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A Learning-Based Model of Quality of Use: Insights from a Case Study of ERP Implementation

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Abstract

It has been argued that simple conceptualizations of usage are inadequate for understanding and studying use of complex information technologies. In this paper we argue that quality of use, instead of simple usage, is useful for understanding the extent to which a complex information technology is being used. An inductive case study of complex technology was conducted which led to the development of a learning-based model of quality of use. This model suggests the inclusion of factors relating to training (either formal or informal), learning, perceptions, and attitudes, their impact on quality of use, and their change over time. Moreover, it describes how perceptions of the system at a given time, along with newly acquired knowledge of the system, may influence perceptions at a later time. Evidence from the case study along with constructs and relationships from the literature are provided to support the model. Implications for future research are also discussed.

* The authors worked equally on this and are thus listed alphabetically.

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Introduction

The antecedents to use of an information system (IS) have been extensively explored in the technology adoption and diffusion literature. Typically, these studies examine the construct of use and its antecedents through models based in Diffusion of Innovations theory (Rogers, 1962, 1995), the Theory of Reasoned Action (Ajzen and Fishbein, 1980), the Theory of Planned Behavior (Ajzen and Madden, 1986), and the Technology Acceptance Model (Davis, 1989). Recently, Venkatesh *et al.* (2003) compared these and other models to a unified model of acceptance and use of technology. Studies of these models often measure perceptions, attitudes, intentions and usage at the same point(s) in time, with a single, simple conceptualization of usage.

It may be argued that such models are not suited for the study of Enterprise Resource Planning (ERP) package implementation, as they are most relevant to simple technologies that can only be used in a limited number of ways. Eveland and Tornatzky (1990) pointed out: "problems arise when the diffusion model is applied in situations where its basic assumptions are not met — that is to say, virtually every case involving complex, advanced technology" (p. 123). Indeed, many studies of adoption/acceptance models based on these theories explore technologies that are relatively simple to use, such as email (e.g., Karahanna and Straub, 1999; Szajna, 1996) and word processors (e.g., Agarwal, Sambamurthy and Stair 2000; Chau, 1996). Because simple technologies are easy to conceptualize and operationalize, and because many people use them, researchers have preferred the study of simple technologies to complex ones for testing their models.

By many accounts, ERP packages qualify as a complex technology (Ribbers, and Schoo, 2002; Umble *et al.*, 2003; Akkermans and van Helden, 2002; Maney, 1999; Gill, 1999). Because

they typically involve many processes[1] that are highly integrated, the basic infrastructure of ERP packages fit systems theorists' characterization of complexity: a large number of elements together with a large number of relationships between them (Flood and Carson, 1993). When introduced within organizations, complex information technologies often impose a substantial burden on would-be users to use them effectively (Attewell, 1992; Fichman and Kemerer, 1997; Robey *et al.*, 2002). Tornatzky and Fleischer (1990) claim that complex technologies tend to be "fragile," because they do not always operate as expected. Moreover, they argue that complex ITs often require hand-holding in their appropriation, because they are difficult to learn.

Because of this complexity, even the successful implementation of an ERP package does not always lead to its effective use. This is consistent with past research, which shows that it is common for complex IT to be successfully implemented, but unsuccessfully appropriated. For example, organizational members often resist changes induced by technology (Kling and Iacono, 1989). They also use technology in ways that are not expected *a priori* (e.g., Kraut and Koch, 1989). As a result, unanticipated (and sometimes contradictory) changes may result from an implementation that was technologically labeled as successful (Robey and Boudreau, 1999). In such a scenario, expected benefits may only be partially, if at all, attained.

Considering that success is a multi-dimensional concept that includes more than a technological component, it is purported that a fully successful implementation of an ERP package is contingent upon its effective use. ERP, in other words, must be utilized to its potential in order for significant benefits to emerge from its use. Based on this assumption, a case study of a technologically successful ERP implementation was conducted. This inquiry led to the development of a learning-based model identifying relevant factors influencing better use of the software, that is, "quality of use". Specifically, quality of use should be understood as one's ability to correctly exploit the appropriate capabilities of software in the most relevant circumstances.

In this paper, we first discuss the construct of use and its antecedents. Specifically, we emphasize the need for a richer conceptualization of use and discuss the potential role of learning in explaining quality of use. Then, the research approach, a case study explored via the grounded theory research methodology, is presented. Next, empirical data supporting a learning-

[1] Glass (1998) contends that an ERP package contains 800 to 1000 business processes, which may be customized with the help of approximately 8000 configuration tables.

base model of quality of use is presented. Finally, the value of an extended version of this model, enriched from the literature, is discussed.

Revisiting use and its antecedents

The construct of use

The literature on the construct of use within the field of information systems reveals that use is one of the most frequently reported measures of system implementation success (DeLone and McLean, 1992; Seddon, 1997). However, IT use has generally been defined narrowly. Indeed, researchers have typically understood use in terms of "usage" and "user satisfaction" (Auer, 1998). When understood in terms of usage, use is further subdivided according to three dimensions (Trice and Treacy, 1988): time, reliance, and diversity. Although this perspective on use has been valuable in past research, it is not as compelling when one tries to assess how "well" an end-user understands a piece of software and how this person can exploit the capabilities of the software in the most relevant circumstances. In other words, "usage" is not an accurate surrogate for "quality of use".

To date, research efforts directed towards the creation of a richer conceptualization of use are few (Agarwal, 2000). Notable steps in this direction have been taken by Saga and Zmud (1994), who focused on the infusion of technology. Infusion is "the extent to which an innovation's features are used in a complete and sophisticated way" (Fichman, 2000; p. 110). Saga and Zmud distinguished three levels of infusion: extended use, integrative use, and emergent use, with each level being more sophisticated than the preceding. Auer (1998) also suggested a taxonomy of five classes of issues to look holistically at quality of use. Contributing to a richer operationalization of use, Nambisan *et al.* (1999) developed a construct labeled "intentions to explore," which measures one's willingness and purpose to find new ways of applying IT to work tasks.

Lassila and Brancheau (1999), Weber (1997), DeSanctis and Poole (1994) and others have recognized and conceptualized a distinction between the "deep structures" of an IS, i.e., the underlying data in table form, rules and relationships among the data, etc., and the "surface structures" of an IS, e.g., formatting and presentation elements. Burton-Jones and Straub (2003) review these and other works on deep structures and suggest that as users gain knowledge of and interact with the deep structures of an IS instead of investing time in surface structures, they can

become more productive. Thus one conceptualization of quality of use would be surface structure use versus deep structure use.

A framework proposed by Lassila and Brancheau (1999) appears particularly appropriate to better understand the use of package software such as ERP. These authors' framework allows for the investigation of the differences in IT utilization based on the relationship between technology and organization change. Inspired by the work of Johnson and Rice (1984), Lassila and Brancheau suggest four "equilibrium states," corresponding to increasing levels of use of a software package. These states represent limited use (i.e., low-integration), use to support existing processes (i.e., standard adoption), use to redesign existing work processes (i.e., expanding), and use to allow the extension of the capabilities of the technology and the work environment (i.e. high-integration). The progression towards higher levels of use is reflective of increasing comfort with the technology, as well as increasing control over the technology and the work processes. Although Lassila and Brancheau's framework aims at discovering how an organization, taken as a whole, may progress towards higher levels of use, their framework can also be applied at an individual level. This way, it is possible to capture how individuals, confronted with an identical technology implemented within the same organizational context, may use the technology differently.

Although these alternative perspectives constitute valuable efforts extending the construct of use beyond its more simplistic operationalizations, none of them offer much insight about what allows a user to progress towards a more sophisticated level of use (i.e., a "high" quality of use), particularly in the context of integrated, complex technology such as ERP.

Traditional adoption/acceptance models and quality of use

We have argued that common models of adoption and acceptance are inadequate for studying use of a complex information technology. However, many of the theories underlying other adoption/acceptance models (such as the Diffusion of Innovations theory, the Theory of Reasoned Action, and the Theory of Planned Behavior) are theories that model behaviors in general, not behaviors toward technologies of any particular complexity. If these theories are useful for increasing our understanding of general behaviors, then they have the potential to be useful for the study of complex technology use. In the current study, we use these models and

studies rooted in these theories to help us make sense of our observations and to contribute to the development of a model explaining Quality of Use.

Training and use

Studies of technology acceptance typically do not investigate the role of training in acceptance, but rather include subjects who participate in training and then use the new technology (e.g., Davis 1989; Agarwal, Sambamurthy and Stair 2000, Venkatesh et al. 2003) or who were identified or identified themselves as being already familiar with the technology (Agarwal and Prasad 1998; Karahanna and Straub 1999). The reason for this lack of focus on training and use in the IS literature might be because use of technology begins in Cooper and Zmud's (1990) "Acceptance" stage, whereas training occurs in the earlier "Adaptation" stage. Thus, studies that examine models of acceptance would not include training or learning as factors in the acceptance models. Many acceptance studies, including those mentioned above, are based on models with formed perceptions as exogenous variables, implying that at least the initial training or other familiarization activities had already occurred. Some (e.g., Venkatesh et al. 2003) measure these perceptions at different points in time with the understanding that experience affects perceptions. However, training is not typically treated as a factor that leads to use, but rather as a necessary condition for a context in which usage-related research can be studied. Quality of use describes how features of an application are used in a complete and sophisticated way, which is the domain of Cooper and Zmud's (1990)'s "Infusion" stage. Thus training/learning, initial use, and quality of use all occur in different stages (i.e., adaptation, acceptance, and infusion) and therefore are often studied separately. Cooper and Zmud's findings, however, are that "…political and learning models may be more useful [than rational decision models] when examining infusion." (Cooper and Zmud 1990, p. 123) This statement supports the notion that quality of use may have antecedents in learning. A model of learning showing the antecedents to quality of use thus implies a model spanning the adaptation, acceptance and infusion stages.

Training, and the resulting learning, have been integrated into models of usage in a variety of ways. Training has been identified as an antecedent to self-efficacy (e.g., Gist 1989, Martocchio and Webster 1992), which has been found to be related to other usage-related perceptions as well as use itself. CASE training availability was found to be related to "CASE

adoption behavior", which was measured according to the number of CASE functions being used in a more-than-experimental manner, similar in concept to quality of use (Rai and Patnayakuni 1996). "Learning performance" has been described as influencing "Attitudes" (Bostrom, Olfman and Sein 1990). Thus there are varying opinions on how to integrate learning and usage into a model, and learning effects on perceptions and usage behavior are supported by these and other studies.

However, the skills necessary for extensive use of a complex technology will develop over time, and therefore a set of perceptions at any single point in time cannot fully capture the influences on quality of use. It is similarly insufficient to measure perceptions and quality of use at multiple points in time if there is no understanding gained as to how the perceptions evolved. Rather, it is necessary to understand how perceptions change, and the influences on those changes, in order to understand how quality of use changes. Because learning is a result of training and learning leads to changes in perceptions, it is necessary to understand quality of use in terms of the training and learning that occurs over time. This is what our case study, presented next, illustrates.

Research Approach

The grounded theory research methodology was chosen for the pursuit of this inquiry (Strauss and Corbin, 1990). Grounded theory uses a qualitative approach and techniques of induction, deduction, and verification to develop or elaborate a theory about a phenomenon (Schwandt, 1997). More specifically, the "Straussian" version of the theory was used. This version differs from the "Glaserian" version in that it allows for the use of prior theory to help researchers gain insight into the data (Strauss and Corbin, 1994; Boudreau, 2002). The grounded theory methodology is not limited to the generation of a new theory, but may include the elaboration of an existing theory (Strauss and Corbin, 1994). Indeed, when prior theories seem appropriate to the area of investigation, these may be elaborated and modified as incoming data are meticulously played against them (Strauss and Corbin, 1994; Vaughan, 1992). Such an "emergent mode" of developing grounded theory (Artinian, 1986) was used in this research, as constructs and relationships from the existing literature were combined with our empirical findings.

A grounded theory should incorporate plausible relationships among concepts and sets of concepts, and such a model may be articulated in the form of a narrative statement, in a series of hypotheses or propositions, or, in the case here, as a visual picture (Creswell, 1998). The phenomenon (i.e., the impacts resulting from a technically successful implementation) was studied within a medium-size (i.e., 3000 employees) public organization from the southeastern United States, PubOrg, during a fifteen-month period spanning 1999-2000. Prior to our arrival in the field, PubOrg had implemented financial modules from a popular ERP vendor, the implementations of which were considered successful because they had been on time and on budget.

Means of data collection included analysis of documents, participant observation, and interviews. Documents such as training manuals, meeting minutes, newsletters, and some electronic mails were made available. Participant observation was possible because the first author had access to the implementation team members and the meetings they attended. Over the period of inquiry, 30 such meetings and training sessions were attended. Furthermore, the project leader agreed to send this author to a two-week training program to become more familiar with the ERP system being implemented. This allowed the author not only to get a deeper understanding of the technology, but also to get involved in the development of a few financial reports, giving her a sense of the issues surrounding the ERP system itself. Seventy-four interviews were conducted with 65 organizational members holding a variety of roles within the institution. More specifically, interviewees included clerical workers (mainly in charge of the entering of basic financial transactions, such as purchase requisitions or purchase orders), finance specialists (in charge of producing and analyzing financial reports, along with making financial entries), and champions of the ERP implementation. Interviewees were selected based upon their involvement with the system and their willingness to be interviewed by one of the researchers. Interviews lasted on average one hour each. They were semi-structured in their format and were all tape-recorded (except for five) and fully transcribed.

Whereas the phenomenon of study was known prior to entering the field, the most important insights emerged during data analysis[2]. This data analysis, conducted with the help of

[2] Grounded theory being an inductive approach, the specific literature on Use and Learning was not reviewed *before* entering the field, but *while* the data was collected and analyzed. Nevertheless, our paper follows a typical presentation format, where the literature is discussed prior to the research methodology.

a qualitative data analysis tool (Atlas.ti), incorporated different types of coding typical of grounded theory: open, axial, and selective coding. Open coding was the process of breaking down, comparing, conceptualizing, and categorizing data. Such coding was realized by comparing each incident, event, quote, and instance gathered during the data collection for similarities and differences. From the verbatim interviews and field notes, similar textual segments were labeled and grouped to form codes[3].

Axial coding necessitated that the data be put back together in new ways by making connections between codes to form factors. This was done by grouping codes based on their conceptual similarity. Through the axial coding emerged a model (called "theoretical network" in grounded theory (REF?)) revealing factors influencing quality of use of an ERP package. This axial coding procedure led us to an understanding of how organizational members had learned, through different means, the new software package.

Finally, during selective coding, the most relevant of these factors were selected to establish a stronger and more parsimonious model representing the main phenomenon. To clarify under-developed factors or relationships between factors, additional interviews were conducted (data collection and analysis are intertwined in grounded theory). Selective coding was considered completed when theoretical saturation was obtained, that is: when no new or relevant data seemed to emerge regarding a factor; when the factor development was dense; and when the relationships between factors were well established and validated. Resulting from this analysis was a model (referred to as "learning-based model of quality of use") explaining antecedents to quality of use of an ERP at PubOrg. The components of this model, along with the relationships between them, are discussed next.

Results

After the ERP system became live at PubOrg, organizational members began using the system. At the beginning, the vast majority of them struggled with even the simplest functionalities of the system. Surprisingly, even after a few months of regular use, many organizational members still considered the interaction with the new system as a challenging

[3] During open coding, 188 codes were created. Each code was associated with one or many text segments, so that overall, these 188 codes represented 2,090 text segments.

task. Other organizational members, however, had made remarkable progress and were using the system in a sophisticated way. Project leaders were puzzled by the existing disparity of use among PubOrg's employees.

Organizational members who were deficient in their use of the system appeared to lack appropriate know-how: "They don't know how to use it... they don't understand it," commented one project leader. Instead of directly interacting with the system (i.e., entering the information on line), these individuals used it indirectly through the available paper forms. For instance, one would choose the appropriate paper form for a particular transaction, fill it with the required information, obtain the necessary signatures for its approval, and transmit it to the staff in the Finance and Administration department. Those users who ventured to use the system more directly felt highly intimidated by it. They were hardly successful in doing anything with the new system, and blamed their inadequacy on their lack of understanding of the system:

> *I don't know how to use half of the functions in this system. I don't know if they pertain to me or not. I know enough to get what I need to get in there.*

> *Most of us use the system like monkeys: we are pushing buttons. We have directions in front of us, that say "Push this button," "Push that button"... we don't push other buttons. People are afraid of pushing the wrong buttons.... They know the buttons to push for their task, but not necessarily what is around.*

Provided their superficial understanding of the system's functionality, these users had difficulty retrieving information, as this was considered a very challenging task. In fact, most users were totally incapable of doing so. Verifying that a purchase requisition had been approved, for example, was something they could not do. Confirming that a check had been cut was also deemed infeasible. Likewise, finding out the free balance of a particular account was problematic. Even though they could enter a basic transaction within the system, users could not, for the most part, track the information; it was "lost in cyberspace."

> *I don't really know of any way of going back to check and see where things are, or if things went through. If you put a request, you order something, and it never arrives, you don't know if somebody down the line is having problem with the system, or if the system failed and you didn't put in the order correctly. So, you wonder, did it work?*

Nevertheless, other users demonstrated a much better understanding of the system. Instead of using the paper forms, these individuals used the system's computerized interface to not only do their job but also to experiment:

> *I enjoy entering the information and digging information out… With [the new system], I am more in control because I am actually entering the information myself, whereas before I would type it and submit it and someone else would put it in. I like to be empowered to put my own stuff in.*

For these users, the system provided real-time information, it banished the shadow systems (which were originally necessary to make up for the outdated information of the legacy system), fostered a paperless office, eliminated perfunctory tasks, and allowed for better reporting capabilities. Moreover, as these users became even more familiar with the system, they eventually felt capable of "tweaking" the system to better respond to their needs when facing its constraints. Such "tweaking," also called "workarounds," allowed them to use the system in a slightly different way than it was intended to work, so that they would get things processed the way they wanted them. Instances of workarounds included the use of a field (the "statistical code") to capture information of another nature (i.e., credit card payments); the use of multiple referenced records to handle a single vendor that has multiple locations; the use of "header comments" to compensate for a line item too short; and the use of a line item to indicate a particular action to take:

> *On a purchase order, if you find that you have to add money, you can't just go and change the line amount. It's not going to work; something is going to happen and Disbursements won't be able to pay it. So, a workaround we have here is to add an additional line to say "Increase PO by x amount of dollars!" just so the dollar amount equals what you need it to equal.*

In summary, whereas some organizational members interacted with the new ERP system beyond its basic capabilities, other could only use it in a very superficial way. Usage greatly differed in terms of *quality*.

Learning as a key predictor of use

What exactly influenced some users to appropriate the new ERP system in a limited way, while others thrived in using it in a more extended fashion? Respondents pointed to many factors

affecting their level of use, but one particular group of factors appeared as being critical to their "quality of use": the extent to which they had learned (and thus understood) the system. Given the complexity of ERP packages, it is necessary (but not sufficient) for an individual to first understand a technology quite well before aspiring to use it in a somewhat sophisticated manner.

Learning initially originated from formal training sessions offered to organizational members. Initial perceptions about the usefulness and ease of use of the new ERP package, however, impacted the extent to which people took advantage of these training sessions. Moreover, such initial perceptions influenced the organizational member's general attitude toward about the new technology, which in turned impacted organizational members' quality of use. The consideration of these factors and their relationships lay the foundation of a preliminary learning-based model of quality of use (see Figure 1). Empirical support for this model follows.

Training / Learning. Training was one major component that clearly influenced the extent to which some users did not understand the system while others appeared to master it. At PubOrg, training sessions were offered a month before the system went live, as well as one month after. It is through these sessions that many organizational members learned about the system and its functionalities. The following quotes are representative of a generally positive relationship between training and learning:

> *Now, I don't think anybody should try to do this without having gone through the training. I don't think they would even know where to start!*

> *I thought the training was good. The training manuals I think are excellent because in the very beginning, some of things I had to do... my first instinct was to grab Debbie but then I said I'll just get my handout and I'll do it like that. I've already left my frantic message for Debbie to "please call me! I have to do something new!", but then I would look at my handout. It was great because it gave you a frame-by-frame screen; click here, click there and it took you exactly through every step to the end. Some things were different because some things changed from training but when you figured it out, it still went through so you say, Cool! It worked. By the time Debbie shows up, I say, "I did it, I followed the manual, and I think I did it perfectly -- look at it!", you know. The training manuals are very good. That is how I learned how to do things on my own and after awhile I did stop calling Debbie.*

At PubOrg, employees were encouraged (but not required) to attend the numerous training sessions. However, to the project leaders' dismay, these sessions had been attended by only a

minority of employees. Understanding the perceptions these employees held about the new system helps clarify why training was only partially successful.

Perceived Ease of Use

Many organizational members had previous experience with basic information technologies, that is, with the previous legacy system and desktop applications such as word processors and spreadsheets. Users' relative experience with technology gave them the (false) confidence that they could learn the system by themselves and did not have to bother with formal training. Many thought that the ERP package would be generic enough to be self-taught:

> *I didn't think the training would be that crucial... that sounds terrible, but I thought that maybe it would be something that you could OJT [on job training] a little bit, that you could learn on the job.... Every system we had here, we learned it that way. You sit down, and you learn it by yourself. So, I had the feeling that this is a standard program, a package... I mean, it is not even specific [to our type of institution], so how hard can that be? That's what I thought. It is not like it was written specifically for us, so we thought that it was created with general, pre-assumed, code.... I did think I would be able to pick it up on the fly, so to speak.*

This finding suggests that perceived ease of use before formal training is negatively related to undergoing formal training.

Perceived Usefulness. The usefulness of the system also had an impact on the attendance of formal training sessions. Some users were highly troubled by what they perceived as a "buggy" system, and therefore, did not consider the system as one ready for use or learning. As the word spread that the system's operationality was questionable and its interface was burdensome, many users made the decision to disregard training sessions until the system was fixed. In other words, for the users who perceived the new system as being not yet ready for use, formal training was considered a waste of time and effort. The general assessment was that there was no point in attending training sessions if the package was going to be modified:

> *I have this kind of German mentality, rigid mentality, where I think that it ought to work. So, I'm waiting for them to straighten that out, I don't feel like, anymore, that I need to go dancing around in circles: I've done enough stuff.*

Other users, though, felt that that the system would be very useful after they underwent training:

I think that once it's learned, it will certainly make the job easier. Certainly easier for tracking and lessening the possibility of losing pieces of paper. I think once we've learned it, that's going to be good.

Some users were motivated to embrace the formal training sessions because of a perceived dependence on using the system. Many users realized that, without the system, they would not be able to respond to different requests from their supervisor. More specifically, the concern of some users was that, if they did not learn the system, they would not know how to track the transactions they had initiated. Indeed, although they could call the Finance and Administration staff to inquire about a transaction, the transaction number (provided by the system) was generally needed in order to find any information about it. If a paper form was used instead of the system, the transaction number was unknown, and therefore the transaction was much more difficult to track:

I definitely wouldn't use paper system on purchase requisitions, just because I don't have no way of finding out purchase order numbers. The only way of finding it is to go through the requisition ID number. There is no way I would go back to doing paper forms on purchase requisitions.

For those users who felt that their job requirements did not allow them to be ignorant of the system's functionalities, formal training became a "must" as this was the most direct way to understand the system's multiple capabilities. These findings suggest that perceived usefulness before formal training is positively related to undergoing formal training.

Attitudes. It was not always the case that trainees' attitudes toward the system were positive as a result of their new learning. In some cases, the new learning led to negative attitudes toward the system:

And then, having to learn it, it was not easy…it's not user friendly. It's called PeopleSoft, but it's not…it's PeopleHard! I hate it!

The attitudes that trainees had after the training were also influenced by their expectations of the system before the training. Comments by some trainees suggested that their post-training attitudes were formed as they reconciled their pre-training perceptions with their new learning. For example,

Before we actually saw the system, I was pretty excited about it. I was thinking: "wow, this is going to be a really great system, it is going to always be in balance, there won't have any problem […]", so I thought it was going to be much better than [the legacy system]. But for a while, the [legacy system] was better than [the ERP]! […] I guess I expected it to run smoothly, and it didn't, so that part I was disappointed.

This person's post-training attitude seemed to be influenced by his pre-training perception of the system's usefulness. Similarly, pre-training perceptions of ease of use seemed also to influence post-training attitude:

But I mean, you know, I guess on reason I thought it would be easier to run is that I run a lot of software packages, and I do a lot on the mainframe with various things to, and some things have steeper learning curve than others, but I had never have one where I absolutely could not find the answer for so long. So I think this was the main frustration. Usually, you just play around, flip enough switches, and something will end up working, but with [the new system], I just didn't have that luck. It may be more difficult to do it on the screen. More confusing. If you have to go through multiple screens to do what you use to do on one piece of paper… then people may end up, down the road, saying, "hey, this is a bigger hassle than the other way".

The previous two quotes also suggest that if a user had a positive attitude toward the system then he was willing to begin using, or attempting to use, the system or the newly learned functionality.

Considering the factors and relationships described above, a preliminary version of a learning-based model of quality of use is represented in Figure 1. This model highlights antecedents to quality of use. It shows that a user has initial perceptions of the system's usefulness and ease of use, and those perceptions influence the user's decision to participate in training. Indeed, even prior to attending any formal training sessions, a potential user has an opinion about the new system, as was exemplified above. The user may then elect to participate in formal training, which will increase his learning of the system and result in a new attitude toward the system. This attitude is also influenced by pre-training expectations, in the form of perceptions that the user had. The more positive these attitudes, the more likely the user is to begin using the system.

Formal training, however, was not the only means through which organizational members could improve their learning of the system. In fact, many of them had only attended a few sessions or had avoided them entirely. Instead of attending the formal training sessions,

some users elected to increase their knowledge of the system through what we call "informal learning," that is, the learning that occurred in a very unstructured and unplanned way. Informal training took multiple forms. It incorporated "water-cooler" conversations, casual questioning of more knowledgeable users, and spontaneous demonstrations of some of the system's functions. At a given time and for a particular system function, a user could either become unofficial trainer or trainee. When a user would discover how to perform a particularly useful task, peers were quickly updated about the tip:

> *I can't tell you how many things that we learned, not because of training, not because the trainers knew it, but because somebody figured it out, and it became kind of folk knowledge.*

For the most part, informal training was continual, that is, it emerged from a "need to know" basis rather than being predetermined (as in the case of formal training). For each informal training opportunity that a user underwent, new learning was created, and the user formed a new attitude toward the system and then made a decision as to whether or not to use the system as dictated by the new learning. Employing this new learning increased the quality of use of the system. The quality of use after an informal training event is therefore a function of quality of use before training and the new attitude toward the system.

Figure 2 depicts a revised learning-based model that takes into account both initial formal training and continual informal training. This model is solely based on the case study's data. It is similar to the model shown in Figure 1, except that the time indices (t_i and t_{i-1}) are used to indicate that each construct from the model changed over time, as informal training continued to occur.

Discussion

Observing how users appropriate technology permits one to take a fresh perspective on an old construct: IT use. In this case study, equating use to any of the three dimensions of usage previously discussed (e.g., time, reliance, and diversity) would have misled one to believe that this system was successfully used. Indeed, although some users exhibited *limited use*, they, at the same time, were spending many hours a week on the system (often through indirect interactions), they relied on it to conduct their work, and they interacted with a wide variety of its functions

(including the processing of purchase requisitions, travel authorizations, express vouchers, consultant agreements, petty cash advances, reimbursements, and journal entries). In other words, according to the dimensions of time, reliance, or diversity, usage was high. Nevertheless, as it was demonstrated, quality of use was limited for users, while being extended for others. Rather than considering use in a simplistic way, it is proposed to reframe this construct so as to make it more appropriate to the study of complex technologies. Quality of use, in the context of complex information technology, is thus a more valuable way to assess use.

Considering quality of use, instead of just usage behavior, facilitates our understanding of what influences some organizational members to use technology in a *limited* or *extended* way. In this case, the extent to which users had learned the system (via formal and/or informal learning) greatly contributed to quality of use through a change in attitude. Perceptions about the ease-of-use and usefulness of the system also influenced such a change in attitude.

Antecedents to training (both formal and informal) were also suggested by the data. Among them, perceived system quality, perceived expertise with the system, and perceived voluntariness of formal training emerged as possible factors explaining formal training. Perceived formal system support and perceived peer pressure emerged as possible factors explaining informal training. These were left out of the models in order to focus on quality of use as the ultimate dependent variable of interest.

It should be noted that other factors are frequently suggested in the literature for explaining use of information technology. For instance, managerial interventions, personal characteristics, and image enhancement, have previously been singled out as important factors impacting post-adoption use (Karahanna, Straub, and Chervany, 1999). Although some of these factors did emerge from the analysis of the case study's data, they did not demonstrate direct influence on the intermediary constructs of training and learning, and therefore were not included in the resulting model.

This is not to say that the model could not be enriched by what we can find in the literature. Being mindful of the Technology Acceptance Model and the Theory of Reasoned Action, we propose that the relationship between perceived usefulness and attitude (and likely, between perceived ease of use and attitude), be reconsidered to include post-learning perceptions. More specifically, as is illustrated in Figure 3, we suggest that the new learning will actually influences post-learning perceptions (of usefulness and ease of use), which in turn will

influence the attitude toward the system. These post-learning perceptions eventually become pre-learning perceptions when the user next undergoes informal training. We believe that this model, grounded in empirical data but extended with theory, offers a powerful means to comprehend how quality of use develops over time. Understanding quality of use implies not only longitudinal methodologies but also a movement away from "snapshot" models of single points in time to models that relate cognition and behavior across time.

In summary, although traditional models of technology acceptance and diffusion may be inadequate when used in their original form with complex technologies, they are still a good starting point for understanding quality of use. This research shows that the inclusion of factors relating to learning and training allows us to better comprehend what contributed to quality of use. Although these factors are not the only ones that will have an impact on quality use, they were, in this case study, the most critical ones to PubOrg's employees.

Conclusion

It has long been recognized that technologies are often not used as designed or intended (Orlikowski, 2000). Although an implementation may be considered a technological success, it is risky for any project leader to presume how the new technology will be used, particularly if the technology is a complex one. This case study reveals that, although organizational members made use of the system, their quality of use was often quite limited, and therefore reduced their efficiency on the job. Such phenomenon ought to be considered seriously, given that previous literature has shown that the use of an IS may be associated with decreased individual performance (Lucas and Spitler, 1999). Quality of use, therefore, is a construct worthy of further development and investigation.

Efforts toward a better conceptualization of use are supported by many, including Agarwal (2000), who thinks that "greater value would be derived from novel ways of [studying] technology use" (p.102) and Karahanna et al. (1999), who encourage the development of "a more sophisticated conceptualization of usage" (p. 202). The model resulting from this case study suggests that the inclusion of factors relating to learning allows us to better understand why quality of use may vary among individual users. The model was inductively created to represent the factors that appear to have the greatest impact on quality of use of a complex technology. From empirical data collected in a single site, we thus extended theory explaining

quality of use. This approach is consistent with the notion of generalizability associated with inductive research and case studies (Yin, 1994; Lee and Baskerville, 2003). Further research calls for empirical validation of this model in various organizational contexts.

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Tables and Figures

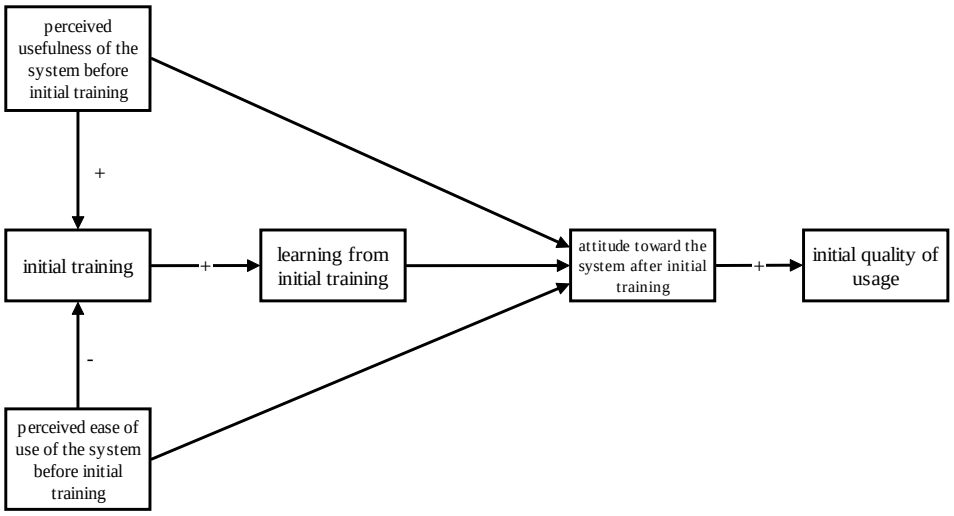

Figure 1. Learning-based model of quality of use (assuming formal training only)

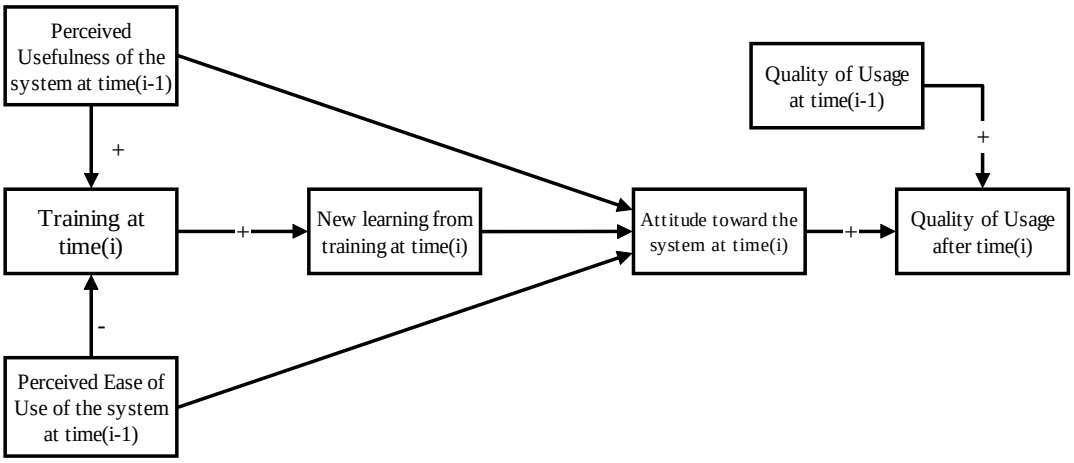

Figure 2. Learning-based model of quality of use (assuming both formal and informal training)

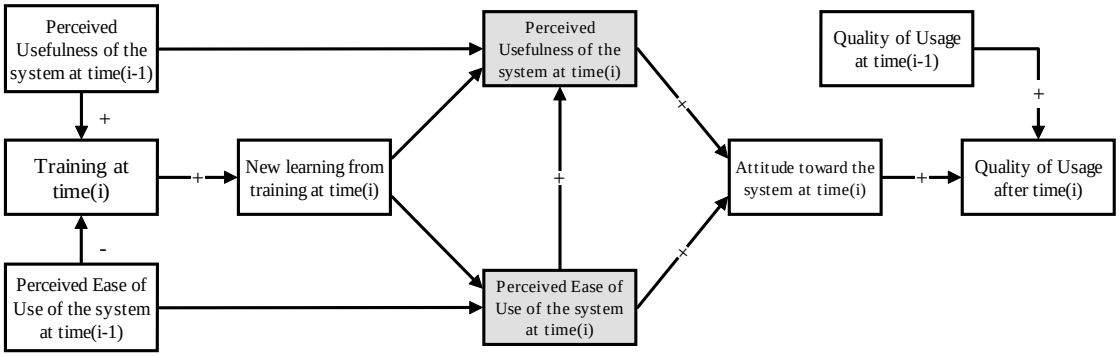

Figure 3. Learning-based model of quality of use (extending empirical support with literature, as shown in gray)