Prior to an interview, all participants except one completed a questionnaire (see Appendix C and table 3 for details) described earlier in this chapter. The participants' answers were then reviewed to see the direction of their responses. Since seven-point Likert scale was used to measure responses, it was easy to understand participants' position in relation to a specific item asked. Knowing every participant's views and experiences on a subject matter prior to the interview allowed the interviewer to prepare questions that would allow participants to explain what made them feel certain way, motivate them to reflect on the events, and provide insights into what happened. Therefore, the participants' responses were used as a roadmap for the interview process.

For example, in the interview guide the following statement "From the start clinic management viewed the new system as being important to clinic's long-term goals" would be

followed with two set of follow up questions depending on whether respondent agrees to it or disagrees. In case where respondent disagrees, the guide included following questions:

In case the respondent disagrees, the guide included the following questions:

- Why do you think management did not view the new system as being important to department's long-term goals?
- Did management's position regarding the new system influence your decision about using the system in any ways?

If the respondent agrees with the statement, he or she will be asked the following questions during the interview:

- Why do you think management viewed the new system as being important to the department's long-term goals?
- Do you think that the management's belief about the new system's importance to the department contributed to your decision to use the system?

The presence of an interview guide insured consistency and reliability of the data collected. The interview guide utilized during interviews can be found in the Appendix D.

**Secondary-source data**

Data were also collected from the written organizational documentation, internal meeting notes, and field notes taken during on-site observations, internal e-mail correspondences and other relevant documents. The opportunity to employ multiple data collection strategies (questionnaire, interview, secondary-source data) aided in the process of triangulation (Eisenhardt, 1989; Yin, 1994), thus enhancing the validity of the case findings. The next section will describe data analysis strategies used to arrive at the study results.

## Data Analysis

### *Quantitative Analysis*

Twelve participants completed the questionnaires. One participant did not complete the questionnaire, thus was asked the questionnaire items during the interview. Data collected via the survey was analyzed as follows: questions were grouped into theoretical categories according to the study model, and the responses between the groups of respondents were compared. If the groups compared had more then three participants in it a Mann –Whitney statistical test was utilized. When the groups had less then three participants, the means were compared. Table 5 below shows what groups were compared.

**Table 5: Quantitative Analysis Strategies**

| Group I | Group II | Test Used For Comparison |
|---|---|---|
| All Physicians | All Nurses | Mann-Whitney Test |
| Physicians adopters | Physicians non-adopters | Mean |
| Nurses who worked with physicians adopters | Nurses who worked with physicians non-adopters | Mean |
| Physicians Adopters & nurses they worked with | Physicians Non-adopters & nurses they worked with | Mann-Whitney |
| Clinic Management | Project Manager | Mean |
| Clinic Management about physicians | Clinic Management about nurses | Mean |
| Project Management about physicians | Project Manager about nurses | Mean |

A mean response to every question and constructs that were measured through a number of questions was calculated for each group identified above. Two quantitative measures were used to describe case findings. First, mean differences were calculated between the groups to

determine the disparity of their responses. A nonparametric Mann-Whitney test was used to determine if the observed differences in the responses were statistically significant (Altman, 1991). Since this study is exploratory in nature and the sample size was small, it is reasonable to have a loose cut off value for interpreting results of Mann-Whitney test. Therefore, a significance level of 0.1 was adopted.

The results of quantitative analysis was used in conjunction with the interview findings. However, in case of discrepancies between the quantitative and qualitative measures, the answers obtained during an interview were used.

### *Qualitative Analysis*

A positivist approach was adopted to analyze data collected from the interviews as well as from the secondary source documents retained during the implementation process (Trochim, 2001). The positivist perspective "is founded on an ontology in which an objective physical and social word exists independently of human's knowledge of it" (Darke et. al., 1998). A researcher first formulates constructs and then investigates and discovers general principles or laws, which govern the natural and social world.

This study involves both inductive and deductive reasoning process. The study begins with the model development that utilizes theories from prior research, which is a deductive approach. Then the study transitions to observing a phenomenon of IS implementation in the real setting, which is an inductive approach. Finally returns to theories with the case findings. This mixed approach allows the researcher to deal effectively with the extensive raw data, establishing associations between the research objectives embedded in the proposed model, and finally, refining the model according to most important case conclusions.

The analysis of the case study data first started with the close reading of interview transcripts and review of documents retained during the course of the new system implementation. To get a deeper understanding of data, the author read the text materials several times.

The next step was to divide data in a meaningful way. A suggested approach by case study methodology is to use a coding technique (Trochim, 2001). For the objectives of this study, a conceptual structure served as a foundation for creating codes. Constructs, that are embedded in the proposed model served as coding categories and their names as a codes. Through multiple readings of the transcripts, text segments that belonged to a particular category were identified and marked. Then, coded text segments were grouped into corresponding categories.

Next, the categories were analyzed to generate the meaning of the coded material. In particular, coded material was examined to see if any patterns or themes emerged, what their frequency, how are they linked together, and what their relationship with other patterns and themes was. Patterns and themes were contrasted by participants. Finally, they were compared to the proposed model. Also, a careful consideration was made to analyze patterns for possible subtopics, contradictory points of view, and new insights. If a link a between particular category and other categories was found, a combined category was created. While performing this analysis, quotations were extracted that could highlight the core theme and convey an importance of a particular category.

**Medical Center's Computer Systems Context**

Along with outstanding patient care that is recognized nationally, this medical center is known for its leadership in developing and applying biomedical and information system innovations into its practices. Medical informatics is viewed as having a vital role in transforming healthcare. A high priority has been given in the medical center for the development of information technology infrastructure that supports education, research, and clinical care. As a part of the strategy to change the practice of the patient care, beginning 1993 the organization took on a number of information technology programs that could help improve quality, efficiency and reduce the potential for medical errors. This initiative has resulted in a number of successful internal products, such as a comprehensive electronic medical record system (EMR), a computerized clinician order entry system, and computer-based tools for care management.

With the development of these technologies, an institution-wide project was initiated in 2000 with the main goal of shifting to electronic medical records and eliminating the use of as many paper processes as possible in the outpatient areas of the center. This project envisioned that all outpatient clinics would become paperless by the year 2003. Several computer tools were developed internally that could assist in electronic documentation process by creating electronic notes stored in the patient's electronic chart. In particular, two applications that aim at patient care document creation became available to physicians and other care providers:

1. Note builder in the EMR
2. Computerized Documentation System (CDS)

The note builder within EMR system was the system used by this study participants prior to the Implementation of the CDS system.

### *Old System for Documenting Clinic Visit Notes*

In the EMR note builder, an electronic note is created via a note builder component of the EMR system. Using this method, users first would have to be trained on how to create a template. They could then create a template that would be used as a default note. This default note would usually contain pre-typed default phrases, sentences or even whole paragraphs. The screen shots of the template are shown in figures 2 and 3. The fields with the text already there are the default fields that user may leave unchanged if the content does not apply to the patient. If the default content does not apply, the user must type information.

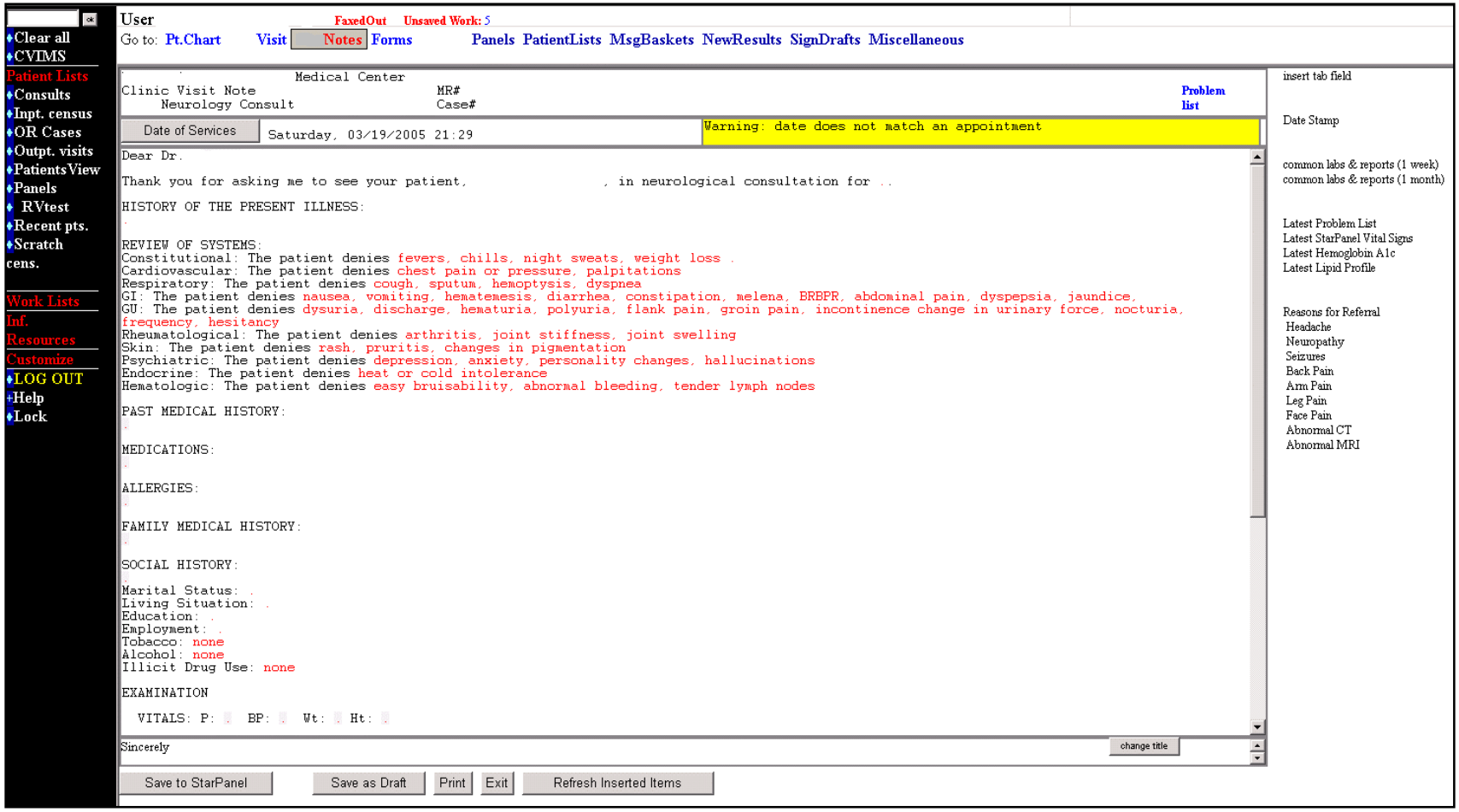


**Figure 5: Screen shot of the EMR Template Part 1**

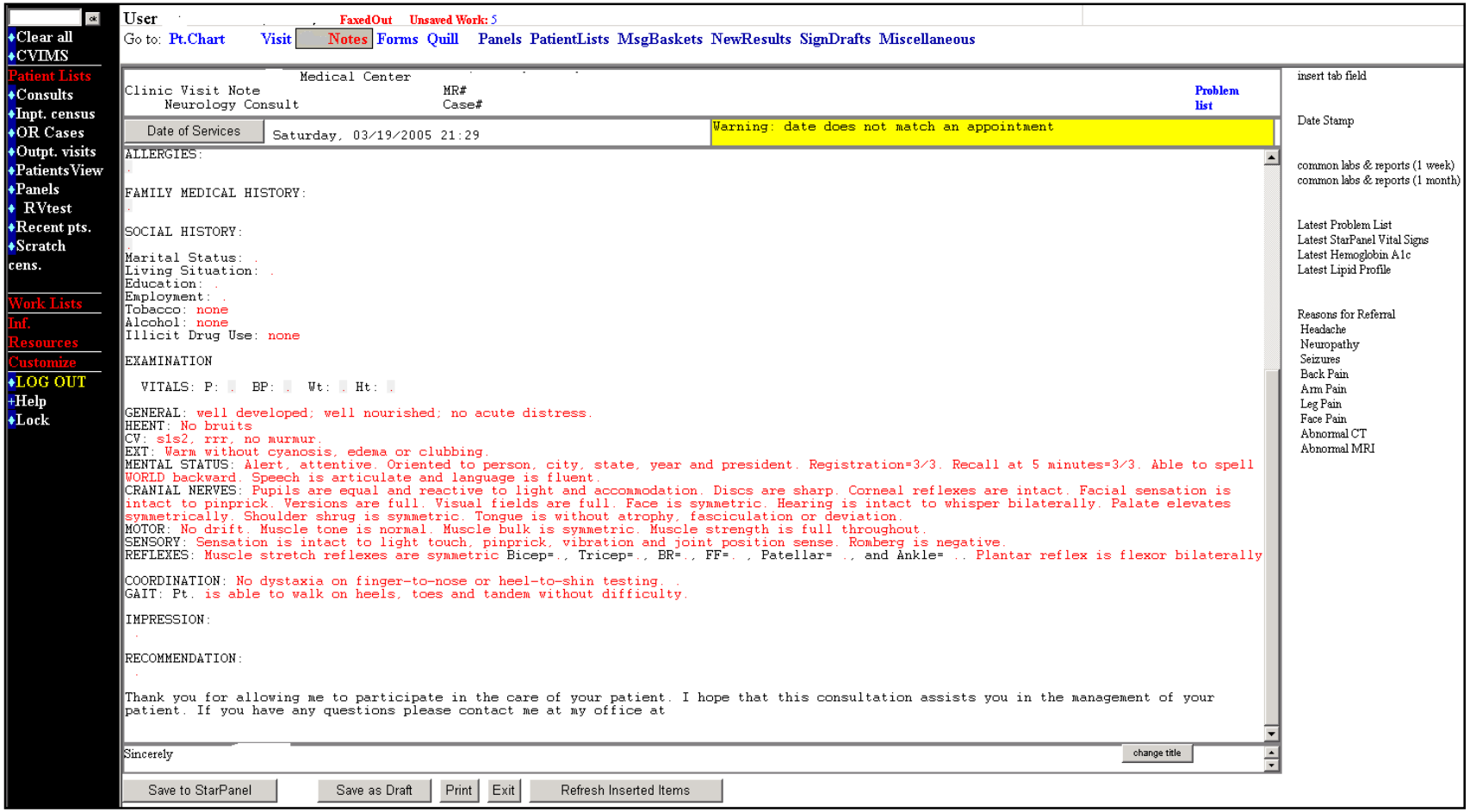


**Figure 6: Screen shot of the EMR Template Part 1**

To create a note for a specific patient, physicians would have to go through the note, keep what applies, and type in any additions. Using this option users had to type the majority of the note. This tool was implemented across the majority of the outpatient clinic. The screen shot that shows what the final note output looks like is presented in the Figure 4.

When physicians in the neurology clinic were using this system to create a clinic visit note, vital signs, allergies and medication list would be imported into the note automatically after nurse entered the values directly into the EMR system. Figure 5 shows the screen shot of the input fields in the EMR system for the vital signs, allergies and medication used by the nurse.

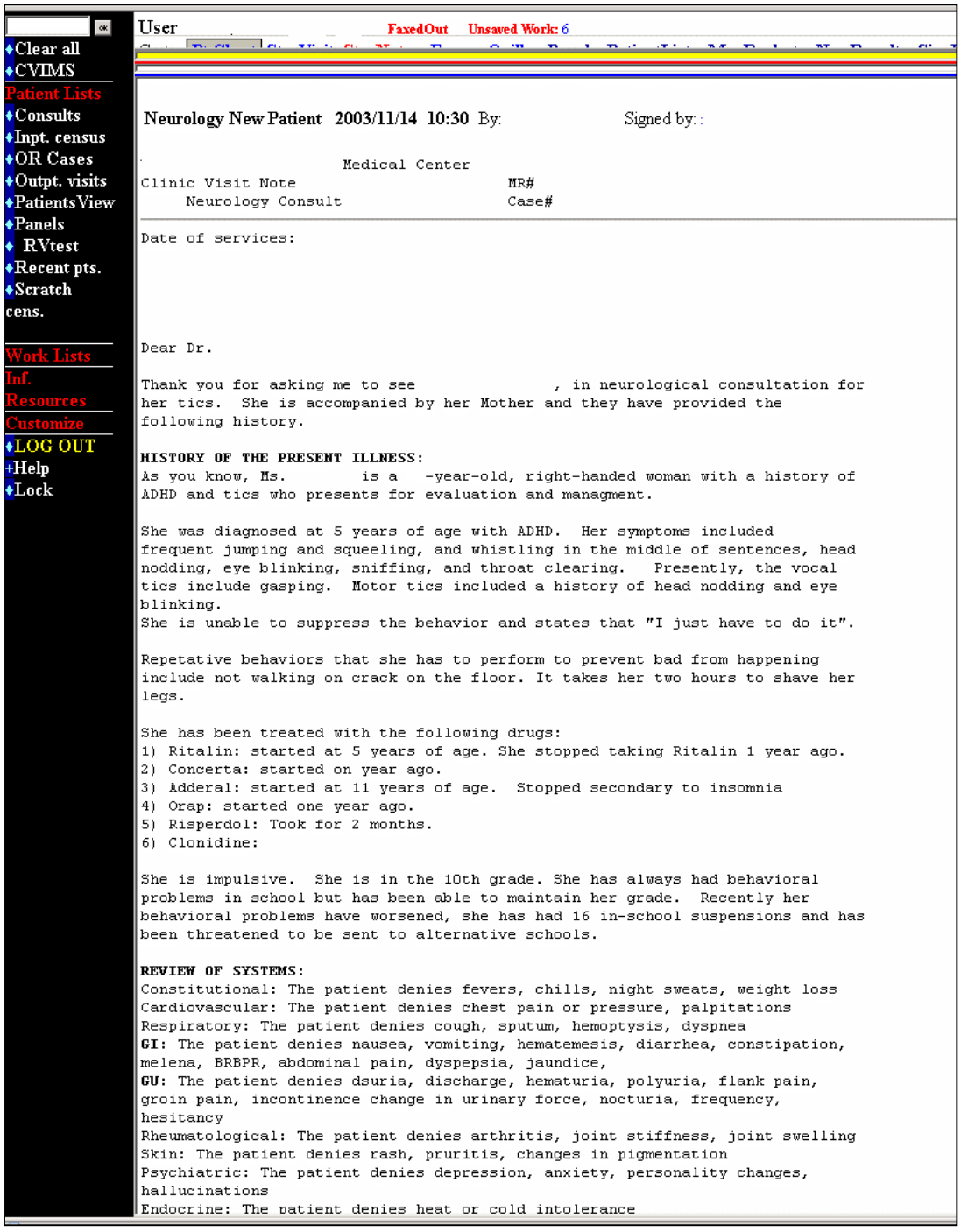


**Figure 7: Screen shot of the note done in the EMR system**

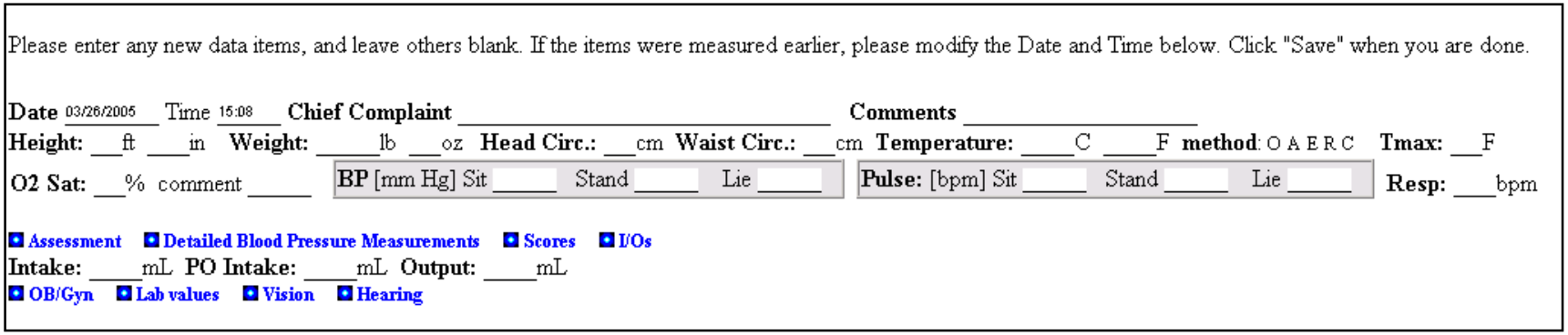


**Figure 8: Screen shot of the EMR entry form for vital sign**

***New CDS system***

The second application developed in the medical center, which is the focus of this study was the Computerized Clinical Documentation system (CDS). This tool offered providers and staff an additional tool to document the patients' clinic visit and directly upload it to the EMR system. The first pilot of this technology was done in the outpatient cardiology clinic. Six cardiologists successfully adopted the application as an alternative to the dictated notes. Neurology clinic was selected as the next candidate for the implementation of this new system. Next we describe in more detail the futures and functionality of the CDS system.

The medical center's informatics department developed the CDS system with the goal of giving care providers a computerized tool for creating electronic notes that could replace dictation practices, eliminate paper processes, and serve as a data repository for all information entered into the system for later research and quality improvement projects.

CDS is an electronic tool for documenting the patient encounter. A patient encounter is what happens with the patient during the visit to the clinic. When a physician documents a note about patient encounter, he or she usually gives a detailed summary of what happened during the visit. In particular, they note the patient's reason for the visit, the patient's history of present illness (HPI), significant past medical diagnoses, family past medical history (FMH), social history, review of the systems (ROS), and the summary of the physical exam. At the end of the note is the physician's assessment and plan for treating the disease.

CDS system creates coherent and legible "letter like" notes using a "point and click" approach. CDS allows inserting the values for lab results, radiology results into the clinic note from the EMR system. In addition, system uploads the complete note into the EMR as well as the individual components such as medications, allergies, and the patient's problem list. Patient

information saved in the system can be also reused to create subsequent clinic visits notes. For example, the provider can upload the previous patient's note (or parts of it) and use it as a starting point for documenting the current visit instead of rewriting sections that often stays constant (e.g. past medical history). Among the biggest claimed advantages that users can realize through CDS use are: 1) system permits a team approach to documentation through collaboration of the templates, 2) information is immediately available to the rest of providers in the enterprise after the note is uploaded onto the EMR, 3) the "point and click" approach is faster compared to typing, therefore if the physician is used to do the clinic note in the room while he or she see the patient, then all required documentation can be completed with the last patient appointment, and 4) can be substitute for the dictation.

**Documentation process in the CDS**

A caregiver (physician, nurse, etc.) can use CDS to document the patient encounter summary during or after the visit. The process of documentation in the CDS is done through the user-customizable templates interface. The templates serve as a basic outline for the patient assessment and reflect the questions that physicians or other caregivers usually address during the patient visit.

To satisfy the documentation needs, users can create templates. The CDS system has a "master template" which is the storage of all findings available in the system's knowledge based on major categories. A "finding" is a clinical concept that a physician may want to document during the patient visit and consists of one word or a phrase. For example, "hypertension" might be considered a "finding". The "master template" is a comprehensive template that is used to build customized templates to meet individuals' clinical documentation needs. If a finding

"hypertension" is not present in the "master template", then it is not a part of the CDS system knowledge base and cannot be included into the custom template.

The screen shot in Figure 6 below shows organization of the application. There are three panels. The left panel is where users templates and a "master template" are located, as well as where the notes from previous encounters are stored. In the middle panel, the documentation process takes place, and the right panel is where user can document a detailed finding (i.e. headache severity).

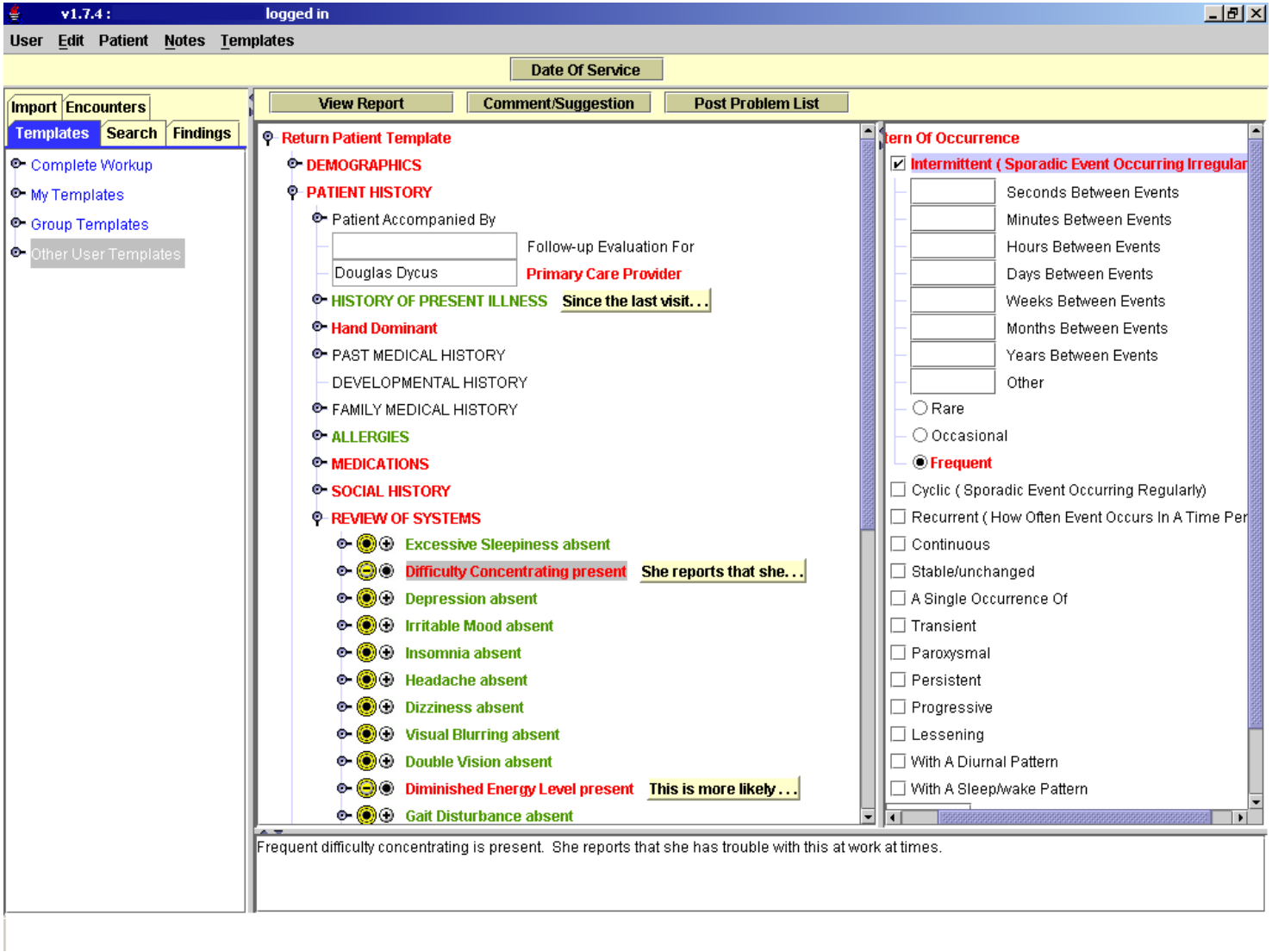


**Figure 9: Screen shot of the CDS Application**

To build a template the user simply chooses findings from the “master template” and puts them together to constitute the final template. Findings can be arranged into separate categories. As a result, a final template contains a subset of the findings to address documentation need, in the order users prefer to address them.

Every finding contains an item list. An “item list” is the list of possible additional information that the user can provide about the finding. For example, if the patient states that he has a “sharp headache”, physicians would first click on the finding “headache” and a list of options to qualify anything about headache would appear. In that list physicians would pick and click the qualifier item “sharp”. The example of what the template looks like is shown below in the Figure 7. The template is located in the middle panel. The “headache” finding is selected, and associated qualifiers are listed in the right panel. On Figure 7 you can see that under item “severity scale”, number 8 is selected.

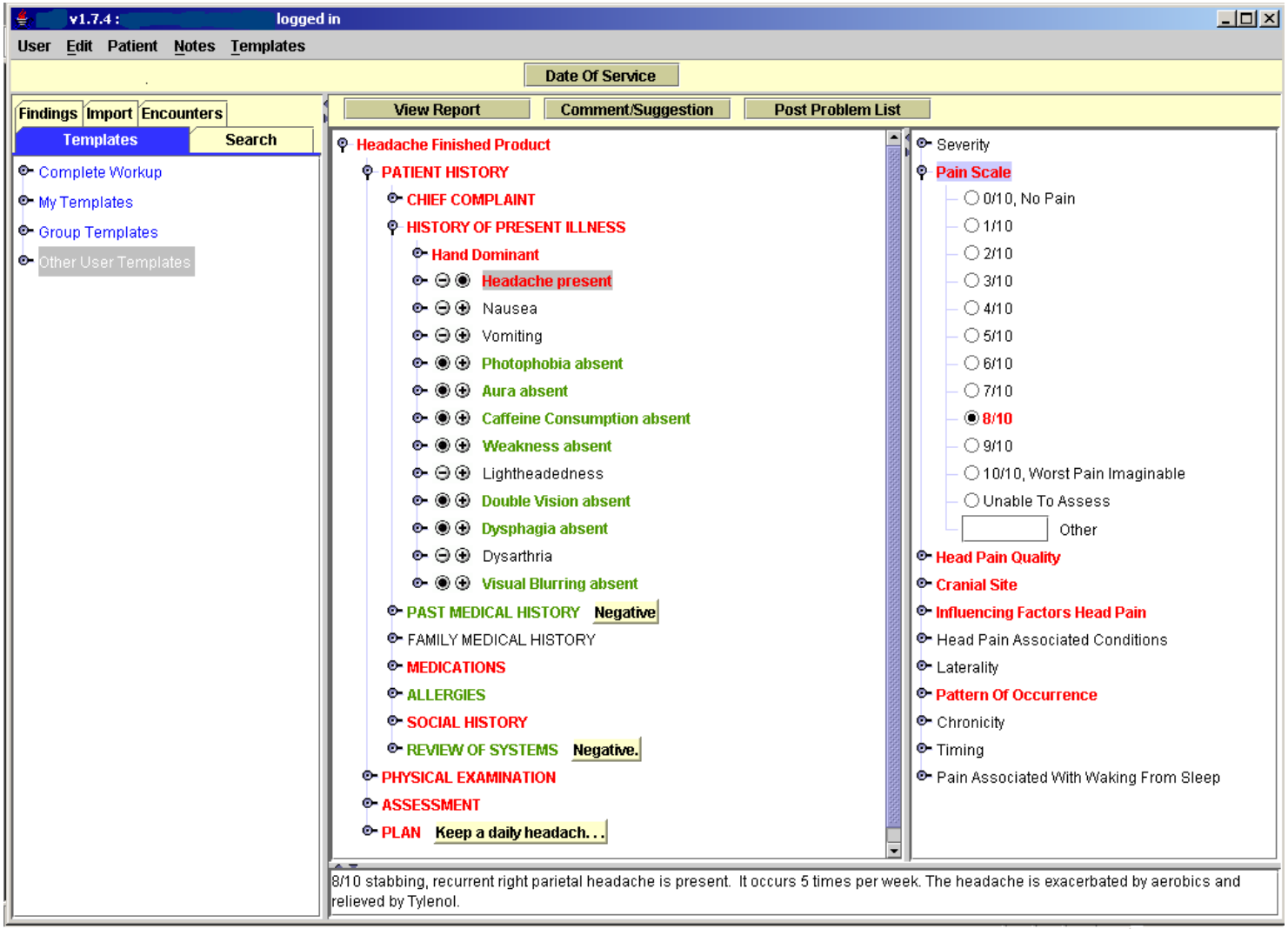


**Figure 10: Screen Shot of the CDS Template**

The input of the data into the template is primarily done using a "point and click" functionality as well as free-text typing where needed; therefore, the amount of typing is minimized. The user completes the template by pointing and clicking on the findings and finding qualifiers to more precisely allow a description of the patient condition. The CDS system then transitions selected findings and their qualifiers into the sentences. For example, a physician might want to document that a patient has class I hypertension, which is under control but causes renal insufficiency. In the template, the physician would click on "hypertension" as a positive finding, and then would be prompt to the list with qualifying terms that help describe hypertension. In that list physician would select "mild" under qualifier severity, "class I" under qualifier hypertension class, "controlled" under qualifier hypertension control, "renal insufficiency" under qualifier hypertension associate conditions. The program then generates the following sentences: "Mild, class I, controlled hypertension is present. The hypertension is associated with renal insufficiency."

The ability to generate sentences from single-word or short phase findings is a distinction of the CDS application from other documentation systems that usually utilize free text input. Therefore, a letter-like note with complete sentences can be generated simply by going through the template and valuing findings by "point and click"; however, free-text comments can be added at any place of the note. Figures 8 and 9 below show the screen shots of the CDS note output.

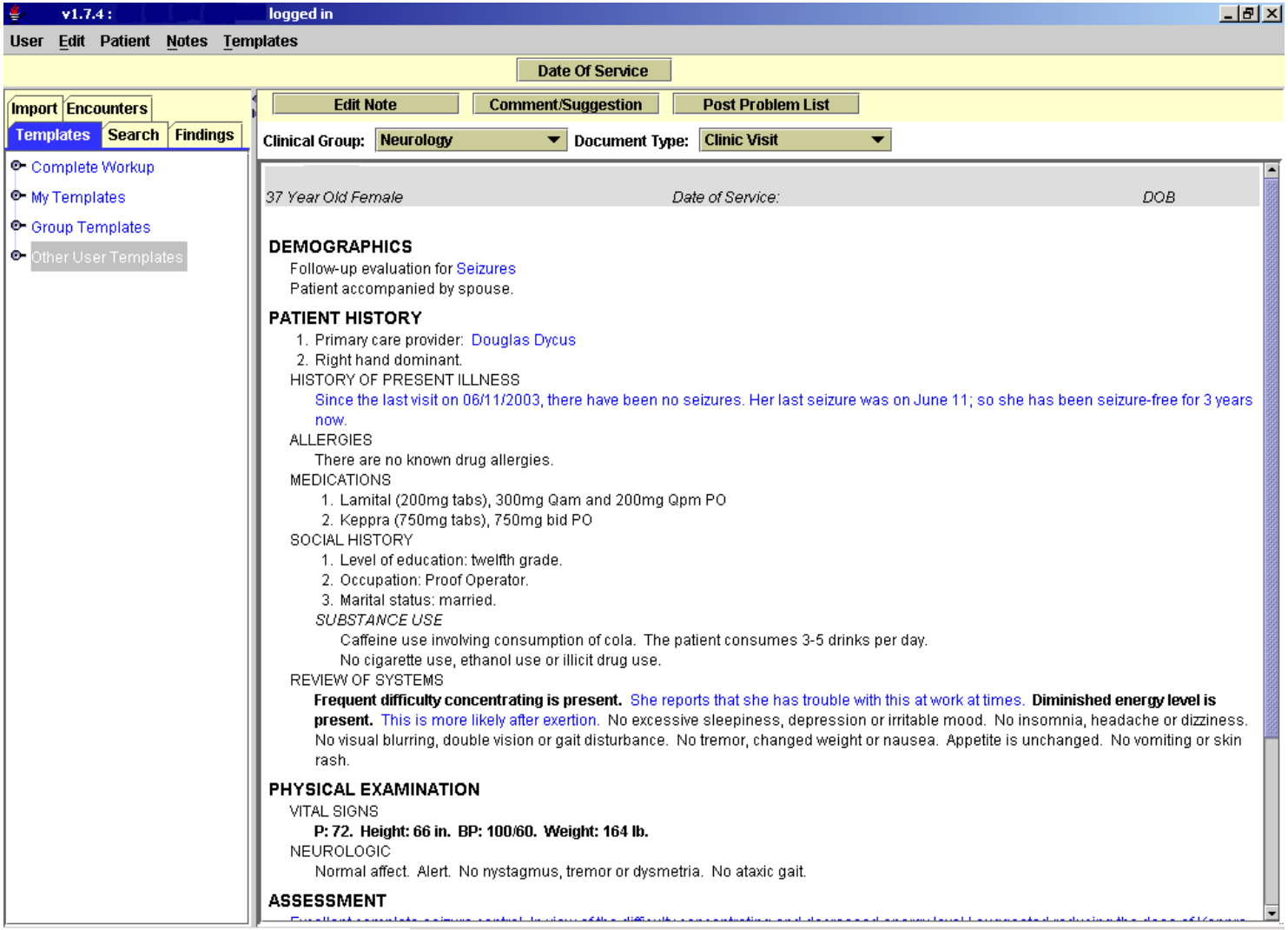


**Figure 11: Screen shot of the CDS Note Output Part 1**

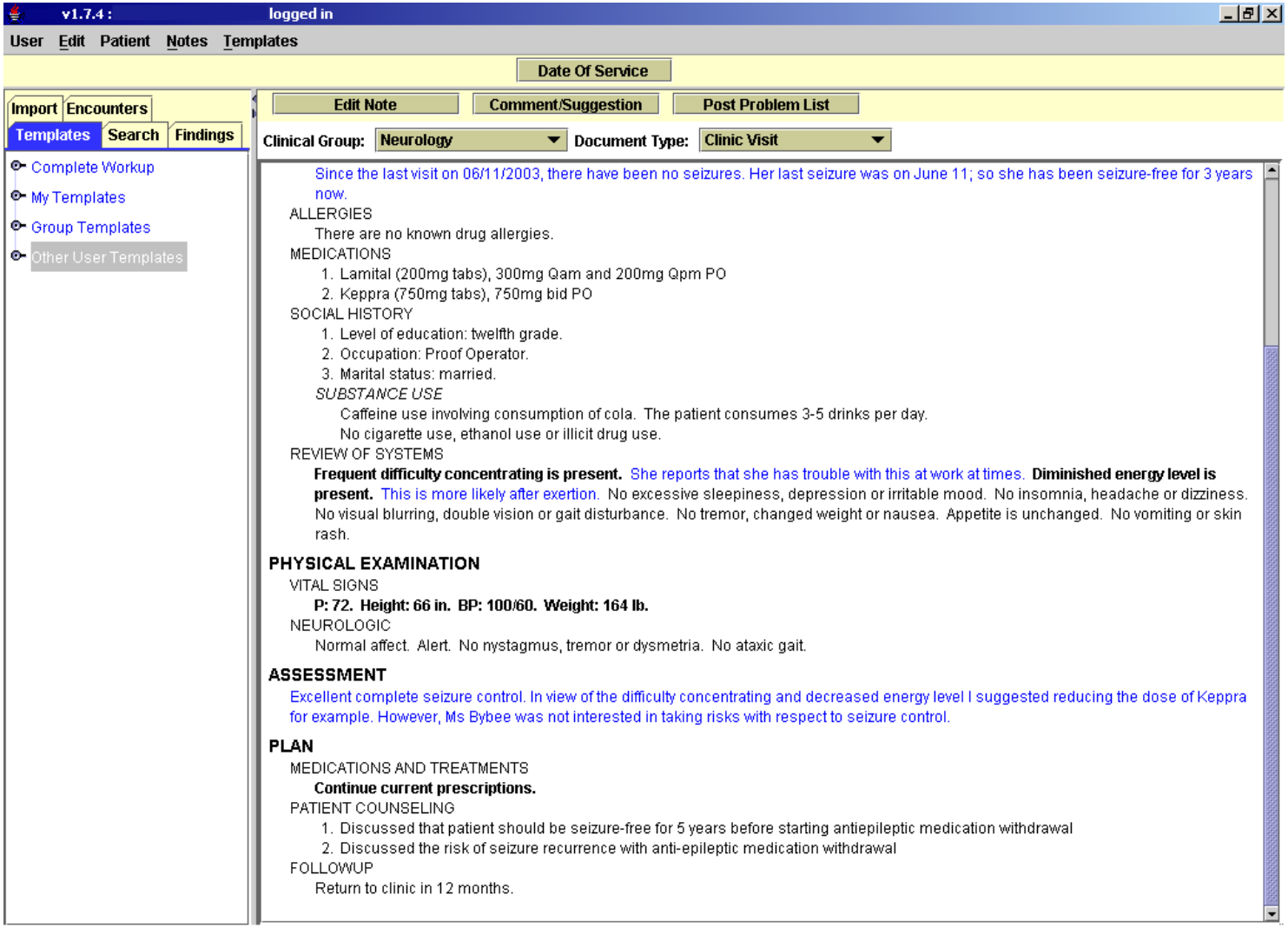


**Figure 12: Screen shot of the CDS Note Output Part 2**

Every user also has the ability to customize the CDS application based on his or her individual needs. In particular, the user can customize how the final note will look based on a certain functionality; the methods of navigation through the template, for instance making the cursor move automatically from finding to finding; creating default values for the findings, for instance having headache appear as absent when valued unless present is selected; and many more.

In conclusion, the new CDS system offered caregivers a different approach to clinical documentation practices. First, the technology allowed for building templates that included words and phrases that users can choose to best fit their documentation needs. Second, such documentation could be used by simply doing "point and click' versus typing the content of the note. Finally, the program generated a "letter-like" note.

# CHAPTER IV

# RESULTS

## Introduction

This chapter assesses and discusses the failed implementation of the Computer Documentation System (CDS) in the outpatient neurology clinic of a large teaching medical center. The implementation took place between May 2003 and August 2003. Five physicians: two from epilepsy subspecialty, two from stroke, and one from general neurology subspecialty, along with five nurses were the target users of the system. Other members of the implementation initiative were one IT representative, a computer systems support person, a charge nurse, and the neurology clinic director. CDS was designed internally by the medical center's informatics center and had been successfully implemented in the cardiology outpatient clinic of the same medical center. The neurology clinic intended to use the system as a means to boost clinic efficiency by building a collaborative relationship between physicians and nurses, to reduce costly dictations, and to decrease the time it takes for physicians to document the clinic visit note while in the room with the patient.

From the very beginning, the CDS implementation project faced serious challenges. First, the organization context was not assessed adequately to prepare users for the system use. The fact that nurses did not possess skills needed to effectively use new technology, as well as skills needed for the new tasks in their workflow, was not taken into account when the decision was made to implement new system. The lack of a clear set of objectives among users and managers lead to different perceptions of the system benefits among users. The lack of management

commitment to the project and workflow change resulted in ineffective support to users. Users were not sufficiently motivated or encouraged, to participate in the system implementation and ongoing development, Later, implementation difficulties were experienced as the system was deployed in neurology without prior process restructuring, user training in the new routines. As a result, users experienced a hard time adjusting to the new technology and processes thus affecting their productivity and lowering their satisfaction level with the system impact on the work environment. Few users were able to find ways in which to incorporate the system into their routines. While attempts were made to help users adjust to the new CDS system and new processes, the level of system usage decreased and only two out of five users accepted new CDS. These two adopters found the new CDS compatible with their values and habits, they were satisfied with the system characteristics and functionality, and were able to become more efficient compared to their old practices. Contrary to adopters, non-adopters did not find technical characteristics of the new system appealing, have already been satisfied with the system in use, believed that management was not enough supportive and encouraging throughout implementation, and did not find system fit their established work practices. A description of the CDS implementation project and why it is failed provided next. The results are summarized by the stages of the implementation process.

## Initiation Stage

### *The neurology clinic interest in implementing the new CDS*

Interviews with key participants established the reason for introducing CDS into the neurology clinic. The neurology clinic leadership sought ways to improve its efficiency,

lowering dictation costs, and increasing the patient flow in the clinic were the areas of intended improvement. The cost of transcribing dictations remained high since not every physician made the transition to create electronic notes. The average charge to transcribe the text line of the dictation is 15 cents, which translate to approximately $200, 000 per year per clinic with 41 faculty members. The clinic was interested in eliminating dictation expenses; moreover, the dictated note has a tendency to be less complete compared to notes that use template guidelines. For example, if a physician completes a physical examination of the patient and then summarize the findings of the exam in the note by typing a free text sentences he or she may be less descriptive, compared to a template note that has predefined parts to be completed. The clinic usually bills insurance companies based on what is written in the note, therefore notes that are less complete get lower reimbursement rates from the insurance companies for patient visits to the clinic. The clinic also wanted to increase patient flow. The more patient appointments the clinic has, the better the financial outcome. Efficient utilization of the nursing staff, decreasing patient visit time, more complete notes, and elimination of dictation practices were the opportunities that the neurology clinic leadership wanted to achieve. The documentation process of creating notes in the new CDS system was based on the template approach, thus the note generated from the template tends to be more thorough, thus increase billing accuracy.

Separate templates were designed for nurses and physicians to allow a collaborative approach to documentation. A nurse could capture patient related information via the template, and later a physician could incorporate that information into the final clinic visit note. The collaborative approach was intended to help to utilize nursing staff more efficiently and help physicians to create a final note in a less amount of time, all of which was intended to improve clinic outcomes.

***Informatics department objective for implementing CDS in the neurology clinic***

The informatics groups' and CDS developers' interest in bringing the technology to the neurology clinic was to continue the process of enhancing system functionality capabilities. After completing a successful implementation of the CDS system in the cardiology outpatient clinic, the development team was looking for the next place where they could apply it. Implementation of the new CDS system in the neurology clinic offered the informatics department an opportunity to improve system functionality. The system's technical capabilities could be expanded by learning about the field of neurology, about neurology specialists' workflow of how they do patient assessment, and how they do clinical documentation. As a result, the CDS ability of being applicable to other medicine specialties and clinics was intended to increase. As a general policy, the committee, (that includes representative from the medical center and informatics department), that oversees the process of technology rollout suggested and approved the CDS system deployment in the neurology clinic. In addition, the CDS system was already in routine use by one physician from the general neurology practice, who also was an administrative director of the clinic. This physician was very satisfied with the system and became a main advocate for bringing it into the clinic.

The initial stage of the implementation process represented a self-learning opportunity for both the neurology clinic and the group from the informatics center that responsible for the system design and development. In the prospective of the common project between neurology and informatics center, the neurology clinic had a chance to evaluate the clinic practices to see what did not work, why it did not work, and how implementing the new CDS system could fix problems. On the other hand, the CDS development team could reflect on its prior

implementation in the cardiology clinic and based on that experience could evaluate whether the neurology clinic was a suitable site for the next CDS implementation.

***Differing objectives for the new CDS system implementation in the neurology clinic***

Analysis of the results reveals that from the start of the project, clinic leadership and physicians had a different outlook for bringing technology into the clinic compared to nurse management. The clinic leadership and physicians perceived the technology as a catalyst for increasing efficiency by getting the nursing staff more involved in patient care. The new CDS system offered an option where nurses would use a template that prompts them to collect comprehensive patient information for the physicians. To complete the template, nurses had to value the findings by "point and click" method and only had to type comments in cases where the template did not offer that option or the comment did not fit within the template content. Because of this feature, physicians could let nurses collect subjective information that patients report such as the reason for the visit, past medical history, family history, social history, and review of systems. With other documentation systems, nurses would have to remember what questions to ask and then type the answers in the free-text format. With the CDS system, nurses would enter elements of subjective information provided by patients into the template by simply valuing the field that applies. Information from the nurse's completed template would be automatically added to the physician's template. The physician were expected to quickly review the information entered by the nurse, correct it if needed, and complete the rest of the patient encounter documentation in his or her template and the program generates the "letter like" note. With the CDS system there would be two people participating in the clinic note creation: nurse

and physician. Figure 10 below illustrates the steps that the nurse and the physician take to create an electronic clinic visit note with the CDS application.

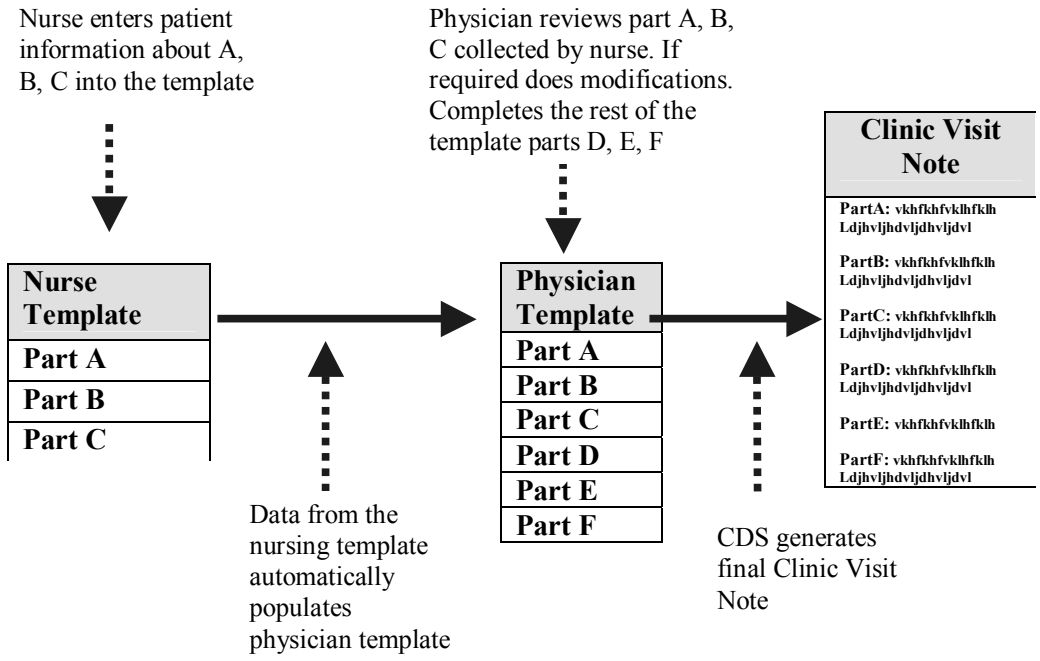


**Figure 13: Steps to Create a Clinic Visit Note in the CDS System**

With the previous system, nurses were only collecting and documenting patients' vital signs, list of medications, and allergies into the EMR system that later was transmitted into the physician note. With the new CDS system, nurses were asked to collect more patient demographics and history information in addition to what they were already collecting and documenting. Therefore, with the old system nurses were collecting approximately 10% of the note content, but now with the new CDS system they would collect about 30% of the information content that becomes part of the note. Figure 11 below illustrates what data elements

of the clinic visit note were collected and documented by nurses and physicians before and after CDS implementation.

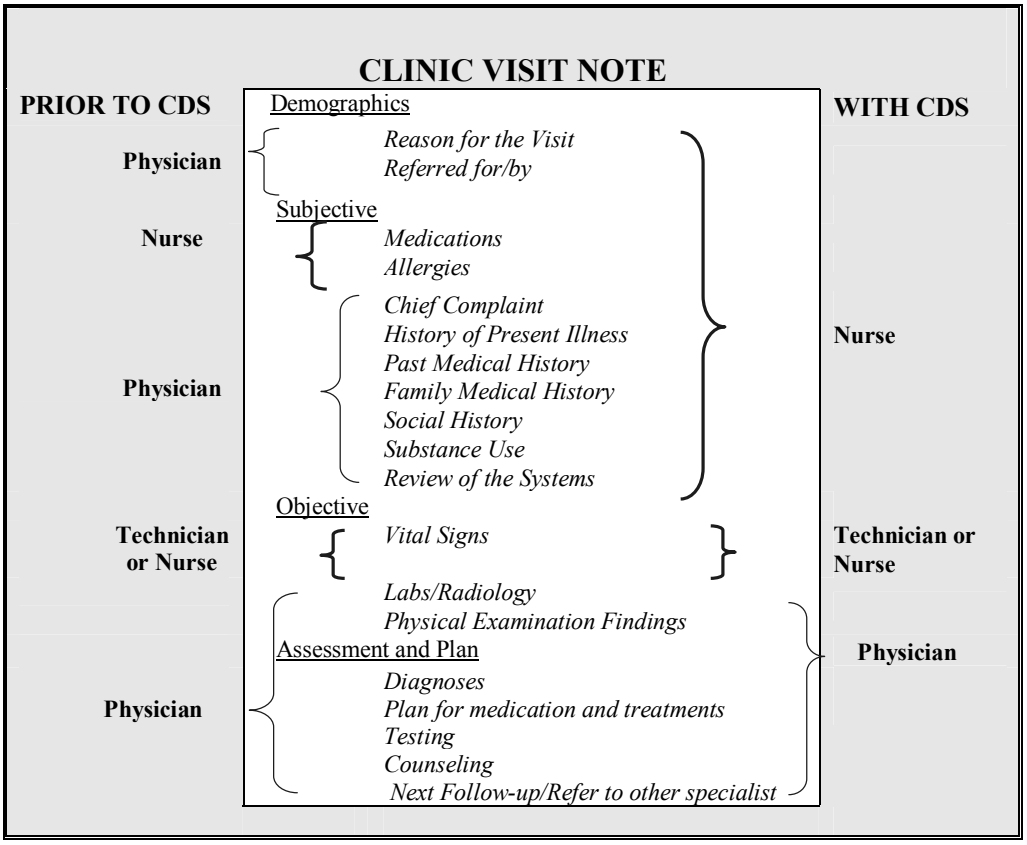


**Figure 14: Clinic Visit Note Content**

By taking this collaborative approach to the documentation, the new system would make nurses more involved in the patient care, and consequently help physicians to be more efficient. The director of the clinic explained that with the current workflow in the clinic nurses were required to collect minimum information from the patient prior to physician encounter with the patient.

> Clinic Director: "We wanted to get the nursing staff more involved in patient care that really was not happening at the time we have started this [CDS implementation]. At least I saw this as an opportunity to try to bring the nursing staff into the process. Previously nurses were bringing patient back to the exam room and that was it, and the physician would take over from that point and were not interacting with one another [nurses and physicians] at all. So, it [implementing CDS] was an opportunity, I thought, to help that process move along."
>
> Physician adopter: There was a hope that the nurse will do a lot more work, and that it will make a complete note, and the process faster. That was the hope.

While the clinic director and physicians were keen proponents of the CDS system because, nurse management views were different. Nursing management believed that the reason why clinic leadership and physicians considered using the new CDS was that it promised to save physicians' time documenting the clinic visit notes and not as a reason to get nursing staff involved more with the patient care process. Therefore, nursing management perceived new CDS system as a documentation tool that would only help physicians by letting them to create electronic notes faster compared to the old system.

> Charge Nurse: "Well, the overall affect they [clinic leadership] were hoping to achieve was to decrease the physicians' time, so that hopefully they could see more patients. I do not remember it [CDS implementation] being approached that [staff is more involved with the patient care] way. It is just that it would be a time saver for physicians."

There was no shared vision in the neurology clinic regarding the purpose of implementing CDS. Differing goals of nurse management and physicians caused conflicts later in the implementation. Nurses resented the system, they felt that they had to do more work to make physicians practice easier, and did not see it as a benefit to improving their skills. This misalignment jeopardized possibilities for structuring and facilitating the physicians and nurses adjustment to the technology as a one group later in the implementation.

***Users satisfaction with the system already in place***

Implementing CDS throughout the organization was not among the highest priorities for the informatics department and was not presented to the neurology physicians as something that they would have to adopt. Therefore, out of 23 physicians who see patients full-time or part-time in the neurology clinic, 16 were interested to learn about it and were approached by the IT representative to give a demonstration. Of these 16, 10 had potential interest in using it, and only five expressed a desire to participate in the implementation process. Other seven physicians either were already using custom-built systems to create electronic notes or wanted to wait and see whether physicians that were going to use the CDS system would like it before making a decision. The rest were just not interested in changing their current processes. It is important to note that when the institution-wide EMR system was implemented in the neurology clinic six months prior to CDS project implementation, the choice of whether the physician could dictate the note or use a computer system to create it electronically was left up to each individual.

Out of five physicians who agreed to participate in the new CDS implementation, all of them were already using built-in EMR functionality for creating electronic notes and some were using dictation as a method to create a clinic visit note for new patients. In addition, physicians were creating their notes during the patient visit right in the room, except for two physicians who were dictating notes for their new patients after the visit. Table 6 below shows what method was used prior to CDS implementation to generate his or her clinic visit note by each physician who agreed to be a part of the implementation.

**Table 6: Participants Clinic Documentation Strategies Prior to CDS Implementation**

| Physician | Specialty | Clinic Note for New Patient | Clinic Note for Return Patient |
|---|---|---|---|
| Physician 1 | General Neurology | Type/point click template in EMR | Type/point click template in EMR |
| Physician 2 | Epilepsy | Dictation | Type/point click template in EMR |
| Physician 3 | Epilepsy | Dictation | Type/point click template in EMR |
| Physician 4 | Stroke | Type/point click template in EMR | Type/point click template in EMR |
| Physician 5 | Stroke | Type/point click template in EMR | Type/point click template in EMR |

It is understandable that when someone decides to switch to a new system, there is something unsatisfactory with the system already in place. When asked the question of how satisfied physicians were with the existing system and whether the old system fit well with their current practices, physicians who ultimately became users of the new CDS system indicated that they were not satisfied with their old system giving on average a response of 2 - disagree on a 7-point Likert scale.

> Physician adopter: "Because it [creating a note for the new patient] was a lot of redundant work. You know, I filled the forms by hand, and I dictated the letter, and then we entered the data in the database. There were three steps, and if we could do everything in one, I felt it would be best, and what I don't like about my process in EMR is templates. Because if you are putting the whole note, then you have to go and take out what does not apply. If you miss, you put things that do not apply, and I have never liked that. I like to have a blank slate, and then you add what applies, as opposed to take out what doesn't apply."

On the contrary, physicians who did not become users of the new CDS system liked their old process and gave on average a response of 5 - agree on a 7-point Likert scale. One physician indicated that at the time of the proposed CDS implementation she was already using EMR

functionality for creating electronic notes. This physician was satisfied with system characteristics and was comfortable with creating electronic notes; however, she was interested in what other alternatives were available to create a note. Another physician also stated that she liked her old process and decided to participate in CDS implementation just to learn about new technology.

Questionnaire results showed that nurses who worked with physicians who adopted the new CDS system were less satisfied with the systems in place. Nurses who worked with the non-adopter physicians liked the existing system.

Quantitative results in Table 7 also demonstrate that non-adopter users were satisfied with the system in place, and CDS adopters did not like using the existing system.

**Table 7: Adopters' and Non-Adopters' Level of Satisfaction Level with Particular System Used**

| Particular System Used | Physician Adopter N=2 (Average) | Physician Non-adopter N=3 (Average) | Nurse Adopter N=2 (Average) | Nurse Non-Adopter N=3 (Average) |
|---|---|---|---|---|
| I was satisfied with the old system | 2 | 4.5 | 3 | 3.6 |
| The old system I was using fits well with my way of doing things | 2 | 5.5 | Not Asked | Not Asked |

Both quantitative results and qualitative results demonstrate that non-users of the CDS system were more satisfied with the use of the existing system compared to users that eventually adopted the new CDS system.

These results suggest that the satisfaction level with existing systems plays a significant role in the motivation to change. Users who had a low level of satisfaction with the system in place had a bigger gap in their performance compared to the users who were already satisfied with existing system, thus adopters were more interested in making the new system work for them. Therefore, the greater satisfaction level was for the system already in use the lower was the incentive for switching to the new CDS system.

***Physician users satisfied with the old system still wanted to get involved with the new CDS implementation***

Physicians who were satisfied with the EMR system characteristics including the functionality that it offered to create electronic notes were, at the same time, disappointed with the lack of nursing support in the current patient care process. All five physicians believed that the staff could take on more responsibilities in helping physicians to take care of patients. Moreover, all five physicians were willing to take time to put forth an effort to learn the new CDS system despite the fact that they had learned how to create electronic notes in the EMR system just six months prior to the CDS initiative. Physicians were excited about the new CDS system because it promised them the kind of support from staff that they could not have with the EMR system.

> Stroke physician non-adopter: "Well, first, we were not on EMR until January of last year 2003, so before that we used to dictate our notes, so compare to that EMR has many advantages. But, in terms of having a clinic that works efficiently we had very little help from the staff, so new CDS promised me the advantage of having a lot of information taken by the nursing staff so that my job will be a little easier and make the clinic more efficient".

> General neurology physician non-adopter: "I thought it [CDS] was a way of learning about the field [neurology]. And maybe to have a better note, a better communication about what we were doing".

The fact that users who were satisfied with the EMR system as a tool to create electronic visit notes but were dissatisfied with the clinic operations and were considering CDS as a "two in one" solution set a high standard for the new system. Now the new CDS system was expected not only to win them over as a better method to do documentation but also to create ways in which the clinic could be more efficient.

The interview results helped depict the neurology clinic environment at the time when the CDS implementation project was initiated, as well as to evaluate whether clinic leadership, nursing management, and IT representatives took into account clinic specifics when deciding to pursue the implementation. Among the characteristics that constituted neurology clinic climate and culture, interviewees emphasized that the new clinic leadership, recent changes in technology environment, and the general concept of how paired professionals work together had a negative impact on the implementation outcome. For example, one physician recognized that clinic was undergoing many changes during or immediately preceding the CDS implementation, thus creating additional strains on the support staff.

> Physician non-adopter: There have been so many changes. The Departmental Chair was new and they [clinic leadership] were trying to address many of the problems in the clinic, some of the billing problems. And you have got to remember that the EMR was fairly new when the CDS started, so I am not sure that they [nurses] were up to date on that yet. I think that they [nurses] were a bit overwhelmed.

The neurology clinic director also felt that being new in the clinic prevented him from recognizing staff skills shortages and reasons for overall clinic inefficiencies.

> Clinic Director: I think that I have probably missed a couple of potential problems, that I have should picked up on and I have not been here long enough to know the staff as well as I should have.

> IT Representative: The clinic director was very new to the clinic, and I did not know that at the time. He was very well spoken and he seemed like he knew what was going on and he knew that although the staff never did that [documented part of patient encounter], but they will and it will not be hard.

An important work group characteristic that this neurology clinic had and that ultimately became an obstacle in the later stages of the implementation is that nurses do not report to physicians, even though their role is to assist physicians with the process of patient care. For example, one physician was frustrated with the fact that since nursing staff reports to the hospital administration and not to physicians they are not making a lot of effort to be productive and do a quality job. In particular, with the new CDS implementation, nurses had to interact more with physicians and learn their specific ways of providing care in order to collect accurate data.

> Physician Adopter: "You know, I cannot-- I cannot enforce her [nurse] to do things that is hospital administration. If the nurse works for me, she is going to be more attentive to my needs".

The interviews disclosed that this clinic did not have a culture of strong partnership between physicians and nurses, which is another important factor that describes work group characteristics present in the clinic. For example, as soon as a patient completes the front-desk check-in procedure, a technician takes routine vital signs and standardized scales, a nurse then meets the patient to obtain the list of medications and allergies as well as to take all the forms that patient has to fill out before the visit with physician. After all pre-physician visit procedures are completed, the nurse leaves the patient in the room until the physician starts the examination. During this process, there were no situations where the nurse would engage in the conversation with the physician about the patient, for instance, brief the physician on the patient's condition. Similar, physicians would not ask the nurse about patient, but rather prefer ask same questions to the patient that nurse already asked themselves. The lack of nurse-physician communication, as

a charge nurse pointed out, was a "chronic thing in the clinic". One reason that might explain why there were no tight working relationships between nurses and physicians is the fact that the nurse to physician ratio was not at a 1:1 level. On average, at any given day about twelve or fifteen physicians were present in the clinic and only three technicians and six nurses were available for their support. Nurses were not assigned to a specific physician or a group of physicians and were rotating chaotically throughout the clinic.

> Stroke Physician: The problem is that there are so many people [physicians] working in the neurology clinic and I do not have one or two consistent people [nurses] who are just helping me. People [nurses] rotate all the time.

The clinic director also pointed out that staff was rotating constantly and this way of practicing was very hazardous because there was no accountability for work that was done. This situation frustrated many physicians. For example, one physician explained that clinic arrangement did not allow for nurses and physicians to develop tight working relationships.

> Epilepsy physician: I think if my nurse were to do their part, you know, she would do a very good job, because she is familiar with what the issues are, what is important, what is not important, and I could train her over years. But the way the clinic system works is, you know, a nurse sees me on Monday, but not on Tuesday, and not on Thursday, Friday, and by the time Monday comes, she would have forgotten what I like, what I think is important, what I think is not important.

The charge nurse confirmed that physicians wanted to have the same staff assigned to work with them routinely, because the more a nurse works with the particular provider the better she or he is at knowing the physician's habits and thus can be more helpful and resourceful.

The disappointment with staffing situation was a hot button topic. Before the CDS implementation, the staff was not assigned to any physician, and often physicians were looking for staff and could not find them when help was needed. One physician who left the clinic not

long after CDS the implementation agreed that if the ratio was at a 1:1 level it would be easier to use new CDS system.

> General neurology physician non-adopter: "I will argue that for the general neurologists there should have been one on one [physician to nurse ratio], because we were there everyday. I think they [clinic management] are doing it now. I think that part of that [1:1 physician to nurse ratio] was created by me leaving, I am not sure that it would happen if I would stay. And I think that kind of inspired them that, you know, they are not going to keep neurologists unless they will change a clinic a little bit."

There was no culture of collaboration in the neurology clinic. An IT representative agreed that the lack of collaborative structure was among the reasons why implementation of the CDS system was challenging from the start and as a result not successful.

> IT representative: "With cardiology, their process already was good. The synergy between the provider and staff was great, so they [staff and physicians] did not have a lot of process changes."

Along with work group characteristics, job content factors turned out to play a significant influence on shaping all users' attitudes towards the new system. Observations and interviews determined that the nursing staff was satisfied and comfortable with their job context. One nurse explained that the only thing they had to do with the EMR system they have been using is to enter down the vital signs, medications and allergies. They did not have to worry about past medical history, family medical history, social history, and review of the system. The charge nurse explained that the reason why the clinic did not utilize nurses to collect more information from the patient was an insufficient level of staff training. Four out of five staff members were Licensed Practical Nurses (LPN). Nursing management believed that because LPN's usually go through only a one-year training program and cover only basic nursing concepts they are not prepared to collect more comprehensive patient related information. However, nursing management believed that even if nurses had enough background to collect past medical history,

perform a review of the system, etc., they still would have difficulty with being proficient in collecting comprehensive patient information because there are twelve different areas of neurology specialization in the clinic that staff would have to learn.

> Charge nurse: "Our nurses are LPN's, and LPNs' are not really taught assessment, and that [taking past medical history, family history, doing review of the systems] kind of thing. They are taught to give medicine and to do the basics. It would be just the whole retraining, and for every person they work for, it would be totally different, because most of the doctors do not ask the same questions."

However, physicians were confident that the type of the degree has nothing to do with an ability to collect specific information that a physician is looking for. They believed that introduction of the new CDS system would promise enrichment to the content of the nursing job and that it would be associated with higher level of satisfaction with the new system; however, this did not hold true for the neurology clinic.

> Stroke physician non-adopter: "There are certainly LPN's who can do this [collect past medical history, social history, family history and do review of the systems] effectively, but it is not so much the degree, as the person, what they like to do and how much they really want to get into it. I think that for nurses, that [using CDS] provides them with more professional involvement in the patient care and it might be of interest to them, but it has not really hand out that way in our clinic."

Additional reasons why implementing the new CDS system was a challenge as recognized by physicians, the IT representative, and clinic management were user characteristics such as insufficient computer experience, a long history of employment with the organization, and the level of positive attitude towards computers and innovations as contributing.

Table 8 below shows that on average nurses had only about 2.8 years of experience working with computers, whereas physicians had 7.4 years.

**Table 8: Users' Computer Literacy**

| Computer Literacy | Nurses N=5 (mean) | Physicians N=4 (mean) | p-value |
|---|---|---|---|
| Number of years as experienced computer user | 2.8 | 7.4 | 0.21 |

In addition, questionnaire results indicated that physicians' and nurses' adopters had more positive attitudes toward computers and innovations in general compared physicians' and nurses' non-adopters; the average response to the question that measured the level of attitude towards computer and innovations showed the mean of 6.75 for adopters and mean of 5.2 for non-adopters. Table 9 illustrates this observation.

**Table 9: Adopters and Non-Adopters Attitude towards Computers and Innovations**

| Attitude towards Computers and Innovations | Physicians and nurses adopters N=4 (mean) | Physicians and nurses non-adopter N=5 (mean) | p-value |
|---|---|---|---|
| Information systems and services are an important and valuable aid to me in the performance at my job. | 6.75 | 5.2 | 0.09 |

One physician summarized that user characteristics such as a lack of extensive computer experience, not being previously involved much in the patient care process, and not being inspired about the CDS system implementation could be a possible reason why the CDS adoption was not successful.

> General neurology physician non-adopter: "Many of them [nurses] were not computer savvy, and again they had not been involved much in the patient care, and the third one, I am not really sure that they were really interested in it [CDS]. It was an older group that did not have a lot other, like the leaders, charge nurse had no computer interest or previous experience. I think that made have hurt for some of the other ones."

The IT representative, however, noticed that a larger weight factor that may have accounted for difficulties in adopting the new CDS system by staff members was the fact that many have been working in the clinic for a very long time. Since the staff was used to the task responsibilities that they had for years, they were prone to resist any new additional tasks that were required to perform to use new CDS. For example, two nurses that worked with physicians who adopted the system on average have been working 4 years in the clinic. Nurses who worked with the non-adopter physicians averaged 17 years of service in the organization.

> IT Representative: "If you looked at the different factors in the clinic, the people that were most resistant and were not comfortable with the process changes are those who were there the longest time. That clinic does not have a lot of turnover. The charge nurse has been there for over ten years; the LPN's have been there for a long time. Some of the nurses who adapted very quickly to new CDS are nurses that are fairly new either to the clinic or out of the nursing program, those are the ones who did not have as much troubles as the nurses that have been there for an extended period of time. So I think their adaptability was not due to inexperience with computers it was really due to the fact that they became comfortable in their role as doing just one piece."

Physicians, on the other hand, had a more positive outlook compared to nurses on the capabilities of new CDS to increasing clinic efficiency. The results of the Mann-Whitney test shown in the table 10 support this conclusion.

**Table 10: Physicians' and Nurses' Attitude toward Change**

| Attitude toward Change | Physicians N=4 (mean) | Nurses N=5 (mean) | p-value |
|---|---|---|---|
| Before implementation started, I was sure that the new system would provide solution to the problem. | 5.5 | 4 | 0.027 |

The clinic failed to have an understanding of its own environmental complexity. Nursing management did not have a vision that the goal of the new CDS system was to act as a strategic asset that can enable the neurology clinic to improve its structures and routines. Consequently, clinic management was not proactive in examining the roots of inefficiency prior to engaging in the system implementation and missed an opportunity to address them prior to implementation. The clinic environment was significant due to a number of characteristics. Clinic leadership was relatively new and was overly confident that the change could be implemented. The reporting structures were not effective for the CDS model. There was no history of collaboration among nurses and physicians. Staff was not experienced enough with using computers and did not have the medical background required to take a more extensive part in patient care process without additional training. The context in which the neurology clinic was operating was not scrutinized carefully. The clinic then faced difficulties with implementation and was unable to deal with them effectively.

On the other hand, the informatics group went through a successful implementation at another outpatient clinic and should know the defining factors, requirements, and weaknesses that any implementation site should possess or at least need to be aware. In the interview, the IT representative pointed out that in the case of CDS implementation in the cardiology clinic, the success of the system was based on culture of collaboration between nurses and physicians.

> IT representative: "With cardiology, their process already was good. The synergy between the provider and staff was great, so they did not have a lot of process changes."

Based on the previous implementation experience computer systems staff knew that important condition was to have a strong collaborative relationship between two caregivers that participate in the interdependent task such as creating one clinic visit note by nurse and physician. However, IT representative did not convince or requested from clinic management to work out process issues first and then implement CDS. Therefore, CDS implementation had fewer chances to succeed right from the start.

> IT representative: "Anybody listening to the experience would say, "Why did IT even attempt to implement CDS in that clinic, knowing what we knew?" And we did not want to. In fact, after I finished the analysis, I went to clinic director and I said, "Listen, this is very risky, your staff have never had to gather this information before, they never did this, and to implement that process, just that process change alone with the new system-- it is really risky and high risk for failure. So even though my recommendation to both him and the team [team that decides where new systems get implemented in the hospital] was not to move forward, they all thought that we needed to move forward, because they were convinced that it was in the best interest of the clinic."

### *Initiation Stage Results Summary*

The neurology clinic overlooked the fact that new CDS system would fundamentally affect their structures and processes. Table 11 below summarizes what factors have an influence on the implementation outcome and are important to consider during the initiation stage of the implementation.

**Table 11: Initiation Stage Findings Summary**

| Factor | Importance | Case Findings | Supported by |
|---|---|---|---|
| *Organization climate* | Important | New leadership; nurses report to administration and not to physicians | Qualitative results |
| *Work group characteristics* | Important | Physician-nurse collaboration was absent | Qualitative results |
| *Job characteristics* | Important | Nurses' job scope and prior educational training was different form the one required by new CDS. | Qualitative results |
| *Satisfaction with particular system already in use* | Important | Non-adopters were already satisfied with the old system, whereas adopters did not like their old system | Quantitative Results (mean difference) |
| *Attitude toward change* | Important | Nurse management and nurse non adopters had a negative attitude toward the change | Quantitative (Mann-Whitney test) and Qualitative results |
| *Positive attitudes toward computers and innovations* | Important | Nurses adopters had more positive attitudes toward computers and innovations compare to nurses non adopters | Quantitative (Mann-Whitney test) |
| *Computer literacy* | Marginally important | Physicians were more computer literate then nurses | Quantitative results (mean difference) and Qualitative results |
| *Number of years in the present position* | Important | Nurses who have been in their position for a very long time were less adaptive to the change | Quantitative results (mean difference) and Qualitative results |
| *IS department power* | Not important | Even though CDS project was not the priority for the informatics department it was not mentioned as a contributing factor | Qualitative results |
| ***New Finding**: Shared vision* | Important | There were no clear vision between nursing management and physicians re: what was the goal of CDS implementation | Qualitative results |

## Adoption Stage

### *The level of user involvement in the CDS implementation project*

Once there was a green light to proceed with the implementation of the CDS in the neurology clinic, the next mission was to make sure that everyone who was going to be involved would give 100% of their backing for the implementation. Both nurses and physicians were

interested and exited about prospective use of the system. Comparing these two groups the results of Mann-Whitney test showed no significant statistical difference in the level of their assessment of how relevant and important they thought the new system would be to them. Both nurses and physicians to the question how they view system to be relevant and important gave a responses higher then 5 - agree on the 7-point Likert scale, however, the response of the physician adopters together with their nurses was slightly higher compared to physicians non-adopters and nurses non-adopters. The table 12 below shows average response for the two groups.

**Table 12: Adopters' and Non-Adopters Level of Involvement**

| User Involvement | Physicians and nurses adopters N=4 (mean) | Physicians and nurses non-adopters N=5 (mean) | p-valu |
|---|---|---|---|
| I was interested and excited about the proposed new system | 6.0 | 5.1 | 0.2 |

In addition when looking at the nurses response by adopters and non-adopters, the results show that nurses non-adopters were less interested in the CDS implementation compared to nurses adopters (see table 13).

**Table 13: Nurses Adopters and Nurses Non-Adopters Level of Involvement**

| User Involvement | Nurses adopters N=2 (mean) | Nurses non-adopters N=3 (mean) |
|---|---|---|
| I was interested and excited about the proposed new system | 5.5 | 4.7 |

When nurse management, clinic management, and IT representative were asked a question whether physicians and nurses were excited and committed to the new change, their observation about nursing staff interest and level of commitment in the project was different then nurses' own assessment.

> Charge nurse: Well, I do not think that they [nurses] necessarily liked their old process, but I do not think that they particularly cared for the new either.

The quantitative results of the questionnaire also supports management and IT Representative assessment that nurses were less involved with the CDS project compare to physicians (see table 14).

**Table 14: Clinic Management and IT Representative Assessment of the Users Involvement**

| User Involvement | Clinic director and charge nurse N=2 (mean) | | IT Representative about nurses N=1 | |
|---|---|---|---|---|
| | About nurses | About physicians | About nurses | About physicians |
| Users were interested and excited about the proposed new system | 2.0 | 4.3 | 3.0 | 4.0 |

***Management commitment***

The clinic director explained that the reason why nurses were not excited about the new system was the prospective changes to their work environment. As a result, nurse management became less optimistic about the new system as they anticipated that there might be a resistance on the nursing side to it.

> Clinic director: "I think there was a lot of resistance to the idea that nurses would be more involved in the clinical processes with the patient, here it is historically have not been that way. The people here have been for a long time

and it was pretty dramatic change and approach for them, and I do not think that there was a lot of enthusiasm there. There were pockets of enthusiasm, but overall people saw it as a negative."

When the IT representative was asked a question whether nurse management was inspired about the prospective change she supported the clinic director's opinion that the nurse management was dedicated to the project.

IT representative: "The clinic leadership was very motivated to change, but it is individual components of the clinic that are not as motivated, and changes of course can be a lot harder."

Physicians and nurses who adopted the system had a different opinion about how committed management was to the change and to the project compared to physicians and nurses who did not adopt the system. The results of the Mann-Whitney test confirm the significant difference between two groups (see Table 15).

**Table 15: Users Assessment of the Management Commitment**

| Management Commitment (measured by three questions) | Physicians and nurses Adopters N=4 (Mean) | Physicians and nurses non-adopters N=5 (Mean) | P - value |
|---|---|---|---|
| **Management Commitment** | **5.75** | **3.6** | **0.05** |
| Clinic management took an active role in the preparing a plan for the new system implementation | 5.75 | 3.6 | 0.11 |
| Clinic management was aware of the benefits that could be achieved by using the new system | 5.75 | 3.6 | 0.03 |
| Clinic management did not realize the complexity of changes that would result as a consequence of the new system implementation (reverse coded) | 5.75 | 5 | 0.38 |

Physicians who adopted the system believed that, of course, it was hard for management to predict how system will blend with the clinic workflows and what the implementation would entail, but at the same time, these physicians thought that management was serious about perusing CDS implementation. Contrary to the adopter's position, physicians who did not adopt the system thought that nurse management did not like new CDS because it required nurses to take on additional responsibilities, and the nurse management had to put an effort to help nurses to accept the changes. The charge nurse was very concerned with the applicability of the new system in the clinic and was skeptical that it could be efficiently used with the amount of staff members clinic had.

> Charge nurse: I thought in the beginning that it is going to be a difficult system, because it was time consuming and the time is not anything that nurses has now. They rushed from the time they get here to get patient in and get them back.

One physician who did not adopt system stated that nurse management was not committed.

> Physician non-adopter: "Our clinic administration never really bought into CDS. Nurses were assigned to input data but they did not really become proficient and were not enthusiastic. They were not much encouraged by clinic administration and usage of CDS dropped off."

Charge nurse explained that the reason why they had started feeling that the system would not work well in the clinic was that there was not a 1:1 ratio of physicians to nurses and the fact that CDS would be time consuming, since it would require nurses to collect more information then previously.

> Charge nurse: The nurses were willing to do whatever physicians wanted them to do, but I feel like a lot of them felt like it was a burden, because it is already had been an overburden system in this clinic, with not enough staff.

However, all physicians completely disagreed with management who used staff shortage as an argument for why new CDS system could not work well in the clinic.

> General neurology physician non-adopter: "At one of our meetings they [clinic management] say there was not enough staff, but that really was not a very good point. When we had substitutes, they had no problems filling in the EMR system the history, medications and all of that, but our nurses were still having problems.
>
> Stroke physician non-adopter: "We [physicians] keep hearing that [not having enough staff] every time there was any suggestion of a change or doing anything system-wise. But, I am just not sure that I buy it. I really am not. I am just not sure that the nurses are that motivated to work, to be hones."

***User Participation***

Since the neurology clinic was only the second specialty where CDS was implemented it was required that some of the system functionalities would have to be readjusted and new technical characteristics added to meet the needs of neurology physicians. Therefore, to make the CDS system meet all required needs of the neurology clinic it was crucial that users would participate actively with the system ongoing modifications as well as implementation process itself. However, no strategies were established to foster user participation, especially to get nursing staff to participate. Physician had a chance to participate more, because they had to meet with IT representative one-one to construct the templates. No activities were offered to the nurses where they could develop beliefs that the new CDS system was important, personally relevant, and a positive development for the entire clinic. For example, IT representative did not get nursing staff to participate in the template creation, similar to what physicians were doing. Often, during the interview, when nurses were asked whether they had a chance to participate in the implementation process, and to contribute to either shaping the plan of the implementation or

maybe giving suggestions how to modify the CDS system to make it better fit and modification, the most common response was that they did not believe that their feedback would be valued and necessary, thus were reluctant to give any suggestions. The lack of nurse participation was supported by the Mann-Whitney test that showed significant difference in the level of nurses and physician participation during the course of the CDS implementation (see Table 16).

**Table 16: Users' Level of Participation**

| User Participation | Physician N=4 (mean) | Nurse N=5 (mean | p-value |
|---|---|---|---|
| I took an active part in helping Computer Systems staff to define the new system requirements and functionality | 6.0 | 4.6 | 0.031 |

The lack of strategies to make nurses to participate and most importantly the lack nurses participation in the implementation endeavor left less chances for nurses to overcome difficulties with learning the system, and the new complex task that system imposed.

As a result no attempts were made to create ways in which nurses and physicians would engage in activities that would help them to understand the need for the change, create some tasks for which nurses and physicians would be personally accountable, and be involved with the decision making process itself. Everyone was interested initially, but that interest was not sustained. Nurse management at this stage of implementation was not a full believer in the system. Therefore, nurse management and clinic management did not take on a role of a changing agent and did not seize strong nursing involvement making the new system work.

***Resources available to support implementation of the CDS***

Another important resource availability factor that may become a partial reason for some physicians to not adopt the system was the fact that the CDS was still in the development phase and not enough developer recourses were used in the project. The clinic director explained that initially he had an impression that many people were working to make the tool fully functional to be able to meet all neurology physicians' needs. He believed that it would be just few months away from having a final product. This was not the case. There was one full time developer assigned, thus it was taking longer for the new requests and changes to be processed.

> Clinic Director: "One of the problems with CDS is that it really was not fully developed product at the time we have started, in fact we are still making constant changes to make it better. Today, I think if we would brought what CDS do, to the physicians, and train them in using it, I think we would have totally different response, because it is totally different product today then it was back then. Back then, it really had limited "bells and whistles" in terms of what it could do. You ended up having to make work around and a lot of people just do not have much tolerance for that."

There were only two out of five physicians, who were willing to invest time in the system and stick with it, because it was bringing them value.

> Physician adopter: "It was not fully developed. The development, I think, can go in parallel with use, but I think there was not enough manpower, not enough developers working directly with physicians."

***Project champion***

One of the reasons why there were no activities to have users more involved and interested in the prospective implementation was clinic management reliance on the experience of one neurology physician who has been successfully using the system and who was also an initiator of the project. This physician champion was also a neurology clinic director. He has

been using the system for about a year. He was very satisfied with it because it helped him to be very efficient. The clinic management and leadership thought that if this physician and the nurse that was most of the times assigned to work with him were able to incorporate the system into their work routines successfully, then it would not be a difficult task for the rest of the users to repeat his experience. However, an important aspect was missed when making this assumption. This champion and the nurse who was assigned to work with him came together from same private practice. In this private practice, they have been working with similar computer system to create notes, hence to use system like CDS was not a new process.

> IT representative: "The champion's nurse came with him from his previous clinic off campus. She is very educated, and she gets a lot of information for him, she does a lot of his notes. I think he was saying, "Well, if my nurse can do it, then surely all others can do it too."

In addition, since CDS technology was intended to be used by nurses as well, it was important to have a champion from the nursing side. For example, the nurse that worked with the physician champion has been a good candidate to share her experience and inspire nurses to accept the change.

Management did not realize or understand the level of commitment required to implement the system. For example, one nurse explained that nurse management handed off the resolution of the problem that staff could have during the implementation to the CDS system support group.

> Nurse non-adopter: "I think for the most part they just left it up to CDS system support group and allowed them show us what we needed. When there were problems, we called computer system support, and because they [nurse management] were busy, management was busy with other things, and so they left it to CDS system support group."

As a result, there was no unified organizational commitment to make the change happen. Users did not find nurse management and clinic management to be fully committed. Users who

did not become CDS users especially noticed the lack of organizational commitment as a factor affecting adjustment to the new CDS. Questionnaire results in the table 17 and table 18 show the mean response to the questions about the management commitment. The non-significant p-values of 0.44 and 0.43 shows that both physicians and nurses equally did not agree that management viewed the new CDS as an important system for the clinic, and found that management was not effective to help with solving difficulties especially for non-adopters.

**Table 17: Physicians' and Nurses' Assessment of the Management Commitment to the Project**

| Management Commitment | Physicians N=4 (mean) | Nurses N=5 (mean) | p-value |
|---|---|---|---|
| From the start clinic management viewed the new system as being important to clinic's long-term goals | 3.5 | 4.8 | 0.44 |
| Clinic management was enthusiastic towards implementation of the new system | 3.5 | 4.6 | 0.43 |

**Table 18: Adopters' and Non-Adopters' Assessment of the Management Commitment to the Project**

| Management Commitment to the project &change | Physicians Adopters N=2 (mean) | Physicians Non-adopters N=2 (mean) | Nurse Adopters N=2 (mean) | Nurse Non-adopters N=3 (mean) |
|---|---|---|---|---|
| When there were difficulties while implementing the new system, clinic management tried hard to find right solutions | 4.5 | 2.5 | 6.0 | 4.3 |

***Adoption stage results summary***

The results from the questionnaire showed that overall, targeted users – physicians and nurses - were exited and ready for the CDS implementation. However, interviews with nurse management, clinic management and physicians revealed that nurses were less interested in the CDS implementation because of the additional tasks that would have been imposed on nurses with the use of the new CDS. This lack of nurse involvement later backfired, since the use of the new CDS assumed that nurse would do a considerable amount of information capture for the physician to finish clinic note. Comparing the means from the questionnaire results and interview findings showed a difference in the adopters and non-adopters outlook on whether management was committed to the projects from the beginning. Users, who did not adopt the system, believed that management was not completely committed to the implementation project and thus did not take actions that would assure that the system would be accepted. As a result, users did not feel involved with the project, thus did not participate later in the implementation. The involvement and participation would be especially helpful in the clinic where physician to nurse ratio is not 1:1 as it would help users to work out strategies to offset stuffing limitations. In addition, IT group was not able to secure more developers time for the project to make sure that all necessary technical changes could be implemented in a timely manner, thus leading users to lower level of satisfaction with the new system. Finally, clinic management did not take an opportunity to learn from the project champion how he was able to achieve successful system use as well as did try to have a champion for the nurses. Table 17 below, summarize what factors had an influence on the implementation outcome and are important to consider during the adoption stage of the implementation.

**Table 19: Adoption Stage Summary**

| Factor | Importance | Case Findings | Supported by |
|---|---|---|---|
| *Management Commitment* | Important | Nurse management did not view system as an important to the clinic goals. From the beginning nurse management had a perception that CDS could not work in the clinic because it would be time consuming and nurse intensive | Quantitative (Mann-Whitney test) and Qualitative results |
| *Commitment to the change* | Important | Adopters were more committed to the project and the change | Quantitative (mean difference) and Qualitative results |
| *Resource Availability* | Important | There were not enough staff members to support the use of CDS system. CDS system required constant modification, but they were not done fast enough to satisfy users, because only one full time and one part time developers were available for the project. | Qualitative results |
| *Project Champion* | Important | Physician Champion's successful experience of using CDS was not adopted successfully by management. Champion had to be more proactive in promoting and encouraging the use of new CDS. Also, there should have been a champion for nurses. | Qualitative results |
| *User Involvement* | Important | Results showed that user who did not adopt the system felt less involved with the project. | Quantitative (mean difference) and Qualitative results |
| *User Participation* | Important | Physicians were more active in participating in the implementation effort compare to nurses. | Quantitative (Mann-Whitney test) and Qualitative results |
| ***New Finding*** | | | |
| *Proactive Champion representative from every group involvea* | Important | It is important to have a champion that not only has an expertise in using the technology and believe that it can work, but also who encourages, and lead the project as well. | Qualitative results |

## Adaptation Stage

Throughout the adaptation stage, additional problems were revealed that eventually impeded the implementation effort.

### *The extent of the project planning*

The process of groundwork preparation started very actively. To prepare the neurology clinic and its users for system implementation, the IT representative had a number of meetings with the charge nurse and nursing management where they have built templates together based on current forms used in the clinic. The IT representative had a number of meetings with the clinic director, who was also the project champion, to learn about the clinic operations and get his ideas on how to implement the new CDS system.

To implement any change of this scope takes not just one person but a group. However, the approach to preparing the implementation plan was not carried out as a team initiative. First, not one meeting took place where everyone involved in the implementation, or at least one representative from each group, was present to discuss the implementation details. The charge nurse explained that the nursing management was not involved in preparing the implementation plan and that it was the IT representative and project champion who created the overall strategy for CDS implementation in the neurology clinic.

> Charge nurse: "I say that [implementation plan] was decided between the champion and the IT representative. There was a lot behind the scenes stuff going on between him and the IT representative that we did not know about and they would just come and say, ok this is what Dr. A wants."

To the question about how actively nursing management was involved in the preparing the plan of the CDS implementation, the IT representative said that nursing management was not participative.

> IT representative: "They [nursing management] were not really involved in it [implementation plan preparation]. We have suggestions from the champion. Because the champion was our first user, we had a lot of content for general neurology. Then we had a lot support from epilepsy. The implementation plan was based on what we had in CDS [referred to CDS knowledge base that is used to build template content] and which physicians wanted to go forward, and nurses that were going to work with physicians."

The informatics group knew that it is important to involve everyone in the planning process before CDS implementation as well as during the implementation. Regular weekly meetings where nurses, physicians, and management, could have an opportunity to work together with developers in the process of making changes to both the CDS system and clinic structures. Unfortunately, nurses, physicians, and nursing management rarely participated in those voluntary meetings. Many said that the time was not that convenient, even though meetings were scheduled for the lunchtime and lunch was always provided. Therefore, an opportunity to discuss and strategize how organization needs will be addresses during implementation, whether users need additional computer training, training in new skills, how to make physician – nurse interaction more effective with all users present was not employed. All preparation unexpectedly became a responsibility of the IT representative. Users would not meet as a group IT representative had to have individual meetings with nursing management and each physician one at a time. The IT representative would meet with the nursing management and get their input on the nursing template content and format. Then the IT representative would meet with every physician individually to gain their feedback on the templates. However, this approach was not effective. The goal was to build a template for a physician in such a way that

certain parts of it could also constitute a nursing template. To build effective templates that are precise, convenient to use, and easily understandable, nurses and physicians would have work closely together to build them, but that did not happen. As a result, the templates were built in isolation; nurses had hard time understanding the template content and knowing how detailed the physician wanted the nurse to be when collecting information.

> IT representative: "We also learned that the nurses only ask what the physicians want them to ask [refers to the content of the nursing template], but see the problem with that was we never got physicians and nurses together, we never could. So what we did we build a physician template and we created nurses templates based on what physicians wanted, but the nurses did not know a lot what that meant, because they did not do it before. That is where a lot of problems were."

The planning process was not thorough. Weaknesses were not addressed prior to the implementation, users and management was not involved in the preparation. Therefore, the unforeseen circumstances had to be addressed during the CDS implementation and that created a stressful situation for physicians as well as for the management. When physicians and management were asked whether implementation process was stressful, all five physicians gave response of 5-agree and management gave 7-atrongly agree.

The clinic director realized that taking a stage approach would have probably allowed staff and nursing management to deal with the problems gradually. Users would feel less pressured and would be able to embrace using the new technology.

> Clinic director: "It is clearly was not a homogeneous group of people in terms of nursing staff or physicians staff and their skills levels and comforts levels with this [new system and new process]. Just starting with everybody at once was not a good approach, I think. Taking couple of people who are comfortable with it, letting them work out the process would be much better approach, then trying to involve everybody."

With the new system, the nurses' job scope was changed. By using the new CDS system, every nurse was going to have a template and take a bigger part in the patient care process by

participating more in the documentation process. At the same time, physicians were going to change their method of documenting patient encounters by using the new tool and letting nurses collect information that later could be transferred into the physician note. Now physicians had to review the information gathered by the nurse plus trust that information. Both physicians and nurses had to be more collaborative and give constant feedbacks to each other to improve and make new process successful. The use of the CDS system assumed that nurse would have to spend more time in the room with the patient collecting information before patient sees the physician, but this process was not compatible with the current clinic practices. Prior to the new CDS system, staff personnel was not assigned to any specific physician or a group of physicians. Everyone was floating freely around the clinic. Patients were called in for the triage procedures by whoever was available next. Figure 12 below shows the flow of admitting the patients into the clinic prior to CDS implementation. Each arrow represents a patient. For the purpose of simplicity, the picture illustrates the clinic workflow with two technicians, four nurses and six physicians. As it can be seen from the picture, there was no structured approach to admitting patients into the clinic. Nurses and technicians were checking patients for all physicians at the same time, thus they were not able to develop tight working relationships with any physician. Physicians complained that when they needed help they either could not find the nurse or simply did not know which one to ask.

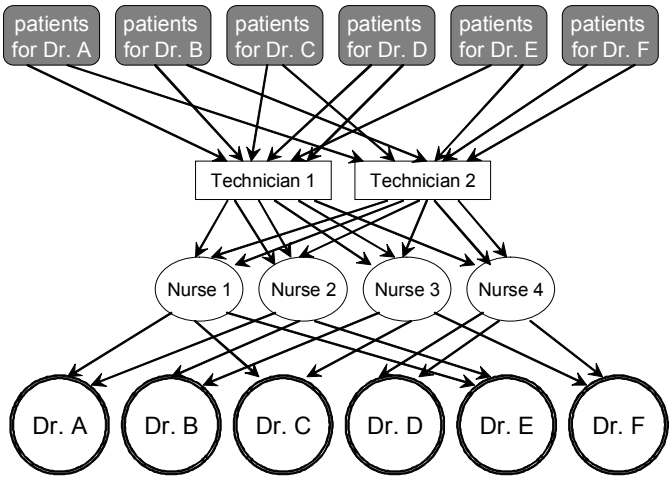


**Figure 15: Neurology Clinic Workflow of Patients Admission prior to CDS Implementation.** The neurology clinic workflow of admitting patients prior to CDS implementation. Nurses are not assigned to work with specific physicians. The patients are processed based on what nurse or technician is available next. Nurses were not readily available to physician when the help was needed, and physician did not always know who checked in the patient.

This chaotic approach to managing patients and preparing them for the visit with the physician could not work if the CDS system was to be used. It was important to make sure there would be equal distribution of nurses to support all five physicians that were going to use the new CDS system. Clinic management and the IT representative knew that the current structure was not as effective as it could be because there were always patients waiting for a room, physicians spending considerable amount of time in the room with the patient doing an exam and documenting the note, while nurses had a large amount of spare time between checking patients. With the implementation of the CDS system, clinic management decided to divide the clinic into "zones" and then assign at least one technician and two nurses to a particular zone. The "zones" were identified based on the clinic exam rooms' locations. In the neurology clinic, every physician would always use the same room or a number of rooms close by if needed, depending on how many patients were scheduled to come. Nursing management identified three zones in the clinic. Each zone had anywhere from one to three physicians working there at one time.

Usually two licensed staff members and one technician would be dedicated to the specific zone. However, nurses still could rotate into other areas if their help was needed and they were available. Figure 13 below depicts the neurology clinic floor plan and shows how it was divided into "zones".

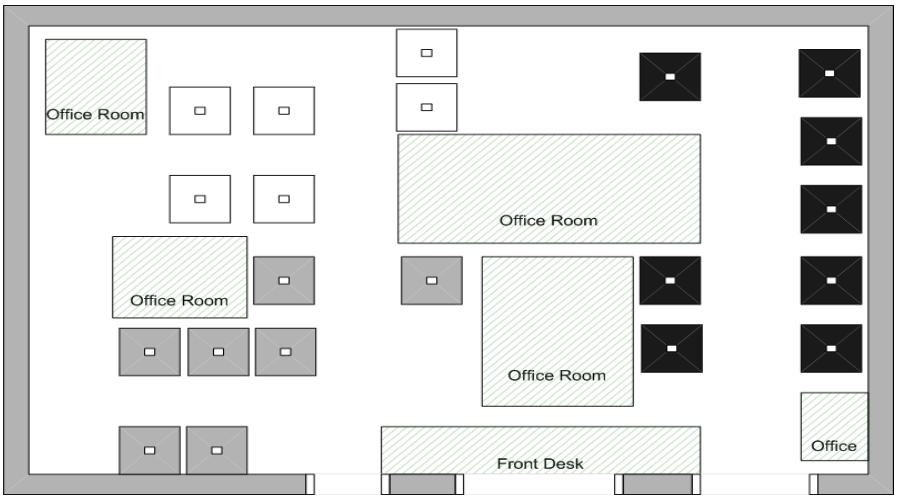


**Figure 16: Neurology Clinic Floor Plan of "Zone" Assignments.** Each small white, grey or black square represents a neurology clinic exam room. Two nurses and one technician were assigned to each zone. ZONE 1 - Grey; ZONE 2 – White; ZONE 3 – Black. An office room areas represent clinic space where offices of some physicians, and support personnel are located**.**

The clinic management thought that staff assigned to "zones" would be would be readily available to physicians, would be more dedicated, more collaborative with physicians and responsible for the tasks outcome. Along with providing a better approach to manage patient flow in the clinic and provide superior help to physicians, the implementation of the new "zone" structure made the clinic environment more compatible with the use of the new CDS system.

The process of managing patient flow in the clinic after the "zone" structure was implemented is shown in Figure 14.

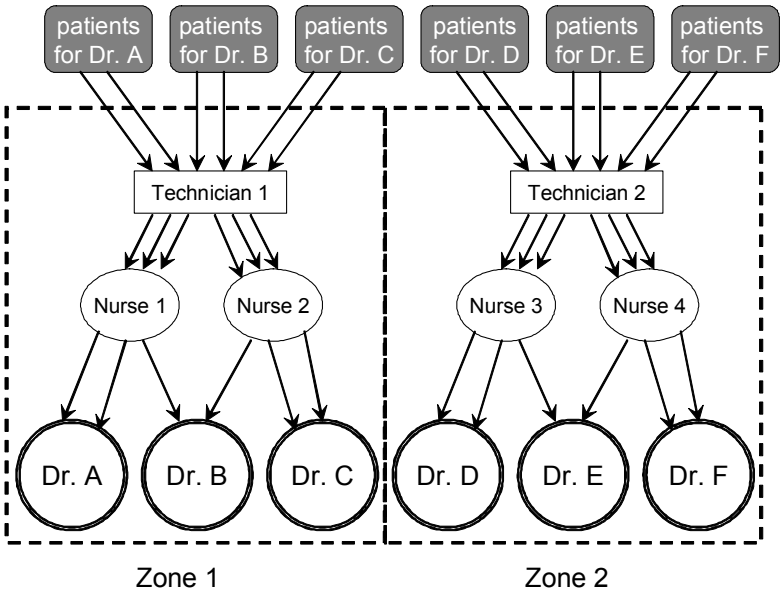


**Figure 17: Neurology clinic workflow of admitting patients with CDS implementation.** Nurses are assigned to work with specific physicians. The patients are processed based on what physician they are to see. Nurses always stay in the area "Zone" were the physician that they work with is located. Nurses are more readily available to support physicians when needed, and the physician always knows who checked in the patient.

The new "zone" approach was very successful; physicians loved it, because nurses were more helpful and more attentive to physicians needs. One physician explained that the new nursing assignments was helpful to physicians.

Physician adopter: Previously we would look for a nurse to see who is available and sometimes not all of them are available. So now, we know who is responsible. Now it is more organized.

However, combining the process change with the implementation of a new technology was stressful for nurses. Clinic director noted that having "zones" implemented along with the new system was not a good strategy.

> IT representative: "Zone system was implemented at the same time with the CDS. They [nurses] were not only learning a new application and how to get information out of the patient, but they had to learn their "zones". They [clinic management] did not implement it because of the CDS, it was going to be done anyway, and they just decided to do it at the same time."

Charge nurse also pointed out that with the new change nurses had to take more time to process patient information for physicians who were using CDS and other physicians began to get less support.

> Charge nurse: We have tried to assign at least two licensed staff to each zone, but a lot of times we do not have staff to do that. And then what it does, the people get really mad about this, if a doctor is doing CDS, then the nurse a get pulled from up there [zone where physicians do not use CDS] to come up back here [zone where physician use CDS], because Dr. A and B are using Quill, and the other doctors aren't and they [physicians who do not use CDS] took a registry nurses up there and they do not have their regular staff.

The uncertainty of the CDS implementation project could be characterized as high. First, the "point and click" structured templates was unfamiliar to the users. Secondly, it required nurses to drastically change their work practices in addition to learning new technology. In addition, no thorough planning effort took place that addressed nurses' training needs for the new task of eliciting new clinical information from the patients, how users would be educated about the project objectives, how users would be motivated, the strategies to make users participate, and how achievements would be measured and recognized.

***Management support throughout the project***

Nursing management took an active role in helping the CDS system support group to customize and prepare the system for clinic introduction. However, management became less active with providing support immediately after the users completed training for the CDS system. When users began to use the system and required extra assistance with the new process, management left the resolution of the problems to the CDS system support group.

> IT representative: I think with the initial kick off meeting there was involvement and even when we did training; the clinic leadership was involved with the training. Nurse Manager wanted to be involved in the whole process from the start to the implementation. So she [nurse manager] was involved very much so in the front. But as soon as, we got caught like after the training, and we really had to start getting the users to use the system, she kind of was more of a background process. She [nurse manager] would not be as proactive, but more reactive."

The management support dissolved right after nurses and physicians were trained in system use. For example, nurses were required to do more extensive assessment that included taking not just vital signs, allergies, and medications, but taking past medical history, family medical history, social history, and review of the system. However, no actions were taken to orient and familiarize nurses with the new medical concepts that they had to ask patients about. One nurse shared her experience with the struggle of asking management for help to learn the new process.

> Nurse non-adopter: "With that particular clinic management, it does not really do any good to bring up any issues, because whatever issues you bring up, there is not anything going to happen with it. They [clinic management] will tell you, 'Oh, yeah, I'm going to do such and such,' and it never happens. I had brought it up in a staff meeting once, that template content needed to be covered better with us [nurses], but that did not happen, of course. I mentioned to our supervisor that there were some things that I felt like I did not have a good understanding of, and that it would be good if it can be gone over with me. Her remark back was that we [nurses] did not have time, for her, to send us over to the School of Nursing to get more training. Kind of sarcastic."

A physician who did not adopt the system said that during one of the clinic management meetings, the nursing manager expressed that the new CDS system would be phased out, which surprised this physician because he never heard that before. Even though there were five physicians trying to adopt the system, nursing management decided to stop supporting the system.

Another example of how unsupportive and non-participative management was during the implementation process was given by IT representative:

> IT representative: "My background is nursing, so when we were doing training it was almost like I was taking a part of a nurse manager and training her [nurse manager] nurses how to elicit that [past medical history, family history, social history, review of the systems] information. So it was not so much of a system's problem it was "How do I get that information from the patient? They [nurses] did not know how to ask the questions. I found myself a lot of the times during the implementation when the nurse really did not know how to ask that question. I think there was a little bit of resentment on nurse manager side, because I was asking and suggesting that management spend some time with her nurses to do this training. And I think that bothered nurse manager a little bit, that a system's person was going to her and telling what the staff needs for training. That is where we had a lot of conflict, I think."

Along with the nurses, the IT representative and physicians also agreed that the quality of management support was "average" and there should have been more encouragement and incentives provided to everyone who participated.

> Physician non-adopter: "The physicians could see the benefits because it would streamline and maybe save time, but for the nurses it [CDS] is more timing and I do not think they saw the benefits, so maybe there should have been more encouragement and insensitive for the nurses. Some of this insensitive can be work one-on-one with the doctor because you are more involved in patient care. On their [nurses] side they have the same responsibilities plus more…"

An interesting result of a quantitative analysis of the users' responses to the questions about management support revealed that physician adopters together with the nurses they worked

with were more satisfied with the level of management support then physician non-adopters and their nurses (see Table 20 below). These results suggest that users who were finding the use of CDS difficult required more help and support from the nurse and clinic management.

**Table 20: Adopters' and Non-Adopters' Assessment of the level of Management Support**

| Management Support | Physicians and nurses Adopters N=4 (Mean) | Physicians and nurses Non-adopters N=5 (Mean) | p - value |
|---|---|---|---|
| **Management Support** | **5.31** | **3.8** | **0.09** |
| Clinic management provided most necessary help and resources to enable the use of the new system | 5.74 | 3.4 | 0.01 |
| Clinic management was very effective in addressing problems to Computer Systems staff | 5 | 3.6 | 0.06 |
| Clinic management was very effective in supporting changes in existing routines and processes that were critical to the new system implementation | 5.5 | 3.8 | 0.06 |

***Computer training***

Questionnaire results (see Table 21) showed that physicians and their nurses who adopted the system found the training programs sufficient and helpful; however, those who did not adapt believed that the system was complex and they would like to have more training opportunities then just one training class.

**Table 21: Adopters' and Non-Adopters Satisfaction with the Level of Computer Training Provided**

| Computer Training | Physicians and nurses Adopters N=4 (mean) | Physicians and nurses Non-adopters N=5 (mean) | p - value |
|---|---|---|---|
| Sufficient Computer Training in System Use | 6.25 | 5 | 0.06 |

Nurses who worked with physicians non-adopters were the less satisfied group with the computer training provided. Their mean response to the whether computer training was sufficient was the lowest among all other users (see table 22).

**Table 22: Physicians' and Nurses' Satisfaction with the Level of Computer Training Provided**

| Computer Training | Physicians Adopters N=2 (mean) | Physicians Non-adopters N=2 (Mean) | Nurse Adopters N=2 (mean) | Nurse Non-Adopters N=3 (mean) |
|---|---|---|---|---|
| Sufficient Computer Training in System Use | 6.5 | 6.0 | 6.0 | 4.3 |

One nurse who worked with the physicians, who did not adopt system, complained that CDS support group failed to recognize that for people who had little experience with computers there should have been more time devoted to the training.

> Nurse non-adopter: "I think the training could have been a lot more in-depth. In-depth, I mean, I seen, you [computer support staff] know, you took people that were not used to typing anything, you [computer support staff] put a keyboard in front of them, and you assumed that they knew how to type".

***CDS system compatibility with how physicians' and nurses' like to work***

During the adaptation stage users were learning more about the new CDS systems' functionality and how it would intermingle in their workflows. With the use of the new CDS system, nurses were asked to collect additional information from the patient that was previously collected by physicians. Physicians who did not adopt the system were very concerned with the fact that nurses would be collecting a big portion of data that was formerly collected only by a physician. Physicians found, that in many cases, information collected by a nurse was not accurate, and it took extra time to go back and correct mistakes. Moreover, compared to using the previous system, with the CDS system physicians were spending less time with the patient. One physician who did not adopt the system explained that the patient-physician interaction during collection of the patient history of illness is valuable for decision-making. Physicians not only obtain information to write in the note, but also asking questions and observing how patient responds helps physicians to give diagnoses. Therefore, if the nurse takes considerable portion of that information, the physician has less time to spend with the patient.

> Stroke physician non-adopter: " I still think you have to sit there with the patients, take their history, observe them, watch them, and examine them, reviewing some of their exam, while you're taking the history, you're watching how they react, how they move, whether they shake. And so to have a nurse or a nurse tech or whatever spend all that time with a patient and then give you this spewed-out document – it just doesn't replace, and yet it adds more time. I cannot treat patients without spending time with them and assessing them while I am talking to them. If somebody else can trust and sort of make assessments based on information that somebody else obtains, and then come in for five minutes and do an exam, then they probably could work with that system just fine, but I cannot."

General neurology physician and stroke physicians who did not adopt the system felt that having the nurse collect such extensive information instead of a physician was dangerous. These physicians felt that since nurses do not have enough training to deal with medical information

they could make many mistakes that physician could miss. The need to check whether information, entered by nurses was correct did not decrease the amount of work for a physician, but instead added to it.

On the other side, physicians who adopted the new system liked the fact that the nurse would collect information for them, making them more efficient. They knew that they would have to double check the information for correctness, but it still was advantageous for them to have a nurse collect patient's past medical history, family history, social history, review of the systems, in addition to vital signs, allergies, and medication list that they have been already collecting.

> Physician adopter: "I did not like a few things about old system. In addition, I had nurses-- I had my epilepsy nurse working with me with EMR template. She was writing things in, but she wrote them in biographically, sometimes with all the paragraphs. That is one thing I like about new CDS. If you click on the sentence, it comes out right. If the sentence is right, you know, it does not come out diagraphic or write it as paragraphs. So this was a way that I could-- even if the nurse could help me, if she clicked on the right sentence, the language would come out right, without any typographical errors. And I don't like that about old system, because, you know, they typed in a lot of things."

A common reason why three physicians did not adopt the system was they did not find that the templates designed in CDS were able to capture the complexity of problems their patients. They realized that for such specialties as general neurology and stroke it is hard to have a predefined template that would be flexible enough to use for all patients they see.

> Stroke physician non-adopter: "But see, neurology is still a little different then some of the other specialties. Symptoms of brain diseases are so variable and people describe them in so many ways, that it makes it much harder to put present illness into a bunch of boxes that you can click. So I never used that part of it. The first day I used CDS I typed in the HPI [history of present illness], so that defeats the part of the system from the beginning."

> General neurology physician non-adopter: "Most epileptic patients have a normal exam. You can always streamline, like with cardiology, but with general neurology that is not so, because you are looking at so many different things."

The questionnaire results confirmed that those who adopted the system found it to be more compatible with their practice, habits, and values. The mean responses for physicians' who found the system compatible are higher to the responses of non-adopter physicians. See Table 23 below.

**Table 23: Adopters' and Non-Adopters Assessment of the CDS Compatibility**

| Compatibility | Physicians adopter N=2 (mean) | Physicians non-adopter N=3 (mean) |
|---|---|---|
| Using the new system fits well with the way I like to work | 6.0 | 3.5 |
| Using the new system is compatible with all aspects of my work routines | 5.5 | 3.0 |
| The new system fits well with our clinic's way of doing things | 5.0 | 2.0 |
| I find it beneficial that this system allows nurses to have greater contribution to the clinic note creation | 6.0 | 4.0 |
| I find it helpful that using the new system requires frequent coordination with the nurses | 5.5 | 5.0 |
| I was not satisfied that with the new system I had more work in entering data | 5.5 | 3.0 |

Such factors as education about the project, personal innovativeness and system trialability were not found to help explain CDS system adoption. All physicians and nurses indicated that they had a good understanding and knowledge about the implementation process. All shoed that they like to use and experiment with new technologies and had an opportunity to experiment with the system before the use.

### *Adaptation stage results summary*

To summarize the adaptation stage, first, the plan was not adequate. Second, the process change was implemented along with the implementation of the new system, making it more challenging for the staff that was not experienced in either new process or technology. Third, management failed to provide sufficient support, they did not put sufficient effort into developing close working relationships with the informatics group. Fourth, implementation project had insufficient development resources. Clinic management viewed the proposed implementation more as an installation process and not as an organization or team endeavor where everyone should have been involved. Implementation plan did not address how to implement CDS so that it would be compatible with users' workflows, therefore, three out of five physicians did not find to system fit their job later in the implementation. Table 24 below summarizes what factors had an influence on the implementation outcome and are important to consider during the adoption stage of the implementation.

**Table 24: Adaptation Stage Summary**

| Factor | Importance | Case Findings | Supported by |
|---|---|---|---|
| *Project Team Composition* | Marginally important | An implementation team was not put together to implement the CDS. | Qualitative results |
| *Project Uncertainty* | Marginally important | The project turned out to have high uncertainty, because organization needs and how system will fit into work procedures were not assessed properly | Qualitative results |
| *Extent of Implementation Planning* | Important | The planning was not throughout. Many unforeseen circumstances occurred during implementation, thus making the whole implementation stressful | Qualitative results and Quantitative (mean difference) |
| *Management Support* | Important | Management did not exhibit strong support, failed to help and motivate nurses to master new work procedures | Quantitative (Mann-Whitney test) and Qualitative results |
| *Compatibility/Job fit* | Important | The CDS was not compatible with the clinic workflow, physicians, and nurse work routines. Management was not effective at restructuring tasks and clinic workflow to make new CDS be more compatible | Quantitative (Mann-Whitney test) and Qualitative results |
| *Computer Training* | Important | Questionnaire results showed that all users were in general satisfied with the training. However, physicians were more satisfied compare to nurses, and user adopters were more satisfied then non-adopters. Qualitative results revealed that there should have been more training provided to the users who were less experienced with the use of computers. | Quantitative (mean difference, Mann-Whitney) and Qualitative results |
| *Education about the project* | Not important | All users indicated that they had a good understanding and knowledge about the implementation process | Quantitative results (mean differences) |
| *Personal innovativeness* | Not important | Was not shown to be important for all users | Quantitative results (mean differences) |
| *Trialablity* | Not important | Was not shown to be important for all users | Quantitative (mean difference) |

**Acceptance Stage**

The acceptance stage is a culmination point that determines the implementation outcome. The events that took place during this stage revealed that management and the CDS system team were not well prepared to induce users to using the new system. Second, the new system did not

align with the clinic work context, as only two out of five users found it highly relevant to their job tasks and could realize positive impact on their performance.

When the new system was employed, the original nurses' workflow was disrupted. Aside form learning the new technology, nurses had to tackle new "zone" assignments in the clinic and get used to the new process of eliciting information from the patients. Obtaining information from the patients turned out to be the hardest change for the nurses.

It all looked easy – the nurse had a template with the information that needs to be asked, the nurse does not even have to type but just selected terms that apply by "point and click". However, it did not turn out to be an easy task for nurses. One of the reasons was that nurses were spending considerably more time then expected in the room with the patient eliciting the information using the new CDS system to complete the template. It was expected that with the new change, nurses would spend more time in the room with the patient since the amount of information that they had to enter into the template was greater than the basic information they have been collecting before. Physicians, on the other hand, were expected to put less information into the template. The information that was captured by nurses was populated into the physician template. Physicians simply had to review information populated by the nurse and proceed with completing the rest of the template, so that the CDS system would generate the final note. However, when physicians were collecting all the information by themselves they never had to wait on the nurse to finish with the patient, but now physicians were waiting for a nurse. It caused physicians to run behind schedule. In addition, nurses were often collecting inaccurate information and physicians had to spend extra time to correct mistakes. As a result, it was taking physicians more time to examine the patient and finish the note.

> Physician non-adopter: "That [nurse collecting and documenting more information for a physician] all certainly sounded appealing, but the thing is it

> did not come to pass; it did not happen, or if it did, it took them so long. It took them an hour to get a new patient. Then the information that they got was not reliable. We just had to go and go through it all ourselves anyway. It ended up that the clinic was later and later and later, but it wasn't really helping us."

One nurse gave her insight in why some physicians were not able to adopt new CDS.

> Nurse non-adopter: One of the things she [physician] is not a physician who is rushes through to see a patient. Her new patients will take her an hour, hour and a half, because she did a thorough work up. When we [nurses] took let say twenty minutes of her time to check patient in, well this is the same with Dr. X. We took twenty minutes of her time, then that sets her behind and she was behind all day, so she preferred to do an EMR."

The routines required to use the new CDS system were not established prior to implementation, and the nursing stuff did not have a chance to practice and become comfortable in the process of obtaining more information from the patient. As a result, nurses were struggling not only with learning new technology but also with becoming skilled at new processes. Their productivity decreased, and that had a significant effect on the physicians' ability to use the new system effectively. Physicians were not satisfied with the nurses' performance and nurses started getting negative feedback about their performance.

> Physician non-adopter: "Well, first, the nurses took a long time and then I had to go over what they put in, because it had inaccuracies and the spelling, things that I did not want to be on top of my name when I signed on. Some of the nurses in the clinic are better then the others. And some of the ones that were helping me were not good at it. I mean it was new and anybody is going to have a learning curve, but I think even in addition to that some of them are just not used to taking information ever."

To make matters worse, when nurses started having trouble nursing management was not working on ways that could help overcome difficulties in adopting new routines and new system. Their only intervention was to alter clinic processes and to aid at the use of the new CDS system was a creation of "zones" for nurses, but even it was not as affective, because was implemented

with CDS. Nurses were not given an opportunity to practice this new "zone" assignment prior to the implementation and had to start it at the same time with using and learning the new CDS system. The IT representative explained that management was not there when their help was needed.

> IT representative: "Nurses got a really bad rap for this whole process, and the physicians made nurses seem like they were stupid. How can you not know how to do a patient history? So the nurses' reputation was so damaged from all of it, and because of that, I think that nurses just wanted to get out of the clinic. Because it was exposing the things, they all knew about. So did the clinic tried to support it when it was going bad? Absolutely not."

Management was reluctant to develop interventions that could help nurses improve their new skills and help them with the new CDS process. For example, the interview results with the IT representative revealed that when users began using the CDS system, she was put in an awkward position. Instead of dealing with implementing the system, gathering user requirements, and incorporating them into the system's functionality, she was finding herself many times getting involved with the issue that nurses really did not no how to do the assessment. However, when nursing management was asked to have that issue addressed, no actions were taken and the IT representative was the one trying to come up with the solution that could help nurses improve patient interviewing skills. To help nurses practice the skills of obtaining information from the patient, the IT representative suggested creating a paper replication of the CDS nursing template. The paper form mirrored exactly the format of the CDS electronic template that nurses had to use to collect information. Nurses were asked to complete a paper form instead of the CDS template as a way to practice interviewing skills to become more familiar and comfortable with the substance of the new information they have been required to collect. However, nurses did not like the "paper CDS" intervention. It took them even longer to elicit information and then write it down on the paper compared to "point and

click" in the CDS system. Nurses dropped using paper forms before gaining any improvement with patient interviewing skills and gaining better understanding of the templates data content.

> IT representative: We thought, ok, we know that this is not a systems problem; we know that it is very easy to say yes, no, yes, no. The problem is that nurses did not know how to ask that information. They did not know what that concept meant. So we decided, I guess to do it partially to help the nurses with the training issues, but also to safe face with the application, because it was really damaging the reputation of the CDS. So I have created paper CDS forms and said: "Let's pull out of the CDS, everybody stop using CDS, let's do it the way we should have begun to do it, and let's do it on forms. That way you do not have the technology to be getting in the way of knowledge, and you can go along with the day and really, you know, have an eye contact with the patient, ask the patient a question you have to ask with out have to worrying about CDS. We created a CDS paper form of all the information the doctor wanted nurses to get. They hated it [paper replica of the CDS template], in fact it took more time for me to create forms and they did not even invest that much tome in to the process. They used it may be one or two times and said I would rather use CDS, then the paper form.

Interviewer: Did it help nurses?

> IT representative: "Oh, of course not. It is never had been CDS. Usually nurses genially care about their patients:" tell me why you are here today, what is your problem, are you feeling any better". These nurses literally go in there to get the information that they need to get, not because they are genially concerned about the patient, but because they need to get the information. So the nurse for example will see that the patient has ulcer, and then they will get that in the medical history, and then they will go down to the ROS [review of the system] and will say to the patient:" So do you have any peptic ulcer?" The patient has told you that three minutes ago. They just getting the data out of the patient and putting it in the system, they are not registering with the patient at all. The quicker they can get out of the room the better they are."

Consequently, nurses developed negative attitudes toward using the system; there were no feelings of enjoyment and satisfaction when working with it, but rather frustration and antipathy. Nurses could not become proficient in the new work routines and could not gather information fast enough for the physicians to see the benefit of nursing involvement in taking and documenting more information. The fact that they were slow in completing the template also influenced other physicians in the clinic who were not a part of the CDS implementation

project. Since the clinic did not have a 1: 1 ratio of nurses to physicians, nurses that worked with the physician that were implementing CDS still had to support other physicians. The IT representative mentioned that this caused a big strain on the providers who were not using the CDS system, providers who were using the CDS system, and the nurses who were feeling torn between the two groups. This tense situation was eventually reflected on nursing management, because in addition to the problems with the CDS system implementation and nurses not improving at the new processes, they also had to deal with non-CDS users' dissatisfaction with the quality of staff support.

> IT representative: "Because it is very stressful for charge nurse, to have to jungle around schedules, because some of the physicians feel like they were not attentive to, because their nurse was doing a CDS patient on the other physician. Even the physicians that do not use CDS are resenting it, because they are not getting their nurse, because the nurse is doing CDS. Charge nurse had to trouble with these issues on a daily basis. So, yes charge nurse would love to see us [CDS team] out of the clinic; she is not going to do anything to make it leave."

For nurses, the changes turned out to be complex and their work environment became stressful. Nurses became more and more resistant to the change that was necessary for the new system to succeed. This subsequently had a huge impact on physicians' ability to realize the benefits of the new system. A physician who did not adopt the system said that for some reason it was hard for nurses to become proficient in the new process. Physicians could see that nurses did not like the new changes.

> Physician non-adopter: "But they [nurses] just did not get it. I mean, it was not rocket science. It just seemed like we were waiting around; they were having problems; they would give up. Then they would just not even want to do it. And so we [physicians] sense all that."

The results from the questionnaire also showed that nurses and physicians who did not adopt system were not satisfied about how the CDS system was affecting

their work. The work environment became stressful as nurses were forced to get faster and faster with using CDS to collect data. Physicians' non-adopters were frustrated with nurses being slow and inaccurate. A nurse who worked with the physician non-adopter confirmed that a part of the reason why the CDS was not adopted is because it was taking more time compare to EMR system to complete the template for the nurse.

> Nurse non-adopter: "For instance, Dr. A did not like it because it made him slower. Because we [nurses] had to take the information, and put it in CDS. And so, that would upset him [Dr. A], and he was already slow, and he has 15 to 19 patients in an afternoon to see. So he just converted back to using EMR like he was. Because it [nurses using CDS] was taking too long for him to get in to see his patients. And I think that was partially our fault, because we was new to CDS, and we didn't know how to use the computer as well as we should have."

As a result, physicians' non-adopters did not assess the CDS system positively and that worsened CDS system chance to be acceptance. Table 25 demonstrates that non-adopters' mean responses were lower to the questions about whether new CDS system had a positive impact on their work environment compared to adopters who were pleased with the way system influenced their work setting.

**Table 25: Adopters' and Non-Adopters' Assessment of the Level of IS Impact on their Work Environment**

| IS Impact on User Work Environment | Physician and nurses adopters N=4 (mean) | Physician and nurse non-adopters N=5 (mean) | p-value |
|---|---|---|---|
| My use of the new system made my communication with (btw) nurses/ physicians more effective | 5.0 | 4.6 | 0.45 |
| My satisfaction with the job increased as a result of using the new system | 5.25 | 3.6 | 0.17 |
| My use of the new system made my work environment less stressful and more pleasant | 4.8 | 3.6 | 0.26 |

Though the p-values in the Table 25 do not show statistically significant differences, the results of the interviews with each participant revealed that users who accepted system were more satisfied with the changes brought by the new CDS system. One physician who did not adopt the system described that using the new system was stressful.

> Physician non-adopter: Was it stressful? You bet it was. The first Monday that Dr. A and I both did CDS, we were all there in clinic until like eight o'clock that night. It was terrible, because it took so long.

As a culmination point, nurses who had the hardest time adapting to the changes associated with the new CDS system were trying to persuade physicians not to use the system. One nurse gave an example:

> Nurse: "Well, I probably should not bring this up, but there is another nurse in the clinic and she did not like it [CDS], and she talked her doctors out of it [CDS]. This nurse does not adapt to change well, so she does not like things changing. She talked her doctor out of it [CDS], and then another doctor came on board and was kind of interested in it [CDS], and followed the suit."

> Physician adopter: "For example, there is a nurse and she would say: "Nobody does CDS in the clinic, and you're the only one who does CDS. "And we

> don't like to use CDS." So even though they [nurses] are saying it in a joking manner, but that is quite negative. Anyone who is not exposed to CDS will think well, she said that, so there must be something wrong with it [CDS]."

Nursing management could not handle the pressure. It was taking nurses too long to check-in patients when using CDS; physicians that were trying to use it were constantly complaining about the slow process; physicians who were not a part of implementation were complaining that they were not getting enough support. Inability to resolve the issues caused nursing management to become negatively predisposed toward new CDS. Nursing management began to talked physicians against using new CDS system.

> Physician non-adopter: "I think that charge nurse and nurse manager were trying to detour physicians away from CDS. They were saying like "I heard that EMR was better"…"

Another explanation of what influenced three physicians not to use the new system was the fact that nurses were not able to become proficient in collecting accurate information and completing a note fast enough was one of the reason.

Physicians who accepted CDS were also experiencing situations were it was taking their nurse an extended period of time to complete patient check-in plus information entered in the template could have mistakes and require revision. However contrary to non-adopters physicians adopters were able to find an alternative ways to adjust to the use of the new system in accordance to what nurses were able to do. For example, when a physician reviews information that a nurse enters for him or her and notices inaccuracy in the data, the physician would provide immediate feedback and tell exactly in what format the information need to be entered. If that meant that the physician had to leave the room in the middle of the patient visit, go find the nurse and explain her mistake, he would do this, so that next time the nurse would not make same mistake. In addition, both physicians agreed upon the strategy that if a nurse was

behind, she or he would just complete the template up to the point when physician was ready to see a patient, and let physician to pick from the place where nurse left filling the template. Despite, nurses performing not to the desired level, physician adopters still liked the fact that with this system nurses were contributing by documenting more information for them then with the old system.

> Physician adopter: They [nurses] were taking too much time asking questions.
>
> Interviewer: So what did you do to solve that?
>
> Physician adopter: We just said, "You know, there's a limit. You know, just you have five minutes, ten minutes."
>
> Interviewer: Did it improve?
>
> Physician adopter: "Yeah, it did improve. We asked them to do less. I said, "Skip the PMH [past medical history, skip ROS [review of the system]," skip a lot of things, you know. Just skip it. I still have to go through it most of the time to verify that it is right, bit it is helpful. They-- with CDS, the nurses still do a lot more than they used to before, that is for sure. So that's a positive thing."

One nurse also confirmed that those physicians who accepted the system were also willing to let nurse finish patient check-in and complete the note.

> Nurse: "Well, the doctors who like it [CDS], like it, and they are willing to wait a little extra. I have one specialist, but he does not see many patients, but if he comes out of the room, and he is a younger doctor, younger doctors are more flexible. But he comes over and if he is in a rush he will say: "Give just vital signs" and he will go in and do the whole thing. "

While, physicians who did accept the system were able to find ways to shape the process to make technology use advantageous to them, those who did not accept it were not able to find ways to make it fit. For example, a charge nurse explained that (opposite to adopters),

physicians who did not adopt technology were not open for a compromise that could help nurses to speed up the process of completing the template.

> Charge nurse: "I know that there were a lot of complaints about this is so slow, and that one so slow, and I do not even want to say. You know for the doctors who complained it take too long for the nurse to CDS a patient, yet we would say well go on and finish, but no, no, no I [physician] want the nurse to finish my patient. So there was no compromise, and it caused a lot of stress."

A nurse who worked with physicians' non-adopters also shared her observation that physicians non-adopters were disillusioned that it was taking a long time for nurses to put information in the note, but at the same time they did not bother to revisit the template and prioritize information input into the template.

> Nurse: If they [physicians] had meet with computer system staff and figure out a way to put down just the questions that they wanted answers to, it would probably be a lot better for them [physicians]. Because I think it [CDS] has potential to being very good, because it is a lot of information that can be put in that can help them [physicians] later."

Another reason contributed to why only two out of five physicians found the new system advantageous, was the technology itself: the specific characteristics of the technology, its design, how it functions, made a different impact on the adopters and non-adopters.

First, it is important to note that physicians who eventually became users of the new system were not satisfied with the prior system they used for the documentation. That placed the new CDS in a beneficial position compared to the old system. In addition, physicians' adopters became very committed, supportive towards implementation, and willing to wait and go through all necessary changes to make the system work in spite the fact that CDS was not fully developed

Another interesting observation is that both physicians who adopted the CDS were epilepsy specialist. They found that system offered a good way of creating templates for a patient population they see. For example, one physician had an epilepsy template, a template for mental disorder patients who also have epilepsy, and a template for patients with sleep disorders. Both physicians would also have a template for a return patient and a new patient. Since, epilepsy disorder is a well defined condition, it was possible to have same template that could fit the description of many patients. In addition, they noted that having a template allowed them to be more thorough when documenting a problem compare to when they had to type. One physician compared a CDS with the template within EMR system he used before.

> Physician adopter: "What I liked about CDS is that the default is blank, and then you have to actively add things. I saw a potential, you know, for making it [CDS] very helpful for a specialty clinic where we could add all the things [template items] that apply to our patients. You could have them [template items] in one place, and then add them as needed."

Two epilepsy physicians were also satisfied with the note output that the system generated. Physicians' adopters knew that output needed improvement but were satisfied with it and were willing to wait for improvements.

> Physician adopter: "Well, it [note output] still needs some fine-tuning, especially the language. It is not that very fluent English, but it conveys its message. And I have agreed to use it with the hope that eventually it will be like that."

Overall, physicians' adopters found that system allowed them to complete a note quicker, the notes they were generating were more complete, and had a better quality.

> Physician adopter: "The outcome was more accurate, because you had to be active to put something in, not to take it out."

In addition, both physicians adopters and their nurses found the system to be easy to learn and to use, whereas physicians non-adopters reported that the template-based approach to documenting was complex and not intuitive. Table 26 illustrates that physicians and nurses non-adopters found system to be technically complex.

**Table 26: Assessment of CDS System Complexity by Adopters and Non-Adopters**

| Complexity | Physician Adopter N=2 (mean) | Physician Non-adopter N=2 (mean) | Nurse Adopter N=2 (mean) | Nurse Non-adopter N=3 (mean) |
|---|---|---|---|---|
| The new system was easy to learn | 6.0 | 4.0 | 6.0 | 5.3 |
| Overall, I believe that the new system is easy to use | 6.5 | 3.0 | 6.0 | 5.3 |

However, the most important factor was physician adopter saw the benefit of having nurses to capture a substantial portion of patient information. Compared to the old system where two physicians adopters would not do a note for a new patient, now they were able to document new patient encounter right during the visit and send it to the EMR system. Both physicians agreed that they were more efficient with the new system. There were some features that they did not necessarily like but were willing to wait for changes. For example, to make CDS be accessible within EMR system. The CDS system was a stand-alone system and was not accessible from the EMR system, and every time a separate login was required. Despite the fact that system was not fully developed to fit the neurology practices, the physicians adopters were willing work together with the developers to keep making it more and more suitable for their needs.

> Physician adopter: "I still feel the advantages outweigh the disadvantages, yes. That is why I am still here. I am sticking with it."

***CDS technical characteristics that made some physicians to use and others not to use it***

In contrast, physicians who were already comfortable with their old documentation system and invested effort to make it fit into their routines did not find that the CDS offered substantially greater advantages to them. Physicians who decided not to use system were not pleased with the format of the note. Because the program would output the note content more in a bulleted format then letter like format, notes were long. Non-adopters were not satisfied with the how sentences sound. As a result, they were not willing to use it.

> Physician non-adopter: "And not to mention the fact that what you got was a very long note, but without substantive English sentences, except for what you typed in, which I was already able to do in EMR, to type in the impressions, to type in the HPI [history of present illness]. You know, all the rest of that stuff that is listed in those long bullets, to me, is very awkwardly written, and not very helpful and not easy to read, not easy to scroll through, and there's nothing nice about it."

Physicians' non-adopters did not find the system to be flexible to their particular specialty. General neurology and stroke physician see patients with various problems, thus it was very hard to have a template or even a set of templates that can be used for all possible patient cases. CDS was not flexible enough to develop a template for general neurology patients that these three physicians often see.

> Physician non-adopter: "But you see, that kind of comes back to my idea that it's [CDS] really not intuitive. It is not how we [physicians] think. Because we all pretty much do similar neuro exams and take histories, and yet, for some reason it was not intuitive how to make templates for like standard neurological patients, and yet you would think it should be."

Non-adopters were not satisfied with the quality of information that nurses were entering into the templates and they needed to go over the information, thus

increasing their time of the documenting the note. Compare to their old system, with the new CDS it took longer for them to create a final note. These group found it highly inconvenient that the system required separate access, since it was not integrated within the institution wide EMR. In addition, all non-adopters could type fast and do the note right in the room with the patient. An ability to type fast allowed them to have control over the note output format, and they were not limited to items presented in the template, thus they were able to use one EMR template for all of their patients.

The results in the Table 27 shows that physicians adopters together with nurses who worked with them were more satisfied then physicians and nurses that did not adopt it with the system quality and the quality of the information it offers.

**Table 27: Adopters' and Non-Adopters' Level of Satisfaction with the CDS system quality and Quality of Information**

| User Satisfaction | Physicians and nurses adopters N=4 (mean) | Physicians and nurses non-adopters N=5 (mean) | p - value |
|---|---|---|---|
| **User satisfaction with system quality and information quality** | **4.8** | **4** | **0.05** |
| The access to the new system is easy and convenient | 5.8 | 5.4 | 0.51 |
| The new system is flexible to changes and adjustments that result from new conditions, demands, or circumstances at my work | 5.25 | 4 | 0.13 |
| The new system does not overloads me with more data than it seems I can possibly use | 5.8 | 4.6 | 0.16 |
| The new system provides output that is complete and accurate | 5.5 | 3.6 | 0.04 |
| The new system does not have errors that I have to work around | 4 | 4 | 1.0 |
| I have a high level of confidence and control when working with the new system | 5.8 | 4.2 | 0.13 |
| The new system has the ability to integrate data with other information systems I use | 5 | 4 | 0.26 |

When looking at the mean responses for the question about relative advantage (see Table 28) of the new CDS compare to the old system, we can see that physicians who adopted new CDS found it to be beneficial and helpful for documenting clinic visit notes. Whereas, physicians who did not adopt CDS system did not find it to be advantageous compared to the old system.

**Table 28: Physicians' Adopters and Physicians' Non-Adopters Assessment of the CDS System Relative Advantage**

| Relative Advantage | Physician adopter N=2 (mean) | Physician non-adopter N=2 (mean) |
|---|---|---|
| Overall, I find using the new system to be advantageous in my job | 6.0 | 3.0 |
| Using the new system enables me to accomplish tasks more quickly | 5.5 | 2.5 |
| Using the new system improves the quality of work I do | 6.0 | 1.5 |
| Using the new system makes it easier to do my job | 6.0 | 2.5 |
| Using the new system enhances my effectiveness on the job | 6.0 | 2.0 |
| Using the new system gives me greater control over my work | 6.0 | 2.5 |
| **Total score for the relative advantage construct** | **5.91** | **2.3** |

***Acceptance stage results summary***

Analyzing events that occurred during the acceptance stage of the implementation project through quantitative and qualitative results showed that the organization was not well prepared to make all users to accept the system. Only two out of five physicians were able switch to CDS as a method to document patient encounter. These two adopters found a way to create electronic visit notes in the CDS system more advantageous compare to an EMR system. The CDS system allowed them to create notes faster and to have a more complete note compare to the typed notes in the EMR system. Adopters were able to find ways to offset nursing insufficiencies so that the process of collecting information by nurses would be efficient. Physicians who used CDS system had a higher degree of satisfaction with the quality of the system characteristics and the quality

of the system information. They were satisfied with the CDS format of the clinic note output, found system easy to use, and were able to create templates that would contain information exactly which they needed a nurse to collect. Adopters found template approach to flexible enough to document a note for different type of patient they see, they did not mind logging into stand alone system, and were able to communicate to nurses exactly how they wanted nursing part of information be incorporated in the template.

On the other hand, for the non-adopters the successful use of the CDS system was undermined because nurses were having difficulty adjusting to the new routines thus affecting the physicians' productivity at work. In addition, non-adopters did not find that the technology functionality fit their tasks and that subsequently it had a huge negative impact on physicians' ability to realize the benefits of the new system. Physicians' non-adopters were not pleased with the way their clinic notes turned out. They did not find the system flexible to their particular general neurology and stroke specialty. They were not satisfied with the quality of information that nurses were putting into their templates, thus increasing their time to correct mistakes. Moreover, they found it inconvenient that system required separate access because it was not integrated within the institution wide network. Table 29 below, summarizes what factors had an influence on the implementation outcome and are important to consider during the adoption stage of the implementation.

**Table 29: Acceptance Stage Summary**

| Factor | Importance | Case Findings | Supported by |
|---|---|---|---|
| *Facilitating Conditions* | Not Important | Was not identified by users as a contributing factor to the implementation failure. | Qualitative results |
| *Relative Advantage* | Important | Adopters found new CDS more advantageous compared to non-adopters | Qualitative results |
| *Task Technology Fit* | Important | Adopters found new CDS to fit their task compared to non-adopters. | Qualitative results |
| *Complexity* | Important | Non-adopters found CDS technology difficult to learn and use | Quantitative results (mean differences) and Qualitative results |
| *Results Demonstrability* | Not Important | Was not identified by users as a contributing factor to the implementation failure. | Qualitative results |
| *User Satisfaction with system quality and information quality* | Important | Adopters were more satisfied with the new CDS system qualities compared to non-adopters | Quantitative (Mann-Whitney test) and Qualitative results |
| *Impact on user environment* | Important | Non-adopters did not find new CDS to impact their work environment in a positive way. | Quantitative results (mean differences) and Qualitative results |
| *Resistance to change* | Marginally Important | Nurses' non-adopters were more resistance to the change and new CDS compare to nurses adopters. | Qualitative results |
| *Attitude toward using new technology* | Important | The attitude toward system was more negative for non-adopters then adopters. | Qualitative results |

# CHAPTER V

# CONCLUSIONS AND FUTURE RESEARCH

## Conclusions

This study utilized four stages of the Kwon and Zmud (1987) model of information technology implementation to develop an inductive understanding of the IS implementation process. The model was examined in the context of a healthcare IS implementation. During this time, there are numerous opportunities when the process can go wrong. When an IS implementation fails, technology is often blamed while in many cases it is not solely the technical issue but organizational, user or managerial together (Berg 2001). We believe that this study contributes to our understanding of what works and what does not during the IS implementation process.

An important observation of the study aligns with the Lewin's (1952) theory of change on which Kwon and Zmud (1987) model and our model is based. The change theory suggests that implementation of the IS, first, and foremost is the process of the organizational change. In our analysis of the failed CDS system implementation in the neurology outpatient clinic, we found that the process of implementation was not approached as an organizational development opportunity, but rather as a matter of the technology deployment. As a result, the new CDS system was not perceived as an integral part of the intended organizational change but more as an object, that necessitated the change.

We found that during the **initiation stage** when the process of identifying the organizational opportunities for change is undertaken and technology is selected as a potential

solution to the problem, it is also equally important to complete a process of evaluating the organizational context. Organizational culture is entrenched and thus is not always easy to change. In this study, we found support that such characteristics of the organizational context, as conductive *organizational climate,* collaborative *work group,* employees' *job characteristics such* as control over work quality and responsibility for the outcome*,* are possible antecedent for the implementation success. It appears that if leadership does not do a good job of learning about its employees, and their competencies the new IS system will fail. The results of our study also showed that users who have less *computer experience*, have negative *attitudes toward computers and innovations*, and long *history of employment* with the organization are less adaptive to the new CDS, therefore, these factors can serve as a signal that implementers need to take extra steps in encouraging the use of the new the IS among users with this characteristics.

An important finding made by the study, which the model did not account for originally, is the importance of the clear vision of the objective for the IS implementation.

Current organizational technology context in particular the *level of the satisfaction with the system already in place* among users provided interesting insights into understanding what motivates users to adopt a new IS system. The results of our study show that there is a relationship between satisfaction with the old system and the successful adoption of the new IS. All three non-adopters were satisfied with the old system they have been using, thus they had a smaller performance gap, and were less stimulated to adopt new IS compared to the users who were unsatisfied with the old system.

Attitude toward change played a defining role in the entire implementation process. In our study, nurses who did not adopt system and nursing management were skeptical toward the change before it even started.

Examining the **adoption stage** of the implementation process showed that the factors that prevented new CDS from being implemented successfully were the lack of *management commitment* to the project that resulted in an inability to get users involved. The lack of management commitment to the change became a blocking stone that obstructed the success of the IS implementation. Users that did not adopt the system felt the lack of management commitment most acutely and cited it as a leading factor for their inability to adopt the system. Users did not develop the feeling of project ownership and responsibility for the implementation outcome because they were not actively involved in the project implementation. When serious problems developed, management was less active, problems were not addressed, and solutions were not provided that would increase the implementation chances for success. The study results suggested that the *lack of participation* by the users whose tasks were restructured the most affected, were least likely to accept the use of the new CDS.

The fact that implementation project had a physician lead as *project champion* was not shown to have a significant impact on the implementation outcome. However, the qualitative results of the study suggest that first of all, the champion was very new to the organization and was not aware of many characteristics of the neurology clinic - thus preventing him from being effective. Even though the champion used the technology successfully, other users were not able to repeat his success. Therefore, project champion acted more as an "exemplar" of the CDS successful use, and not as an opinion leader that could inspire others to adopt the technology. Another factor that our results identified as important is that in the environment where two groups of professionals work together, for instance nurse and physician, it is important to have a champion representative from the each side.

It is important to accentuate that systems often require additional development to fit particular needs of users to minimize user dissatisfaction and set reasonable objectives. Sufficient development resources must be devoted to the system implementation project. The results of our study show that due to thin development resources, not every user was willing to wait for the system changes especially if such users were satisfied with the old systems. The inability to address the user needs for change in the system can lead to user dissatisfaction and withdrawal from the new system use.

The results of the **adaptation stage** indicated that the organization was not well prepared to support users during the implementation. First, the project was not managed by the project team that included representatives from physician, nurses, management, and IT. This is partially explained by the lack of management commitment and user involvement. Where system use and the execution of particular tasks, such as creation of the clinic visit notes by physician and nurse in our case - is interdependent it is extremely important that users work together to prepare for the system use and management provide extensive support for that.

Although, it is difficult to plan and predict the outcome of the IS implementation, having a plan is vital. The results of the study show that the level of the *implementation planning* affects the IS implementation outcome. In our case, the neurology clinic did not have plans to address how organizational and users needs would be met. Most importantly, a plan is required to show how current structures are going to be re-designed, or how users will be trained in the new routines. In addition, what are the new evaluation criteria and reward system that need to be initiated to exploit the most appropriate use of the new IS, how to educate users about the project objectives and what is expected of all parties. In our study, adopters and non-adopters were equally satisfied with *the extent of education about the project*, availability of the technology for

the *trialablity* before actual use, and personal innovativeness, hence we did not find theses factors help in understanding why some users adopted or did not adopt the system.

There was a relationship between *management support* and users who adopted the system. Non-adopters who had trouble with adopting new CDS and required more supportive management, suggests that management support has a significant impact on the implementation success.

Finally, the results of our model support that the more users perceive the technology to be *compatible* with their existing work practices, past experiences and future needs, the more chances that the technology implementation will be successful. Our study also supports that the factor of technology compatibility is especially important to consider during the adaptations stage, since at that stage users try the system for the first time and start to form initial decisions about commitment for further technology use.

Finally, the results from the **acceptance stage** demonstrated that adopters who realized that the new *technology characteristics fit their individual needs* did not find the system to be complex to learn and use, were more satisfied with the system quality and were satisfied with the quality of the information from the system. As a result using the new CDS allowed adopters to realize the *relative advantage* of the system to them and realized positive impact on their work environment.

Some adopters saw the advantage in the use of the new system, thus were more willing to bear with the fact that system required additional technical changes to meet all their needs, whereas for non-adopters the system with technical limitations to meet their needs represented a significant barrier for the system acceptance. Another reason that contributed to non-adopter withdrawal from the new system use was that nurses did not become proficient in the new

routines associated with the system and these non-adopters were not willing to wait and did not believe that nurses would become sufficiently proficient to provide effective support when the CDS is used.

The results demonstrability factor - the degree to which the effects of an innovation are visible - was not found to affect CDS implementation in either negative or positive way on system acceptance. Other factor that was not found to explain system use was facilitating conditions associated with the level of support provided by CDS computer system staff throughout the project.

An important finding was that the nurses who worked with physicians' non-adopters were more resistant to the change and thus physicians' non-adopters and nurses non-adopters had a negative attitude towards using the new technology.

A refined model is proposed based on the study results (Figure 15). Factors that were shown to have no impact on the implementation outcome, thus were not important, were marked as "~" in the model. The remaining factors were differentiated by their level of importance according to the study results. To classify important finding we use "**" and marginally important we use "*". In addition, new factors that were identified are added to the model and highlighted in bold. Table 30 below also provides a summary of the study results that shown support for previous IS implementation research theories, results that were found to be only marginally important in explaining implementation outcome as prior theories showed, and new constructs that were identified to potentially account for the implementation outcome.

**Table 30: Summary Results**

| Initiation | Adoption | Adaptation | Acceptance |
|---|---|---|---|
| **Factors that were shown to support prior research findings** | | | |
| Organization climate<br>Work group characteristics<br>Satisfaction level with particular system already in use<br>Attitude toward the change<br>Positive attitudes toward computers and innovations<br>Job tenure (Number of years in the present position) | Management commitment<br>Commitment to change<br>Resource availability<br>Project champion<br>User involvement<br>User participation | Project Team Composition<br>Project Uncertainty<br>Extent of Implementation<br>Planning<br>Management Support<br>Compatibility/Job Fit<br>Computer training | Relative Advantage<br>Task technology Fit<br>Complexity<br>User Satisfaction with system quality and information quality<br>Impact in user environment<br>Attitude toward using technology |
| **Factors that were shown to be marginally important** | | | |
| Computer literacy<br>IS department power | | Education about the project<br>Personal innovativeness<br>Trialabiliy | Facilitating conditions<br>Results demonstrability<br>Resistance to change |
| **New Findings** | | | |
| **Initiation** | **Adoption** | **Adaptation** | **Acceptance** |
| Shared Vision | Proactive champion representative from every group involved | | |

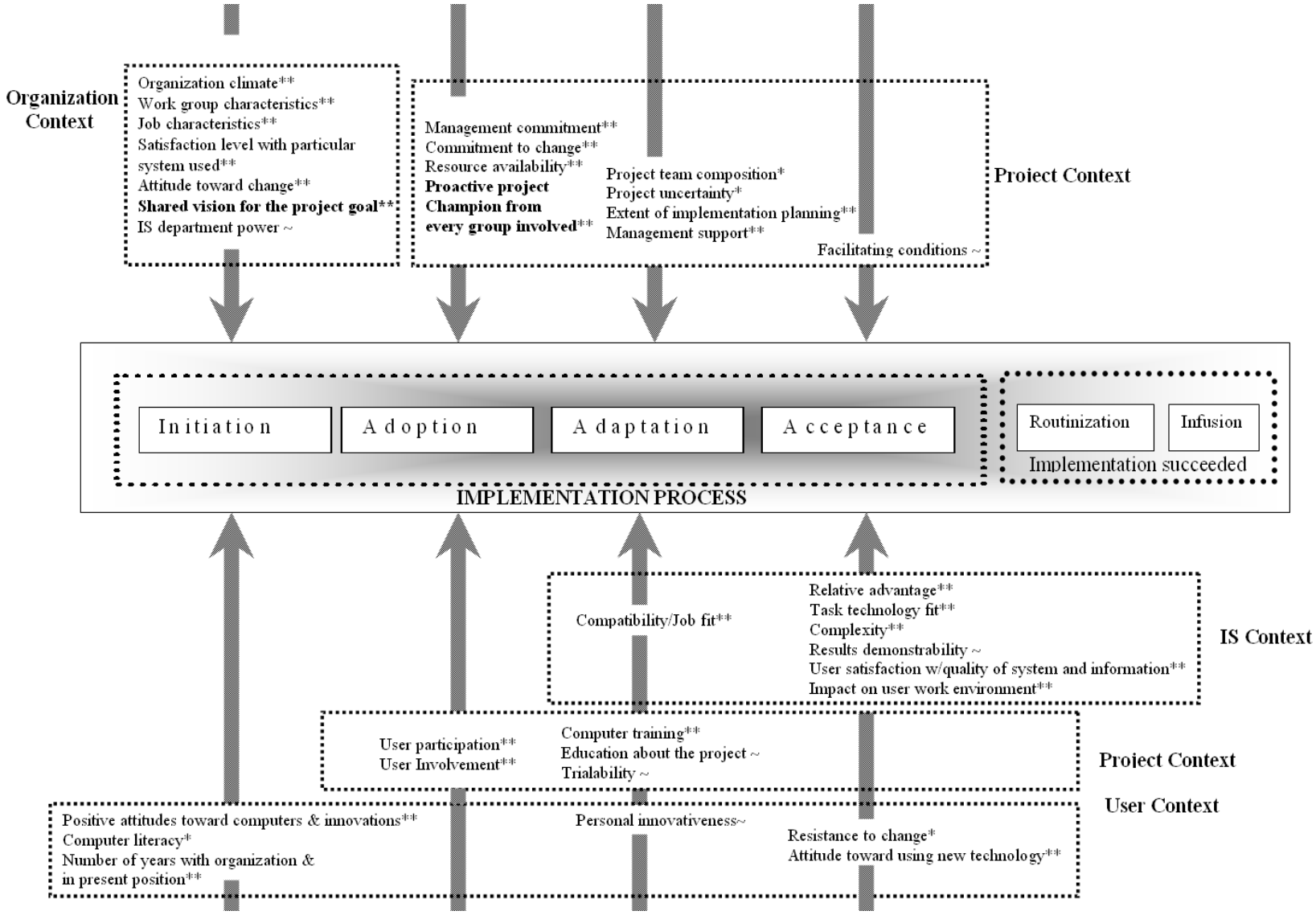


**Figure 18: Revised IS Implementation Model**

## Study Limitations

Several limitations of the study should be also addressed. First, the study was limited to a single case. The dependence on a single case is a frequent criticism of the case study research (Yin, 1994). However, the single case selected was the best option because it allowed to maximize what could be learned in the period of time when this particular IS implementation occurred. The single case factor can be offset by the fact that it was selected on the basis that the case had conditions that allowed to test the model on the failed IS implementation. Secondly, the sample size was very small and consisted only responses from thirteen participants. However, everyone who had participated in the implementation case became a participant of the study. Another limitation was that the case was limited to one particular implementation in one type of organization. IS implementation research is sensitive to the context in which it occurs and that usually is the subject of the concern to the generalizability (Trochim, 2001). One more limitation of this study is the fact that it took place a year later after the implementation was completed, thus interviewees had retrospective memories about the project.

## Future Research

Future research is necessary to address the limitations of the study. Since the research was limited to a particular technology within a healthcare setting, further studies can be done to test the model in other settings with other type of IS. Further research would need to include more case studies that can identify additional variable for inclusion, elimination, as well as provide better understanding of the causality among the factors. Also, since we studied a failed implementation project and thus only four stages out of six stages were analyzed, further studies can extend the model by including the routinization and infusion stage.

# APPENDIX A - IRB FORM

## Vanderbilt University Institutional Review Board
## Request for Exemption

**1. Principal Investigator Information**

| | | | |
|---|---|---|---|
| First Name: Kristina | Middle Initial: N | | Last Name: Statnikova |
| Degree(s): ☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ R.N. ☒ Other, specify: M.S. | | | |
| Job Title: Graduate Student | | Affiliation: ☐ VU ☐ Stallworth ☐ VA-TN Valley HS ☒ Other, specify: Graduate School | |
| Department/Division: Electrical Engineering (Management of Technology Program) | | School/College: School of Engineering | |
| Campus Address: | | Zip+4: | |
| Campus Phone: 615-322-8494 | Fax: | Pager: | Email: kristina.statnikova@vanderbilt.edu |
| **Complete if PI does not have campus address:** | | | |
| Address: 421 Elmington Ave, Apt1311 | | City: Nashville | |
| State: TN | Zip: 37205 | Phone: 615-298-1619 | |

**2. Faculty Advisor (complete if PI is a student, resident, or fellow) ☐ NA**

| | | | |
|---|---|---|---|
| Faculty Advisor's name: Dr. David Dilts | | Title: Prof. Mgmt. Of Technology | |
| Department/Division: EECS | | School/College: School of Engineering | |
| Campus Address: 338 Featheringhill Hall | | Zip+4: | |
| Campus Phone: 322-3479 | Fax: | Pager: | Email: david.dilts@vanderbilt.edu |

**3. Study Contact Information (complete if primary contact is different from PI) ☐ NA**

| | | | |
|---|---|---|---|
| First Name: Kristina | Middle Initial: N | | Last Name: Statnikova |
| Degree(s): ☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ R.N. ☐ Other, specify: M.S | | | |
| Job Title: Graduate student | | Affiliation: ☐ VU ☐ Stallworth ☐ VA-TN Valley HS ☐ Other, specify: Graduate School | |
| Department/Division: Electrical Engineering (Management of Technology Program) | | School/College: | |
| Campus Address: | | Zip+4: | |
| Campus Phone: | Fax: | Pager: | Email: |
| **Complete if contact does not have campus address:** | | | |
| Address: | | City: | |
| State: | Zip: | Phone: | |

**4. Study Information:**

A. Give a brief synopsis of the research, including background information and rationale.

Modern progress in information technology (IT) brings challenges and opportunities to organizations. Therefore, adopting new technologies is essential for sustaining competitiveness and improving productivity for many organizations (Dewett and Jones 2001; Grover et al. 1998; Ives and Learmonth 1984; Lucas and Baroudi 1994; Porter and Millar 1985). However, while the strategic importance of information technologies is well recognized across various industries, less is known about how to implement information technologies

effectively to achieve organizational intended benefits, making this topic still one of the challenging issues facing the IS field (Larsen 2003; Marble 2000; Moore and Benbasat1991). As a result attempts at implementing information technologies in organizations have resulted in widespread failures on account of behavioral problems involving users, organizational characteristics and sometime technological features of particular technology (Alavi and Joachimsthaler 1992; Davis et al 1992; Edmondson et al. 2001; Ewusi-Mensah and Przasnyski 1991; Keil 1995; Kumar et al.1998; McCauley and Ala 1992). Viewed from a technological diffusion prospective, information technology implementation is defined as an organizational effort directed toward diffusing appropriate information technology within user community (Cooper and Zmud 1990). To clearly understand factors affecting diffusion of technology, the six-stage model proposed by Kwon and Zmud (1987) was found to be a useful tool, because this model views implementation as going through certain stages before technology becomes widely used in organization. Later, Cooper and Zmud (1990) applied this model to examine the implementation of MRP system. This model includes following stages: initiation, adoption, adaptation, acceptance, routinization, and infusion. Klein and Sorra (1996) argued that implementation is a critical gateway between decision to adopt the innovation and the routine use of the innovation within an organization. Thus, implementation effectiveness can be viewed as routinization and infusion of the technology into the organization (Cooper and Zmud 1990). One of the most difficult issues that can arise in connection with introducing new technology is how to implement information technology successfully. Previous research on information technology implementation issues shows that implementation process is a complex endeavor which effectiveness may be influenced by many different factors. Based on the review of literature, Larsen (2003) provided a useful taxonomy that groups these factors into twelve concept categories: IT artifact, IT and support, project, performance, IS maturity, interorganizational relations, structure, task communication, task, individual, MIS department, environment. This taxonomy as well as Cooper and Zmud (1990) implementation model was adopted to serve as a conceptual framework for my project. Using Larson's typology as a basis for selecting factors critical to implementation effectiveness I grouped them into two major categories: organizational and social. The stage model and associated issues in each of the six-stages are shown in the Figure1 (Attached on pg.9) and represents a model of information technology implementation process, which will be used in this study. This figure shows a list of the literature sources that support and organize each factor in research design. A qualitative study of outpatient clinic that made a decision to adopt an innovative technology for clinical documentation purpose will be used to explore the implementation process and determine the factors that critical to implementation effectiveness.

B. *Describe the subject population/ type of data/specimens to be studied. Note: Research involving prisoners, fetuses, pregnant women, non-viable neonates, or human in vitro fertilization are not eligible for exemption from IRB review.*

*Research Design.*

Previous research on information technologies implementation issues proved that case study approach is one of the most important methods of documenting organizational implementation efforts. Case studies suited for research in information systems, since the research interest entail study of organizational rather than the technical issues (Benbasat et al 1987). Therefore, by the means of interviews with key personnel, observations of meetings, work settings, document analysis, questionnaire, case study allows to capture and describe in rich details studied phenomenon (Yin 1994). Since the objective of this study is to explore an actual information technology implementation process and to understand more about what factors are crucial to implementation success, this research plans to employ a follow-up case study of a single project of implementing computerized clinical note application that took place in Vanderbilt University Neurology Clinic in summer 2003.

*Data Collection.*
Three major research techniques will be employed as a source of data for the case: questionnaire, interviews and textual analysis. Since the author was a member of an implementation team and had a chance to participate in key activities such as training, progress meetings, as well as provided support on the site, a number of documents were collected on various stages of the implementation. These included: training material, progress reports, observation notes and e-mail correspondence relevant to the project. Therefore, qualitative analytical procedures will be employed to study these documents in order to provide insights into organizational, behavioral and technical aspects of the case. The author will perform all data collection. The data will be qualitative in nature, and results will be untraceable to its source.

C. Describe the source of data/specimens and if these are publicly available. If not publicly available, describe how prior approval will be obtained before accessing this information (attach approval letter if available).

First, before conducting open-ended interviews with sixteen members of organization who participated in the implementation project they will be asked to fill a questionnaire as a part of a case study. The purpose of this questionnaire will be to ask respondents for the facts of a matter and to indicate their level of agreement (on a 7-point Likert Scale) with that matter. By knowing how particular respondent feels about certain fact/or event in advance I will have an opportunity to better utilize limited interview time and ask to propose his or her own insights into certain occurrences and may use such propositions as the basis for further inquiry. All responses of the questionnaire will be strictly confidential. Data will be aggregated, and the information will not be reported in a way that enables others to identify the respondent or the respondent's institution. Please see attached questionnaire on the pg. 11 (Appendix B).

Next, In-depth, open-ended interviews with sixteen members of organization who participated in the implementation project will be the major source of data for this study. Interviews will be conducted with following members:

1. Medical Personnel – Seven physician and five nurses from Neurology Clinic who were directly involved in the implementation effort.
2. Information Services – There will be one interviewee from the Informatics Center who was the project manager of the implementation process. Interview with this person will be very important source of information about technical aspects of the implementation process as well as information about decision to introduce technology to particular group.
3. Administrative staff – There will be three interviewees from the administrative staff. One is a charge nurse, one is administrative manager of the clinic and one is administrative director of the clinic.

Interviewees will be recruited through e-mail on a voluntary basis. The content of this e-mail letter will include description of the study and will ask prospective interviewees for permission to include them as study participants with the guarantee of confidentiality (see pg.10). In order to document valuable finding during interview and for better concentration prospective participants will be asked permission to audiotape the interview. However, the interviews will be audiotape only if I am given a written consent via e-mail. If the permission to audiotape will be received, all tapes along with notes taken during interview will be transcribe into the files and store confidentially in the locked cabinet. The only people who will be allowed to access those files will be my academic advisor – Professor David Dilts and I. The tapes will be kept for two years after completion of the study, and then will be destroyed. Please see attached letter (pg.10) and interview question guide (pg.16).

D. Does this study involve the collection of existing records or data often referred to as "on-the-shelf" data [see 45 CFR 46.101 (b)(4)]? Describe how this data is collected, stored and de-identified.
☐ No ☒ Yes
Since the author was a member of an implementation team and had a chance to participate in key activities such as training, progress meetings, as well as provided support on the site, a number of

documents were collected on various stages of the implementation. These included: training material, progress reports, observation notes and e-mail correspondence relevant to the project. After the project all documents will be store confidentially in the locked cabinet. The only people who will be allowed to access those files will be my academic advisor – Professor David Dilts and I.

E. Describe the recruitment process, including any advertisements, to be used for this study.

Interviewees will be recruited through e-mail on a voluntary basis.

F. *Describe any procedures to be used during this study.*

There will be no procedures.

G. Is this study affiliated with any other IRB-approved studies?
☒ No ☐ Yes
*If "Yes", please list by IRB#:*

H. Is this proposal associated with a grant or contract?
☒ No ☐ Yes
*If "Yes", attach copy and list the funding source associated with the grant or contract.*

**CATEGORIES OF EXEMPTION**

Involvement of human subject research in the following categories may be declared exempt from IRB Review by the IRB. Only the IRB may determine which activities qualify for an exempt review. From the six categories presented below, check "**Yes"** for the categories that you believe describe your proposed research and "**No"** for all others. If none of the categories apply, complete an application for expedited or standard IRB review or contact the IRB staff for instructions.

**YOU MUST CHECK "YES" OR "NO" FOR ALL OF THE FOLLOWING:**

**45 CFR 46.101(b)(1):**
☐ Yes ☒ No **EVALUATION/COMPARISON OF INSTRUCTIONAL STRATEGIES/CURRICULA**
Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

*If "Yes", describe the educational setting in which the research will be conducted and the type of normal educational practices involved.*

**45 CFR 46.101(b)(2):**
☒ Yes ☐ No **EDUCATIONAL TESTS, SURVEYS, INTERVIEWS, OR OBSERVATIONS**
Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

**Note: This exemption is not available for research involving children unless the research is limited to observation of public behavior when the investigators do not participate in the activities being observed.**

**45 CFR 46.101(b)(3):**

☐ Yes ☒ No **PUBLIC OFFICIALS OR CANDIDATES FOR PUBLIC OFFICE**

Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under the previous paragraph if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) Federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Describe how subjects may be identified or are at risk, or state the federal statute that allows the confidentiality of the subject to be maintained throughout the research and thereafter.

**45 CFR 46.101(b)(4):**

☒ Yes ☐ No **COLLECTION OR STUDY OF EXISTING DATA**

Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

**Note: To qualify for this exemption, the data, documents, records, or specimens must be in existence before the project begins. Additionally, under this exemption, an investigator (with proper authorization) may inspect identifiable records, but may only record information in a non-identifiable manner. See IRB Policy III.D for additional information and examples regarding this exemption.**

**45 CFR 46.101(b)(5):**

☐ Yes ☒ No **RESEARCH & DEMONSTRATION PROJECTS**

Research and demonstration projects which are conducted by or subject to approval of federal Departmental or Agency heads (such as the Secretary of HHS), and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; (iv) possible changes in methods or levels of payment for benefits or services under those programs.

Proof of approval by Department/Agency Head is attached. ☐Yes ☐No

**Note: This exemption applies to federally funded projects only and is most appropriately invoked with authorization or concurrence from the funding agency. Additionally, specific criteria must be satisfied to invoke this exemption (see IRB Policy III.D). Also, this exemption category does not apply if there is a statutory requirement that this project be reviewed by an IRB or if the research involves physical invasion or intrusion upon the privacy of subjects.**

**45 CFR 46.101(b)(6):**

☐Yes ☒ No **FOOD QUALITY EVALUATION & CONSUMER ACCEPTANCE STUDIES**

Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome food, without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA or approved by the EPA or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

**5. Will Protected Health Information (PHI)[1] be accessed (used within VUMC) in the course of preparing for this research?**

☒ No ☐ Yes

***If "No", skip to the Conflict of Interest statement on the next page.***

STATEMENT OF AFFIRMATION

If Protected Health Information (PHI)[1] is accessed (used) in the course of preparing for this research the following 3 conditions must be met:

1. The use or disclosure of the PHI is sought solely for the purpose of preparing this research protocol.
2. The PHI will not be removed from the covered entity.
3. This PHI is necessary for the purpose of this research study.

*The above 3 conditions must be met to allow for the access (use) of PHI as "preparatory to research."*

A. Will a de-identified data set be created *(all 18 HIPAA identifiers must be removed, see list attached)*?
☐ No ☐ Yes

B. Will a limited data set be created?
☐ No ☐ Yes *If "Yes", complete the VUMC "Data Use Agreement" below.*

*The data use agreement below sets forth the terms and conditions in which the Covered Entity (VUMC) will allow the use and disclosure of a limited data set [2] to the Data Recipient (Principal Investigator). The limited data set must have direct identifiers removed, but may include town, city, and/or 5-digit ZIP codes as well as date elements (e.g., dates of birth, admission, discharge, etc.).*

**VUMC DATA USE AGREEMENT** ☐ **NOT APPLICABLE**

In addition to the Principal Investigator, identify all individuals who will be requesting authorization to access the limited data set:

| Name of Institution and/or Individual | Non-VUMC Data Use Agreement Required?* |
|---|---|
| | ☐ Yes ☐ No |
| | ☐ Yes ☐ No |
| | ☐ Yes ☐ No |
| | ☐ Yes ☐ No |
| | ☐ Yes ☐ No |
| | ☐ Yes ☐ No |

**A Non-VUMC data use agreement is required to disclose the limited data set to an Individual or an Institution outside of VUMC. A template is available at:*
*http://www.mc.vanderbilt.edu/irb/Forms/Form1109DataUseAgreement.doc.*

**As the Principal Investigator of this study I agree:**

Not to use or disclose the limited data set for any purpose other than the research project or as required by law.

To use appropriate safeguards to prevent use or disclosure of the limited data set other than as provided for by this Agreement.

To report to the Covered Entity (Vanderbilt University Medical Center) any use or disclosure of the limited data set not provided for by this agreement, of which I become aware, including without limitation, any disclosure of PHI to an unauthorized subcontractor.

To ensure that any agent, including a subcontractor, to whom I provide the limited data set, agrees to the same restrictions and conditions that applies through this agreement to the Data Recipient with respect to such information.

Not to identify the information contained in the limited data set or contact the individual.

**Conflict of Interest Statement**

Do you or any other person responsible for the design, conduct, or reporting of the research have an economic interest in, or act as an officer or a director of any outside entity whose financial interests would reasonably appear to be affected by the research? ☐ Yes ☒ No

**Investigator Assurance and Compliance Statement**

As the PI of this study I agree:

☒ To accept responsibility for the scientific and ethical conduct of this project;
☒ To ensure all investigators and key study personnel have completed the VU human subjects training program;
☒ To submit for approval any additions, corrections or modifications to the protocol or informed consent document to the IRB prior to the implementation of any changes; and
☒ This project will not be started until final approval has been granted from the IRB.

_____ _____
Principal Investigator's Signature Date

_____ _____
Faculty Advisor (if PI is non-faculty) Date

[1] **Protected Health Information (PHI):** Protected health information (PHI) is individually identifiable health information that is or has been collected or maintained by Vanderbilt University Medical Center, including information that is collected for research purposes only, and can be linked back to the individual participant. Use or disclosure of such information must follow HIPAA guidelines.

Individually identifiable health information is defined as any information collected from an individual (including demographics) that is created or received by a health care provider, health plan, employer, and/or health care clearinghouse that relates to the past, present or future physical or mental health or condition of an individual, or the provision of health care to an individual or the past, present or future payment for the provision of health care to an individual and identifies the individual and/or to which there is reasonable basis to believe that the information can be used to identify the individual **(45 CFR 160.103).**

A covered entity (VUMC) may determine that health information is not individually identifiable (**De-identified**) health information only if all of the following identifiers of the individual or of relatives, employers, or household members of the individual are removed:

1. Names;
2. Any geographic subdivisions smaller than a State, including street address, city, county, precinct, zip code, and their equivalent geocodes, except for the initial three digits of a zip code;
3. All elements of dates (except year) for dates directly related to an individual (e.g., date of birth, admission);
4. Telephone numbers;
5. Fax numbers;
6. Electronic mail addresses;
7. Social security numbers;
8. Medical record numbers;
9. Health plan beneficiary numbers;
10. Account numbers;
11. Certificate/license numbers;
12. Vehicle identifiers and serial numbers, including license plate numbers;
13. Device identifiers and serial numbers;
14. Web Universal Resource Locators (URLs);
15. Internet Protocol (IP) address numbers;
16. Biometric identifiers, including finger and voiceprints;
17. Full-face photographic images and any comparable images; and
18. Any other unique identifying number, characteristic, or code.

[2] **Limited data set:** The limited data set is protected health information that **excludes** all above data elements with the exception of elements of dates, geographic information (not as specific as street address), and any other unique identifying element not explicitly excluded in the list above.

## APPENDIX B - PARTICIPANTS RECRUITMENT LETTER

Dear [participant's name]:

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in Management of Technology at the Vanderbilt University under the supervision of Professor David Dilts. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

As you know, in summer 2003 Informatics Center of Vanderbilt University Medical Center implemented innovative information system at Neurology Clinic. I had a chance to participate in this project and this experience influenced my academic research interest in the area of information technology implementation processes. Particularly, I am exploring what various contextual organizational, technological and social factors impact implementation and diffusion of information technology into the organization. I believe that because you were actively involved in the information system implementation project at your department, you are best suited to speak to the various issues, such as what influenced you decision to try new information technology, how easy it was to learn how to use it, what type of support you were provided during implementation process, how well new information technology fit with your work style and the way you like to work, etc. The purpose of this study, therefore, is to explore the implementation process and determine the factors that critical to implementation effectiveness.

Participation in this study is voluntary and all data collected will be confidential. It will involve a completion of a questionnaire that will take approximately from ten to fifteen minutes and interview of approximately one hour in length. Interview will be scheduled after questionnaire is completed and will take place in a mutually agreed upon location. You may decline to answer any of the questionnaire or interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be tape-recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered completely confidential. Your name and position will not appear in any thesis or report resulting from this study. All data collected during this study will be retained for two years in an office of my supervisor. Only my supervisor and I will have access to files. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact

me at (615) 322-84-94 or by email at kristina.statnikova@vanderbilt.edu. You can also contact my academic supervisor, Professor David Dilts at (615) 322-3479 or email david.dilts@vanderbilt.edu.

This study has been reviewed and received clearance through the Vanderbilt University Institutional Review Board Office. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Vanderbilt University Review Board Office at (615) 322-2918 or toll free at 866-224-8273

I look forward to speaking with you and thank you in advance for your assistance in this project.

Sincerely,

Kristina Statnikova

# APPENDIX C – LIST OF QUESTIONNAIRE CONSTRUCTS WITH THEIR SOURCE

| CONSTRUCT | QUESTIONNAIRE QUESTION | SOURCE |
|---|---|---|
| Attitude toward change | Before implementation started I was sure that the new system would provide solution to the problem. | Ginzberg (1981) |
| Commitment to Change | I was willing to make necessary changes in my work routines that were important for the new system to work. | |
| Commitment to Change | If I had realized at the beginning the amount of resources required (time, people) I might have not participated. | Ginzberg (1981) |
| Commitment to Change | When there were difficulties while implementing new system Computer Systems staff tried hard to find right solutions. | Ginzberg (1981) |
| Commitment to Change | Changes in the work routines and procedures were an important consideration in assessing my use of the new system. | Ginzberg (1981) |
| Compatability<br>Task technology Fit | Using the new system fits well with the way I like to work.<br>Using the new system is compatible with all aspects of my work routines.<br>The new system fits well with our clinic's way of doing things. | Moore and Benbasat (1991)<br>Goodhue (1995) |
| Complexity | The new system was easy to learn.<br>Overall, I believe that the new system is easy to use | Moore and Benbasat (1991)<br>Davis (1989) |
| Computer Training | The level of training I received in the system use was sufficient to understand the system's functional and technical features. | Sanders and Courtney (1985) |
| Education about Implementation Project | I was familiar with detailed objectives that were defined for the implementation project.<br>I had a good understanding /knowledge about the implementation process I would need to go through before the new system implementation started. | Torkzadeh and Dwayer (1994)<br>Zmud and Cox (1979) |
| Extent of Project Definition and Planning | Implementation was a stressful process.<br><br>All in all, I am satisfied with the way implementation was handled at my clinic. | Ginzberg (1981) |
| Extent of Project Definition and Planning | Computer Systems staff had a good understanding about my work routines. | Ginzberg (1981) |
| Extent of Project Definition and Planning | When we started implementing the new system, I had a clear-cut plan to guide me. | Ginzberg (1981) |
| Facilitating Conditions<br><br>IS Service Quality | Computer Systems staff kept me well informed about the progress and/or problems during the new system implementation.<br><br>The time taken by Computer Systems staff to respond to my requests was acceptable.<br><br>I was satisfied with the services and help provided by Computer Systems staff during the new system implementation. | |
| IS Impact on User Work Environment | I find it beneficial that this system allows nurses to have greater contribution to the clinic note creation.<br><br>I find it helpful that using the new system requires frequent coordination with the nurses/physicians.<br><br>I was not satisfied that with the new system we were having more work in entering data.<br><br>I was not satisfied that with the new system there was assignment of additional tasks. | Guimaraes et al., (1996)<br>Joshi and Lauer (1998)<br>Turner (1984) |
| IS Impact on User Work Environment | My satisfaction with the job increased as a result if using the new system. | Guimaraes et al., (1996)<br>Joshi and Lauer (1998)<br>Turner (1984) |
| IS Impact on User Work Environment | My use of new system made my work environment less stressful and more pleasant. | Guimaraes et al., (1996)<br>Joshi and Lauer (1998)<br>Turner (1984) |

| CONSTRUCT | QUESTIONNAIRE QUESTION | SOURCE |
|---|---|---|
| IS Impact on User Work Environment | My use of the new system made my relationships/communication with nurses (physicians) more effective. | Guimaraes et al., (1996)<br>Joshi and Lauer (1998)<br>Turner (1984) |
| Management Commitment | Clinic management did not realize the complexity of changes that would result because of the new system implementation. | Management Commitment |
| Management Commitment | Clinic management took an active role in the preparing a plan for the new system implementation. | Management Commitment |
| Management Commitment | Clinic management was aware of the benefits that could be achieved using the new system. | Management Commitment |
| Management Commitment | Clinic management was enthusiastic towards implementation of the new system. | Management Commitment |
| Management Commitment | From the start clinic management viewed the new system as being important to clinic's long-term goals. | Management Commitment |
| Management Support | Clinic management provided most necessary help and recourses to enable the use of new the system. | Management Support |
| Management Support | Clinic management supported and encouraged me to use new system. | Management support |
| Management Support | Clinic management was very effective in addressing problems to Computer Systems staff. | Management Support |
| Management Support | Clinic management was very effective in supporting changes in existing routines and processes that were critical to the new system implementation. | Management Support |
| Management Support | When there were difficulties while implementing new system clinic management tried hard to find right solutions. | Management Support |
| Particular System used | I was not satisfied with the old system.<br>The old system I was using did not fit well with my way of doing things. | Goodhue (1995) |
| Personal Innovativeness | I generally like to experiment with new information technologies tools and methods when they become available. | Agrawal and Prasad (1998) |
| Positive attitude toward computers and innovations | Information systems and services are an important and valuable aid to me in the performance at my job. | Goodhue (1995) |
| Relative Advantage | Overall, I find using new system to be advantageous in my job. | Moore and Benbasat (1991)<br>Davis (1989) |
| Relative Advantage | Using the new system enables me to accomplish tasks more quickly. | Moore and Benbasat (1991)<br>Davis (1989) |
| Relative Advantage | Using the new system enhances my effectiveness on the job. | Moore and Benbasat (1991)<br>Davis (1989) |
| Relative Advantage | Using the new system improves the quality of work I do. | Moore and Benbasat (1991)<br>Davis (1989) |
| Relative Advantage | Using the new system makes it easier to do my job. | Moore and Benbasat (1991)<br>Davis (1989) |
| Results Demonstrability | I would have difficulty explaining why using new system may or may not be beneficial. | Moore and Benbasat (1991) |
| Trialability | Before committing to the use of new system, I had a chance to experiment with it on a trial basis. | Rogers (1983) |
| User Involvement | I was interested and excited about proposed new system | Hartwick and Barki (1994) |
| User Participation | My participation in the system implementation process and in ongoing system development was extensive.<br><br>I took an active part in helping Computer Systems staff to define the new system requirements and functionality. | Hartwick and Barki (1994) |

| CONSTRUCT | QUESTIONNAIRE QUESTION | SOURCE |
|---|---|---|
| User Satisfaction with the information and quality of the system | I have a high level of confidence and control when working with the new system. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The access to the new system is easy and convenient. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The new system does not have errors that I have to work around. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The new system has the ability to integrate data with other information systems I use. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The new system is flexible to changes and adjustments that result from new conditions, demands, or circumstances at my work. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The new system overloads me with more data than it seems I can possibly use. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | The new system provides output that is exactly what I need.<br>The new system provides output that is complete and accurate. | Bailey and Pearson (1983)<br>Doll and Torkzadeh (1988) |
| User Satisfaction with the information and quality of the system | Using the new system gives me greater control over my work. | Moore and Benbasat (1991)<br>Davis (1989) |

# APPENDIX D - AN INTERVIEW GUIDE

| CONSTRUCT | QUESTIONNAIRE QUESTION | INTERVIEW QUIESTION |
|---|---|---|
| | Implementation was a stressful process.<br><br>All in all, I am satisfied with the way implementation was handled at my clinic. | If agrees: What in your opinion made the implementation process stressful for you?<br><br>If disagrees: What made the implementation process smooth?<br><br>If agrees: What contributed to your satisfaction with the way implementation was handled at your clinic?<br><br>If disagrees: What aspects of implementation process made you to be unsatisfied? |
| Attitude toward change | Before implementation started I was sure that the new system would provide solution to the problem. | If agrees: What made you to be sure that the new system would provide solution to the problem?<br><br>If disagrees: What made you hesitant in the new system ability to provide solution to the problem? |
| Commitment to Change | I was willing to make necessary changes in my work routines that were important for the new system to work. | If agrees: How difficult it was for you to make changes in your work routines that were necessary for the new system to work?<br><br>If disagrees: Why you were not committed to make necessary changes in your work routines that were important for the new system to work? |
| Commitment to Change | If I had realized at the beginning the amount of resources required (time, people) I might have not participated. | If agrees: Why your decision about new system use and implementation would be changed if you knew in advance the amount of resources (time, people) it required?<br><br>If disagrees: Why you would not change your decision about system use and its implementation no mater how much resources (time, people) that required? |
| Commitment to Change | When there were difficulties while implementing new system Computer Systems staff tried hard to find right solutions. | If agrees: How effective was Computer Systems staff in handling problems during implementation of new system?<br><br>If disagrees: Why do you think Computer Systems staff was not able to handle problems during implementation process? |
| Commitment to Change | Changes in the work routines and procedures were an important consideration in assessing my use of the new system. | If agrees: How important it was for you that the new system would change some of you work routines?<br><br>If disagrees: Why changes in the work routines were not an important consideration for you when deciding whether to use the new system? |
| Compatability<br>Task technology Fit | Using the new system fits well with the way I like to work.<br>Using the new system is compatible with all aspects of my work routines.<br>The new system fits well with our clinic's way of doing things. | If agrees: What makes the new system to fit well with your work routines and the way you like to work? How would you describe time and effort required to alter your process flow to align with the process built into the new system?<br>If disagrees: What aspects of your work routines are not compatible with the new system? |
| Complexity | The new system was easy to learn.<br>Overall, I believe that the new system is easy to use | If agrees: What makes this system easy to use?<br>If disagrees: Tell me please what makes this system difficult to use/hard to work with?<br>If agrees: What made the new system easy to learn?<br><br>If disagrees: What made the new system hard to learn? In your opinion what should have been done to make the system easy to learn? |
| Computer Training | The level of training I received in the system use was sufficient to understand the system's functional and technical features. | If agrees: How you were trained in system use? In your opinion what made the training you have received in system use sufficient and effective?<br><br>If disagrees: How were you trained in system use? Why you did not find the training you have received sufficient and effective to understand the system's functional and technical features? |

| CONSTRUCT | QUESTIONNAIRE QUESTION | INTERVIEW QUIESTION |
|---|---|---|
| Education about Implementation Project | I was familiar with detailed objectives that were defined for the implementation project.<br>I had a good understanding /knowledge about the implementation process I would need to go through before the new system implementation started. | If agrees: Could you please tell me how have you learned about implementation project plan, schedules, steps you would go through? Who provided you with this information?<br><br>If disagrees: Were you satisfied with the level of information you were given about proposed implementation project? Do you think that if you would have more information about implementation process the results of your new system use would be different? |
| Extent of Project Definition and Planning | Computer Systems staff had a good understanding about my work routines. | If agrees: How important it was that Computer Systems staff had a good understanding about my work routines?<br><br>If disagrees: How the results of the new system use and its implementation would be different if the Computer Systems staff had a better understanding about your work routines? |
| Extent of Project Definition and Planning | When we started implementing the new system, I had a clear-cut plan to guide me. | If agrees: How helpful it was for you that you had a plan to guide you?<br><br>If disagrees: How the results of the new system use and its implementation would be different if you had a plan of implementation process? |
| Facilitating Conditions<br><br>IS Service Quality | Computer Systems staff kept me well informed about the progress and/or problems during the new system implementation.<br><br>The time taken by Computer Systems staff to respond to my requests was acceptable.<br><br>I was satisfied with the services and help provided by Computer Systems staff during the new system implementation. | If agrees: How would you describe the manner and methods of interaction between you and Computer Systems staff regarding the progress, changes, and problems during the implementation process? How helpful it was for you?<br><br>If disagrees: Why do you think Computer Systems staff did not do a good job in keeping you informed about the status of implementation project?<br><br>If agrees: How would you describe the Computer Systems staff skills, knowledge, and assistance they provided during implementation?<br><br>If disagrees: Why you were not satisfied with the services and help provided by Computer Systems staff during the new system implementation? |
| IS Impact on User Work Environment | I find it beneficial that this system allows nurses to have greater contribution to the clinic note creation.<br><br>I find it helpful that using the new system requires frequent coordination with the nurses/physicians.<br><br>I was not satisfied that with the new system we were having more work in entering data.<br><br>I was not satisfied that with the new system there was assignment of additional tasks. | If agrees: Why do you find it beneficial that this system allows nurses to have greater contribution to the clinic note creation?<br><br>If disagrees: Why don't you find it beneficial that this system allows nurses to have greater contribution to the clinic note creation?<br><br>If agrees: In what ways the new system helped you to have better coordination with nurses/physicians?<br><br>If disagrees: Why you did not find it helpful that using the new system requires frequent coordination with the nurses/physicians?<br><br>If agrees: Why you did not like that the new system required you to perform additional tasks?<br><br>If disagrees: Why you were not dissatisfied that new system required you to perform additional tasks? |
| IS Impact on User Work Environment | My satisfaction with the job increased as a result if using the new system. | If agrees: What influenced the increase in the job satisfaction with the introduction of the new system?<br>If disagrees: What influenced the decrease in the job satisfaction with the introduction of the new system? |
| IS Impact on User Work Environment | My use of new system made my work environment less stressful and more pleasant. | If agrees: In what ways your work environment has been changed since the introduction of a new system? 2What changes associated with the system use have been beneficial to your work?<br>If disagrees: What changes made your work more stressful? |
| IS Impact on User Work Environment | My use of the new system made my relationships/communication with nurses (physicians) more effective. | If agrees: In what ways the introduction of the new system made your relationship with nurses more effective?<br><br>If disagrees: Why the introduction of the new system made your relationships/communication with nurses less effective? |

| CONSTRUCT | QUESTIONNAIRE QUESTION | INTERVIEW QUIESTION |
|---|---|---|
| Management Commitment | Clinic management did not realize the complexity of changes that would result as a consequence of the new system implementation. | If agrees: Why do you think clinic management did not foresee the complexity of changes that would result as a consequence of the new system implementation?<br><br>If disagrees: What clinic management did to analyze and prepare for changes that would result as a consequence of the new system implementation? |
| Management Commitment | Clinic management took an active role in the preparing a plan for the new system implementation. | If agrees: Did clinic management consulted with you regarding the implementation plan? Were you able to make any changes in the implementation plan?<br><br>If disagrees: Why do you think clinic management did not take an active part in the preparing a plan for new system implementation? How the results of new system implementation would be different if clinic management took an active part in preparing a plan? |
| Management Commitment | Clinic management was aware of the benefits that could be achieved using the new system. | If agrees: How well do you think clinic management was familiar with what the new system could do for the clinic?<br><br>If disagrees: In your opinion how important it was for clinic management to be aware of what benefits the new system could bring to the clinic? Do you think that the results of the implementation would be different if clinic management knew well how the new system could contribute to the clinic? |
| Management Commitment | Clinic management was enthusiastic towards implementation of the new system. | If agrees: How would you describe the level of management involvement during implementation process? Do you feel that management had a good understanding/knowledge about implementation process? Did management agree with the implementation team on how to implement the system?<br><br>If disagrees: In you opinion what were the reasons why clinic management was not enthusiastic about implementation of new system? Do you think that the results of system adoption would be different if clinic management putted more interest in it. |
| Management Commitment | From the start clinic management viewed the new system as being important to clinic's long-term goals. | If agrees: Why do you think management viewed the new system as being important to department's long-term goals? 2) Do you think that the management belief about new system importance to the department contributed to your decision to use the system?<br><br>If disagrees: Why do you think management did not view the new system as being important to department's long-term goals? Did management position regarding the new system influence you decision about using the system in any ways? |
| Management Support | Clinic management provided most necessary help and recourses to enable the use of new the system. | If agrees: How important that was for the system success?<br><br>If disagrees: How do you think the results of system implementation would be different if enough of resourced would be secured? In your opinion why there were not enough resourced pulled into the project? |
| Management Support | Clinic management supported and encouraged me to use new system. | If agrees: How management supported and encouraged you to use new system and to participate in the implementation effort? Do you think that was important for the success of the project?<br><br>If disagrees: Why do you think clinic management did not support and encouraged you to use the new system and to participate in the implementation effort? Would you decision about system use and participation in the implementation effort be different if clinic management supported and encouraged you to use new system and to participate in the implementation effort? |
| Management Support | Clinic management was very effective in addressing problems to Computer Systems staff. | If agrees: How do you think clinic management ability to communicate effectively with Computer System Staff contributed to the new system implementation process?<br><br>If disagrees: Why do you think clinic management was not effective in addressing problems to Computer Systems staff? |

| CONSTRUCT | QUESTIONNAIRE QUESTION | INTERVIEW QUIESTION |
|---|---|---|
| Management Support | Clinic management was very effective in supporting changes in existing routines and processes that were critical to the new system implementation. | If agrees: How clinic management supported new changes in existing routines and processes? How do you think that contributed to the new system acceptance?<br><br>If disagrees: How do you think the results of your system use and implementation process would be different if clinic management was more effective in the supporting and promoting changes in existing routines and processes that were critical to the new system implementation? |
| Management Support | When there were difficulties while implementing new system clinic management tried hard to find right solutions. | If agrees: How effective was clinic management in handling problems during implementation of new system?<br><br>If disagrees:<br>Why do you think clinic management was not able to handle problems during implementation process? |
| Particular System used | I was not satisfied with the old system.<br>The old system I was using did not fit well with my way of doing things. | If agrees: Why? How well that system fitted with the clinic and your way of doing things? What was system impact on your job effectiveness and productivity?<br><br>If disagrees: Why have you decided to use the new system if you were satisfied with the old one? |
| Personal Innovativeness | I generally like to experiment with new information technologies tools and methods when they become available. | If disagrees: Do you prefer that other people will work out the bugs and problems with the new system before you will use it? |
| Positive attitude toward computers and innovations | Information systems and services are an important and valuable aid to me in the performance at my job. | If agrees: How would you describe the organization computer environment and its impact on your effectiveness and productivity in your job? Why do you find that computer systems and services are an important and valuable aid to you in the performance of your job?<br><br>If disagrees: Why do you think computer systems and services are not an important and valuable aid to you in the performance at your job? |
| Relative Advantage | Overall, I find using new system to be advantageous in my job. | How would you describe your understanding of computers and your previous computer experience?<br>Do you feel that system implementation results depended on the level of technical expertise present in the organization (of targeted users)?<br><br>If agrees: What aspects of the new system are more advantageous to you in performance at the job in comparison to the old system?<br><br>If disagrees: What makes the new system less advantageous to you in comparison to old system? |
| Relative Advantage | Using the new system enables me to accomplish tasks more quickly. | If agrees: In what ways the new system enables you to accomplish tasks more quickly?<br><br>If disagrees: Why the new system does not help you to accomplish tasks more quickly? |
| Relative Advantage | Using the new system enhances my effectiveness on the job. | If agrees: How using the new system enhances your effectiveness on the job?<br><br>If disagrees: Why using the new system does not enhance your effectiveness on the job? |
| Relative Advantage | Using the new system improves the quality of work I do. | If agrees: How using the new system improves the quality of work you do?<br><br>If disagrees: Why using the new system does not improve the quality of work you do? |
| Relative Advantage | Using the new system makes it easier to do my job. | If agrees: What aspects of the new system make it easier to do your job?<br><br>If disagrees: Why using the new system does not make it easier to do your job? |
| Results Demonstrability | I would have difficulty explaining why using new system may or may not be beneficial. | Could you please tell me more about your results working with the system? Are these results apparent to you? |

| CONSTRUCT | QUESTIONNAIRE QUESTION | INTERVIEW QUIESTION |
|---|---|---|
| Trialability | Before committing to the use of new system, I had a chance to experiment with it on a trial basis. | If agrees: How important it was for you to try out the new system first? Did it help you to make a decision about whether or not you would continue using it?<br><br>If disagrees: How do you think your use of the new system would be different if you had an opportunity to experiment with it on a trial basis before committing to its use? |
| User Involvement | I was interested and excited about proposed new system | If agrees: Did you feel that new system was both important and personally relevant to you?<br><br>If disagrees: Why you were not exited and interested in the new system implementation effort? |
| User Participation | My participation in the system implementation process and in ongoing system development was extensive.<br><br>I took an active part in helping Computer Systems staff to define the new system requirements and functionality. | If agrees: In what ways did you participate in system implementation process and in its ongoing development? What made you to participate in the system implementation process and in ongoing system development? How did it influence your decision to continue using new system?<br><br>If disagrees: Why you did not participate in the system implementation process and in ongoing system development? How do you think your system use would be different if you took an active part in system implementation process and its ongoing development? |
| User Satisfaction with the information and quality of the system | I have a high level of confidence and control when working with the new system. | If agrees: To what do you attribute the high level of confidence and control you have while working with the system?<br><br>If disagrees: What makes you lack the feeling of confidence and control while working with new system? |
| User Satisfaction with the information and quality of the system | The access to the new system is easy and convenient. | If agrees: What makes the system easy and convenient to access?<br><br>If disagrees: What makes the system hard and not convenient to access? |
| User Satisfaction with the information and quality of the system | The new system does not have errors that I have to work around. | If agrees: Did you come across some bugs in the new system? How that affected you work effectiveness? Was it hard to figure out how to work around those errors? |
| User Satisfaction with the information and quality of the system | The new system has the ability to integrate data with other information systems I use. | If agrees: How convenient and easy it is to integrate data from new system with other systems you use?<br><br>If disagrees: How important it is for you that the system would have the ability to integrate it data with other systems you use? |
| User Satisfaction with the information and quality of the system | The new system is flexible to changes and adjustments that result from new conditions, demands, or circumstances at my work. | If agrees: What makes the new system easy to do what you want?<br><br>If disagrees: What makes new system difficult to adjust to the changes at the way you work and new conditions at the job? |
| User Satisfaction with the information and quality of the system | The new system overloads me with more data than it seems I can possibly use. | If agrees: Why do you think this happens? Does it usually take you more time to select proper option? How irritating is it to you? |
| User Satisfaction with the information and quality of the system | The new system provides output that is exactly what I need.<br>The new system provides output that is complete and accurate. | If agrees: How satisfied are you with the output?<br><br>If disagrees: Why the output of the new system does not fit the output you require? |
| User Satisfaction with the information and quality of the system | Using the new system gives me greater control over my work. | If agrees: How using the new system gives you greater control over your work?<br><br>If disagrees: Why using the new system does not give you greater control over your work? |

## REFERENCES


1. Agarwal, R., and Prasad, J. "The Antecedents and Consequents of User Perceptions in Information Technology Adoption," *Decision Support Systems* (22:1), 1998 pp.15–29.

2. Agarwal, R., and Prasad, J. "The Role of Innovation Characteristics and Perceived Voluntariness in the Acceptance of Information Technologies," *Decision Sciences* (28:3), 1997 pp.557–582.

3. Alavi, M., and Joachimsthaler, M. "Revising DSS Implementation Research: A Meta-analysis of the Literature and Suggestions for Researches," *MIS Quarterly* (16:1), 1992 pp.95-116.

4. Altman, D.G. *Practical statistics for medical research*. London: Chapman and Hall, 1991.

5. Bailey, J.E., and Pearson, S.W. "Development of a Tool for Measuring and Analyzing Computer User Satisfaction," *Management Science (*29:5), 1983 pp.530-545.

6. Bandura, A., and Cervone, D. "Differential Engagement of Self-reactive Influences in Cognitive Motivation," *Organizational Behavior and Human Decision Processes* (38:1), 1986 pp.92–113.

7. Baronas, A.M., and Louis, M.R. "Restoring a Sense of Control During Implementation: How User Involvement Leads to System Acceptance," *MIS Quarterly* (12:1), 1988 pp.111–123.

8. Beath, C.M., "Supporting the Information Technology Champion," *MIS Quarterly* (15:2), 1991 pp.355-372.

9. Benbasat, I., Goldstein, D.K., and Mead, M. "The Case Research Strategy in Studies of Information Systems," *MIS Quarterly* (11:3), 1987 pp.369-386.

10. Brailer, D., "Recasting IT Strategy," *Hospitals & Health Networks* (78:10), 2004 pp.110-110.

11. Compeau, D.R., and Higgins, C.A. "Computer Self-efficacy: Development of a Measure and Initial Test," *MIS Quarterly (*19:2)*,* 1995 pp.189–211.

12. Connolly, C. (2005, March 21). Cedars-Sinai Doctors Cling to Pen and Paper. *Washington Post.* Retrieved March 22, 2005, from http://www.washingtonpost.com

13. Cooper, R.B., and Zmud, R.W. "Information Technology Implementation Research: A Technology Diffusion Approach," *Management Science (*36:2), 1990 pp.123–139.

14. Darke, P., Shanks, G., and Broadben,t M. "Successfully Completing Case Study Research: Combining Rigour, Relevance and Pragmatism" *Information Systems Journal* (8:4), 1998 pp.273-289.

15. Datamonitor (2004, August 11) *US healthcare ICT spending opportunities*. Retrieved February 24, 2005, from http://www.cbronline.com/research.asp?guid=DMTC1008

16. Davis, F.D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly (*13: 3), 1989a pp.319–340.

17. Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science (*35:8), 1989b pp.982–1003.

18. Davis, G.B., Lee, A.S., Nickles, K.R., Chatterjee, S., Hartung, R., Wu, Y. "Diagnosis of an Information System Failure: A Framework and Interpretative Process," *Information & Management* (23:5), 1992 pp.293-301.

19. DeLone, W. H. and McLean, E. R. "Information Systems Success: The Quest for the Dependent Variable," *Information Systems Research* (3) *pp.*60-95.

20. Dewett, T., and Jones, G.R. "The Role of Information Technology in the Organization: a Review, Model, and Assessment," *Journal of Management (*27), 2001 pp.313-346.

21. Doll, W.J., and Torkzadeh, G. "A Discrepancy Model of End-User Computing Involvement," *Management Science* (35:10), 1989 pp.151–1171.

22. Edmondson, A.C.; Bohmer, R.M; and Pisano, G.P. "Disrupted Routines: Team Learning and New Technology Implementation in Hospitals," *Administrative Science Quarterly (*46), 2001 pp.658-716.

23. Ein-Dor, P., and Segev, E. "Organizational Context and the Success of Management Information Systems," *Management Science (*24:10), 1978 pp.1064–1077.

24. Ein-Dor, P., and Segev, E. Organizational Context and MIS Structure: Some Empirical Evidence. *MIS Quarterly* (5:3), 1982 pp.55–68.

25. Essex, P.A.; Magal, S.R.; and Masteller, D.E. "Determinants of Information Center Success," *Journal of Management Information Systems (*15:2), 1998 pp.95–117.

26. Ewusi-Mensah, K., and Przasnyski, Z.H. "On Information Systems Project Abandonment: An Exploratory Study of Organizational Practices," *MIS Quarterly* (15:1), 1991 pp.67-86.

27. Fletcher, M. (2005, January 28). President Promotes Switching To Electronic Medical Records. *Washington Post.* Retrieved February 23, 2005, from http://www.washingtonpost.com

28. Ginzberg, M.J. "Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Questions," *Management Science (*27:4), 1981a pp.459–478.

29. Ginzberg, M.J. "Key Recurrent Issues in the MIS Implementation Process," *MIS Quarterly (*5: 2), 1981b pp.47–60.

30. Goodhue, D.L. "Task-technology Fit and Individual Performance," *MIS Quarterly (*19:2), 1995 pp.213–236.

31. Gottschalk, P. "Implementation Predictors of Strategic Information Systems Plans," *Information and Management (*36), 1999 pp.77-91.

32. Grover, V., Teng, J., Segars, A., and Fiedler, K. "The Influence of Information Technology and Business Process Changes in Perceived Productivity: The Executive's Perspective," *Information and Management* (34:3), 1998 pp.141-159.

33. Guimaraes, T., Yoon, Y., and Clevenson, A. "Factors Important to Expert Systems Success: A Field Test," *Information & Management (*30: 3), 1996 pp.119–130.

34. Hartwick, J., and Barki, H. "Explaining the Role of User Participation in Information System Use," *Management Science (*40:4), 1994 pp.440–465.

35. Healthcare Information and Management Systems Society (2003).*14th Annual HIMSS Leadership Survey sponsored by Superior Consultant Company*. Retrieved March 22, 2005, from http://www.himss.org/2003survey/docs/Healthcare_CIO_final_report.pdf

36. Hiltz, S.R., and Johnson, K. "User Satisfaction with Computer-Mediated Communication Systems," *Management Science (*36:6), 1990 pp.739–764.

37. Hong, K., and Kim Y. "The Critical Success for ERP Implementation: An Organizational Fit Perspective," *Information and Management* (40), 2002 pp.24-40.

38. Hunton, J.E., and Price, K.H. "Effects of the User Participation Process and Task Meaningfulness on Key Information System Outcomes," *Management Science (*43:6), 1997 pp.797–812.

39. Iacovou, C.L.; Benbasat, I.; and Dexter, A.S. "Electronic Data Interchange and small Organizations: Adoption and Impact of Technology," *MIS Quarterly (*19:4), 1995 pp.465–485.

40. Ives, B., And Learmonth, G.P. "The Information System as Competitive Weapon," *Communications of ACM* (27), 1984 pp.1193-1201.

41. Ives, B., and Olson, M.H. "User Involvement and MIS Success: A Review of Research," *Management Science* (30: 5), 1984 pp.586–603.

42. Jarvenpaa, S.L., and Ives, B. "Executive Involvement and Participation in the Management of Information Technology," *MIS Quarterly (15:*2), 1991 pp.205–227.

43. Johnson, J.D., Meyer, M., Woodworth, M., Ethington, C., and Stengle, W. "Information Technologies Within the Cancer Information Service: Factors Related to Innovation Adoption," *Preventive Medicine (*27: 5), 1998 pp.S71–S83.

44. Joshi, K., "A Model of Users Perspective on Change – The Case of Information-System Technology Implementation," *MIS Quarterly* (15:2), 1991 pp.229-242

45. Joshi, K., and lauer, T. "Impact of Information Technology on Users' Work Environment: A Case of Computer Aided Design (CAD) System Implementation," *Information and Management* (34), 1998 pp.349-360.

46. Karahanna, E., Straub, D.W., and Chervany, N.L. "Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-adoption and Post-adoption Beliefs," *MIS Quarterly (*23:2), 1999 pp.183–213.

47. Keil, M. "Pulling the Plug: Software Project Management and the Problem of Project Escalation," *MIS Quarterly* (19:4), 1995 pp.421-447.

48. Klein, H. K. and Myers, M.D. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly, Special Issue on Intensive Research* (23:1), 1999, pp.67-93.

49. Klein, K.J., and Sorra, J.S. "The Challenge of Innovation Implementation," *Academy Management Review* (21:4), 1996 pp.1055-1080.

50. Kolb, D., and Frohman, A. "An Organization Development Approach to Consulting," *Sloan Management Review* (12:1), 1970 pp.51–65.

51. Kumar, K., Van Dissel, H.G., and Bielli, P. "The Merchant of Prato-revisited: Toward a Third Rationality of Information Systems," *MIS Quarterly* (22:2), 1998 pp.199-226.

52. Kwon, Tae H. and Robert W. Zmud, "Unifying the Fragmented Models of Information Systems Implementation," in R.J. Boland and R. Hirschheim (Eds.), *Critical Issues in Information Systems Research*, John Wiley, Chichester, England, 1987, pp.227-251

53. Larsen, K.R.T. "A Taxonomy of Antecedents of Information Systems Success: Variable Analysis Studies," *Journal of Management Information Systems* (20:2), 2003, pp.169-246

54. Lee, A.S. "A Scientific Methodology for MIS Case Studies," *MIS Quarterly* (13:1), 1989, pp.33-52.

55. Lewin, K. "*Group Decisions and Social Change: readings in social psychology*," 2nd edn. New York: Holb., 1952

56. Lorenzi, N. M., and Riley, R.T. "Managing Change: An Overview," *Journal of American Medical Association* (7), pp.116-124.

57. Lucas, H., and Baroudi, J. “The Role of Information Technology in Organizational Design,” *Journal of Management Information Systems* (Spring), 1994 pp.9-24.

58. Lucas, H.C. “Empirical Evidence for a Descriptive Model of Implementation,” *MIS Quarterly* (2:2), 1978 pp.27-42.

59. Majchrzak, A., Rice, R.E., Malhotra, A., King, N., and Ba, S. "Technology Adaptation: The Case of a Computer-Supported Inter-Organizational Virtual Team," *MIS Quarterly* (24:4), 2000, pp.569-600.

60. Mann, R.I., and Watson, H.J. “A Contingency Model for User Involvement in DSS Development,” *MIS Quarterly (*8:1), 1984 pp.27–38.

61. Marble, R.P. “A System Implementation Study: Management Commitment to Project Management,” *Information and Management* (41), 2003 pp.111-123.

62. Marble, R.P. “Operationalising the Iimplementation Puzzle: An Argument for Eclecticism in Research and Practice,” *European Journal of information Systems* (9), 2000 pp.132-147.

63. Markus, M.L. Power, politics, and MIS implementation. *Communications of the ACM* (26: 6), 1983, pp.23–33.

64. McCauley, N., and Ala, M. “The Use of Expert Systems in the Healthcare Industry,” *Information & Management* (22:4), 1992 pp.227-235.

65. McKeen, J.D., and Guimaraes, T. “The Relationship between User Satisfaction and User Participation: An Investigation of Four Contingency Factors,” *MIS Quarterly* (18:4), 1994 pp.427–451.

66. Montazemi, A.R. “Factors Affecting Information Satisfaction in the Context of the Small Business Environment,” *MIS Quarterly (*13:2), 1988 pp.239–256.

67. Moore, G.C., and Benbasat, I. “Development of An Instrument to Measure the Perceptions of Adopting an Information Technology Innovation,” *Information Systems Research (*2:3), 1991 pp.192–222.

68. Moore, G.C., and Benbasat, I. “Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation,” *Information Systems Research* (2:3), 1991 pp.192–222.

69. Nelson, R.R., and Cheney, P.H. “Training End-Users: An Exploratory Study,” *MIS Quarterly* (11:4), 1987 pp.547–559.

70. Nidumolu, S. “The Effect of Coordination and Uncertainty on Software Project Performance: Residual Performance Risks as an Intervening Variable,” *Information Systems Research (*6:3), 1995 pp.191–219.

71. Orlikowski, W. J. "The duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), 1992 pp.398-427.

72. Orlikowski, W., Yates, J., Okamura, K., and Fujimoto, M. "Shaping Electronic Communication: The Metastructuring of Technology in the Context of Use," *Organization Science* (6), 1995 pp.423-444.

73. Orlikowski, W.J. & Baroudi, J.J. "Studying Information Technology in Organizations: Research Approaches and Assumptions", *Information Systems Research* (2) 1991, pp.1-28.

74. Porter, M.E., and Millar, V.E. "How Information Gives you Competitive Advantage," *Harvard Business Review (*63:4), 1985 pp.149–160.

75. Porter, M.E., and Millar, V.E. "How Information Gives you Competitive Advantage," *Harvard Business Review* (63:4), 1985 pp.149–160.

76. Premkumar, G., Ramamurthy, K., and Nilakanta, S. "Implementation of Electronic Data Interchange: An Innovation Diffusion Perspective," *Journal of Management Information Systems* (11: 2), 1995 pp.157–186.

77. Purvis, R. L., Sambamurthy, V. and Zmud, R. W. "The Assimilation of Knowledge Platforms in Organizations: An Empirical Investigation," *Organization Science* (12:2), 2001 pp.117-135.

78. Raghupathi, W., and Tan, J. (1999) Strategic uses of information technology in health care: a state-of-the-art survey. *Top Health Information Management* (20:1), 1999 pp.1-15.

79. Rai, A., Lang, S.S, and Welker, R.B. "Assessing the validity of IS success models: An empirical test and theoretical analysis," *Information Systems Research* (13:1), 2002 pp.50-69.

80. Retchin S.M., and Wenzel, R.P. "Electronic Medical Record Systems at Academic Health Centers: Advantages and Implementation Issues," *Academic Medicine* (74:5), 1999 pp.1999 pp.493-498.

81. Rogers, E.M. *Diffusion of Innovations,* 3d ed. New York: Free Press, 1983.

82. Rogers, E.M. *Diffusion of Innovations,* 4th ed. New York: Free Press, 1995.

83. Sanders, G.L., and Courtney, J.F. "A Field Study of Organizational Factors Influencing DSS Success," *MIS Quarterly (*9:1), 1985 pp.77–92.

84. Seddon, P.B. "A Respecification and Extension of the Delone and McLean Model of IS Success," *Information Systems Research* (8:3), 1997 pp.240-253.

85. Sharma, R. and Yetton, P. "The Contingent Effects of Management Support and Task Interdependence on Successful Information Systems implementation," *MIS Quarterly* (27:4), 2003, pp.533-555.

86. Taylor, S., and Todd, P. "Assessing IT usage: The Role of Prior Experience," *MIS Quarterly (*19:4), 1995b pp.561–570.

87. Taylor, S., and Todd, P.A. "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research* (6:2), 1995 pp.144–176.

88. Thompson, R.L., Higgins, C.A., and Howell, J.M. "Personal Computing: Toward a Conceptual Model of Utilization," *MIS Quarterly* (15:1), 1991 pp.125–143.

89. Torkzadeh, G., and Dwyer, D.J. "A Path Analytic Study of Determinants of Information System Usage," *Omega* (22:4), 1994 pp.339-348.

90. Tornatzky, L.G., and Klein, K.J. "Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings," *IEEE Transactions on Engineering Management* (29:1), 1982 pp.28–45.

91. Turner, J.A. "Computer Mediated Work: The Interplay Between Technology and Structured Jobs," *Communications of the ACM* (27:12), 1984 pp.1210–1217.

92. Vanderbilt University Medical Center (2005a) Overview of Vanderbilt University Medical Center. Retrieved March 25, 2005, from http://www.mc.vanderbilt.edu/root/about_us.html

93. Vanderbilt University Medical Center (2005b) VUMC by the numbers. Retrieved March 25, 2005, from http://www.mc.vanderbilt.edu/root/bythenumbers.html

94. Vanderbilt University Medical Center Department of Neurology (2005) Neurology at Vanderbilt. Retrieved March 25, 2005 from http://www.mc.vanderbilt.edu/neurology/

95. Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), 2003 pp.425-478.

96. Webster, J., and Martocchio, J.J. "Microcomputer Playfulness: Development of a Measure with Workplace Implications," *MIS Quarterly* (16:2), 1992 pp201-226.

97. Yin, R. *Case Study Research: Design & Methods*, 2nd edition, Thousand Oaks, CA: Sage Publications, 1994

98. Zmud, R. W., and Cox, J.F. "The Implemenation Process: A Change Approach," *MIS Quarterly* (3:2), 1979 pp.35-43.

99. Trochim, W.M.K. "*The Research methods Knowledge Base,"* 2nd edn. Cincinnati: Cornell University., 2001

100. McDonald, C.J. "The Barriers to Electronic Medical Record Systems and How Overcome Them," *Journal of American Medical Informatics Association (*4:3), 1997 pp.213-221.

101. Pare, G., and Elam, J.J. "Understanding the dynamics of Information Technology Implementation: A Study of Clinical Information System," *Medinfo*, 1995, 8 Pt 1:544.

102. Dixon, D.R. "The Behavioral Side of Information technology," *International Journal of Medical Information* (56), 1999 pp.117-123.

103. Rajagopal, P. "An Innovation – Diffusion View of Implementation of Enterprise Resource Planning (ERP) system and Development of a Research Model," *Information and Management* (40), 2002 pp.87-114.

104. Eisenhardt, K.M. "Building Theories from Case Study Research," *Academy of Management Review* (14:4), pp.532-550.