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# GOING IT ALONE: THE EXPERIENCED IT WORKER AS INTEGRATOR OF BUSINESS AND IT DOMAINS OF KNOWLEDGE

*Completed Research Paper*

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## **Abstract**

*Though the need for user participation to successfully develop information systems is a commonly accepted MIS axiom, empirical studies have failed to consistently establish the benefits of user participation. To resolve this paradox, we reconsider the underlying premise that business knowledge must be provided by business workers. Instead, as IT is embedded in the business, IT workers necessarily learn both domains in the act of work, and the integration of the two can be achieved through experienced IT workers. To examine this proposition, we studied a group of IT workers who implemented an IS in forty-seven sites over a two year period. Through learning curve methods and change-point analysis, we find that the IT workers achieved greater success as their experience increased while concurrently user participation activities decreased. These findings, consistent with the main proposition, suggest a new approach to valuing the IT workers' contributions.*

**Keywords:** User Participation, Information System Development, IT Professionals, Group Learning

## **Introduction**

An enduring challenge for organizations has been the alignment of IT workers' efforts with the goals of the business. Consequently, those in both practice and academia have offered the axiom that in order to achieve alignment, business workers should share their business knowledge with IT workers in an act labeled "user participation." More specifically defined, user participation is the purposefully structured interaction of IT workers and business workers (Hartwick and Barki, 1994). Through this structured interaction, business knowledge is integrated with IT efforts to assure the generation of value for the organization.

Unexpectedly, meta-analysis studies have revealed a failure to establish empirical evidence consistent with this conventional wisdom (e.g., Ives and Olson, 1984; Pettingell, Marshall, and Remington, 1989; Hartwick and Barki, 1994; He and King, 2008). This failure is particularly acute with respect to the relationship between user participation and business value (as opposed to, for example, user participation and IT system use). The logic supporting the need for user participation is straightforward – given that IT efforts require business knowledge, and given that business users possess business knowledge, it follows that business users must be engaged during IT efforts. Consequently, IS researchers have primarily chosen not to reexamine the logic supporting the need for user participation, but instead have recommended the use of more nuanced constructs (Barki and Hartwick, 1994), more elaborate measurement methods (Ives and Olson, 1984), and the identification of boundaries (e.g., IT projects pertaining to server rationalization would not be dependent upon user participation as it does not rely upon business knowledge).

Rather than introduce new measures, constructs, and boundaries, we reconsider the premises that support the need for user participation. While accepting the need for business knowledge as a boundary condition, we examine the premise that business users must be the chief provider of business knowledge. Based upon a longitudinal, process view of knowledge that explicitly includes learning (e.g., Cook and Brown, 1999), we propose an alternative perspective that IT workers, in the act of delivering IT services, become knowledgeable in the business. Over time, IT workers learn the business and become the mechanism through which the business domain knowledge can be applied in IT projects. Extensive user participation becomes less relevant as the IT workers have become "fluent" across the two domains. The two domains of knowledge, both still crucial, achieve coherence through the efforts of the experienced IT workers, and the marginal value of user participation is diminished.

To empirically examine this proposition, we collected data on a group of IT workers who over the course of two years implemented a workflow information system at forty-seven sites. As the sites were clustered into seven independent subsidiaries, each set of sites was a distinct encounter, with the IT workers serving as the only consistent presence across the subsidiaries. Using standard learning curve empirical methods, we find that the IT workers' performance as measured by the effectiveness of the implemented IS improved as the IT workers gained experience, indicating learning on the part of the IT workers. Employing change-point techniques, we show a concurrent diminished reliance on user participation activities. Together, the two results provide evidence consistent with the proposition that IT workers in the course of their work learn both IT and the business and can become the mechanism through which both sets of knowledge are applied. As such, experienced IT workers who work in a consistent business domain have less of a need for user participation activities.

The recognition that IT workers can achieve a significant understanding of the business may advance IT practices by suggesting more efficient and effective means for IT to deliver business value. For instance, recognizing the greater self-sufficiency on the part of experienced IT workers will increase overall efficiency by lessening the demand of the business users' time as the business users transition from active direction and deliberation activities with the less experienced IT workers to less time consuming validation tasks with more experienced IT workers. Effectiveness may also improve as the experienced IT workers, credited with their business knowledge, serve as a primary (though not exclusive) IT and business knowledge integrating mechanisms, achieving a gestalt of understanding, overcoming the difficulty of communicating across different mental frames and thereby avoiding the accompanying problems (e.g., Dougherty, 1992).

Yet these practice implications extend beyond project staffing decisions. This research suggests a new perspective on the value that the IT workers are capable of contributing to an organization. Anecdotally, the work of the IT worker is often perceived as routine and undifferentiated (e.g., Tynan, 2008), contributing to the belief that IT departments should be managed as cost centers (e.g., InformationWeek, 2004). Organizational policies developed and enforced with this cost-centric view result in higher turnover and fewer opportunities for IT workers to learn.

This perspective then becomes self-fulfilling, as IT workers are denied the learning opportunities that arise naturally in the course of their work and can then indeed only deliver efforts routine in nature. Through the understanding that IT workers will learn IT in the context of the business in which they serve, the business can more effectively value the contributions of the IT worker and purposefully manage human resource policies and IT worker learning opportunities to the ultimate benefit of the organization.

## **Theory and Proposition**

Through user participation, business users communicate to IT workers the needs of the business, IT workers communicate the opportunities and boundaries of the information system, and the two groups together arrive at an information system design and solution. The underlying logic behind the need for this interaction, uncontested in this paper, is that two domains of knowledge, that of the business and that of IT, must be represented and integrated for effective IS development and implementation. An underlying premise of user participation is that the two domains of knowledge must be possessed by two distinct sets of personnel: the business users, who have a privileged position from which to develop business domain depth, and the IT workers, who have a privileged position from which to develop information systems depth. This premise is reflected in the earliest developments of the user participation construct. For instance, Lucas (1974) argued that business domain knowledge is not available in the IS group, and must be accessed through what he termed “user involvement.”

At the same time, Swanson (1974), recognizing the lack of rigorous research regarding the “a priori involvement” of business users, issued a call to the IS research community to empirically establish the significance of user participation in IS development. Over the next several years, numerous attempts were made to establish the link between greater user participation and improved IT implementation results. Yet ten years later, a meta-analysis of this research revealed unexpectedly weak support. Ives and Olson (1984) wrote that “...it is almost an axiom of the MIS literature that user involvement is a necessary condition for successful development of computer-based information systems,” yet they found that the empirical research did not allow for such a case to be made. Of six studies that specifically measured systems quality (defined as the benefits of an information system to an organization), only two (Boland, 1978; Gallagher, 1974) found a positive relationship between user involvement and systems quality. One study was a formal lab experiment, the other used self-reported estimates of the value of the reports that the users helped define.

Ives and Olson’s explanation for this unexpected finding was the existence of methodological flaws and poor theory development, and they called for further research to remedy these shortcomings. The expectation was that once proper methods and theory were deployed, conventional wisdom would prevail. Nevertheless, subsequent research as revealed by later meta-analytic studies reflected similar weak support (Pettingell, Marshall, and Remington, 1989; Barki and Hartwick, 1989; He and King, 2008). The empirical support that has been established concerns perceptual, subjective user satisfaction ratings that may more accurately reflect psychological engagement rather than the organizational impact of a new information system. This distinction was identified by Barki and Hartwick (1989), who refine the user participation construct into two distinct constructs: user involvement, the subjective psychological state reflecting the importance and personal relevance of a system to the user, and user participation, defined as a set of behaviors or activities performed by users in the system development process. Following a similar logic, He and King (2008) performed a meta-analysis of user participation research by dividing existing user participation efforts by attitudinal/behavioral and outcome dependent measures. Once again, a weak relationship is found between user participation and outcomes.

### ***Reexamining the Premises of User Participation***

One possible explanation for the lack of user participation value is a lack of absorptive capacity on the part of the IT workers, a problem described as a “gap” in mutual knowledge (e.g., Nelson and Coopridge, 1996). Recently hired IT workers or those IT workers that rotate across business functions and are unfamiliar with the business may have great difficulty incorporating the knowledge of the business users when they do not have the language and framework to process the business information. In this paper, we approach the issue from the opposite perspective – considering the IT workers who have extensive experience in the business domain. The user participation premise that the two domains of knowledge must necessarily be possessed by two sets of workers reflects a rationale of specialization, where workers are boundedly rational and must select specific domains in which to focus. These workers obtain the benefits of developing a deeper understanding in a specific domain, are allowed the opportunity

to receive directed feedback, have a greater number of opportunities for repetition, and as a result develop a deeper understanding and specialized heuristics for the domain in which they participate (see Sun, 2005). When working on broad IS implementations requiring multiple specialists, the argument goes, knowledge must be integrated across these domain specialties to achieve collective goals. Based upon this perspective, the need for user participation is clear.

Critics of this view of specialization and integration claim that knowledge is inappropriately framed as a static asset through an “epistemology of possession” knowledge perspective (Cook and Brown, 1999). There is an alternative approach to knowledge (Eisenhardt and Santos, 2001), an “epistemology of practice,” where knowledge emerges in the act of work, and integration includes aspects of learning (Szulanski, 2000). In the act of work, workers not only achieve immediate goals relating to a particular assignment but also learn from their activities that occur *in situ* (Brown and Duguid, 1991). Under this view, context is a crucial element and part of the learning experience, as work is “...informed by a particular organizational or group context,” and the shaping of the understanding of properties of the world as they relate to the user (Cook and Brown, 1999). The functional boundaries we identify a priori are not necessarily consistent with what workers learn in the act of work.

Research from the fields of education psychology and cognition support this alternative view of specialization. Learning theorists explain that the minds’ use of categories and relationships allows people to address an environment too complex to cognitively grasp in its entirety. Rosch (1973, 1978) discusses the cognitive organization of categories, relationships between the categories, and hierarchies within the categories as a simplification mechanism. These categories can include a variety of topics, including things, actions, chronology, and the relationship between the parts (Lakoff and Johnson, 1980). Assigning newly experienced instances into a category allows the assignment of attributes that do not need to be maintained for every object encountered.

Yet the simplification achieved through these mental categories need not align with the conventional functional domains. Instead, these categories are formed through the identification of patterns through which sense making becomes automatic (Goldberg, 2001; Hart, 1999). The brain has evolved to deal with this initial multitude of information, and the context rather than being screened out is part of the gestalt of understanding, the scaffolding that provides meaning and is innate in the pattern recognition and sense making. Awareness of the context, of “being there,” facilitates transfer to long term memory (Kovalik and Olsen, 2005), while processing many inputs at one time creates a holistic experience that reinforces later recall (Cromwell, 1989; Caine and Caine, 1991). In addition, the categories of the experienced person evolve (Charness, 1991), growing more elaborate while the understanding of the context becomes less mechanical and more innate (Dreyfus and Dreyfus, 1998). Learning is thus situated, that is, occurs unintentionally through activity and is not abstract but part of the context (Lave and Wegner, 1991).

Relating this research to the IT worker, it follows that the categories created in the mind in the act of IT work are shaped and possess information relating to both IT and the business, if the two must be considered distinctly. As Simon (1945) observed, the definition of specialization is problematic, as it depends upon conveniently a priori defined domains, domains that do not necessarily map to the brain’s assimilation of the environment. The IT worker can best be characterized as learning a solution which involves both IT and business knowledge. As a result of the learning, the experienced IT workers are less in need of assistance from business specialists. To state this idea differently, learning can be characterized as holistic in that the learning that occurs in the act of implementation pertains to the IT domain and the business process domain together – the learning is not “placed” into two “buckets” in the mind. The IT workers in the act of work examine with the business users the processes, take great pains to represent the business processes and needs in formal deliverables, consider the business understanding during the IS design, then implement the IT solution. While the IT and business process domains are typically conveniently described as distinct, for the IT workers the two are inseparable. Our central argument is that as IT is embedded in business, the IT workers cannot specialize in IT as a distinct competency apart from the business. Since the IT workers necessarily learn the business in the course of their activities, the premise that the business users possess privileged business knowledge is not complete.

### ***Propositions***

The learning that occurs during the act of work has often been measured by researchers through learning curve techniques (Argote, 1999). Experience, as the independent construct, is represented by cumulative output of a

product or service, this output serving as a "...proxy variable for knowledge acquired..." (Darr, Argote, and Epple 1995).

The dependent construct employed through the learning curve approach is typically either a measure of efficiency or a measure of effectiveness. This selection between efficiency and effectiveness measures is well vetted in IS research. Barki, Rivard and Talbot (2001) present this choice as one between process performance and product performance. Process performance concerns capturing measures of the quality of the implementation, such as the number of hours worked, the ability to meet deadlines, and the expenses incurred. Yet process performance measures may be problematic in that the baseline expectations are often politically negotiated, and overruns may be just as likely a sign of improperly set expectations as poor performance. More significantly for this research, improved process performance more closely indicates learning in the IT domain of knowledge. A reduction in development time, for instance, may reflect the IT workers' growing familiarity in a programming language.

Product performance concerns the quality of the end product, that is, it relates to the actual impact of the implemented information system; it may be the reason the organization approved and funded the IS project. Representative product performance measures include improved decision making, reduced wait times for customers, and improved communication between employees. As such, product performance more closely reflects the efficacy of the incorporation of business knowledge into the IT workers' efforts. Product performance as a measure is similar to DeLone and McLean's (2002) development of the dependent construct "net benefit," an extension of the IS dependent constructs of individual impact and organizational impact (DeLone and McLean, 1992). The term is "constructively ambiguous" to allow IS researchers the discretion to frame the benefits related to the specific context under study. Adhering to the learning curve research for proposition development based upon this use of independent and dependent constructs, the first proposition is then:

**As IT workers' project experience increases, the net benefits from IT projects increase**

The empirical results of tests for this proposition alone could lead to several different interpretations. For instance, the business users and IT workers may have achieved a more effective working relationship. A corollary proposition is needed to provide a test of the IT workers' growing independence from the business users. Assuming efforts are efficiently managed, business users will participate in fewer user participation activities as the IT workers gain self-sufficiency. The corollary proposition is then:

**As IT workers' project experience increases, user participation activities decrease**

The empirical results of tests for the latter proposition alone are also not sufficient to support the overall theme that experienced IT workers can become the mechanism through which IT and business domains of knowledge are applied in IS efforts. A decline in user participation activities without concurrent evidence of improved net benefits could indicate overall project "fatigue" or poor project management as user participation activities take secondary importance to the immediate urgent project needs of development and testing (as the old joke goes, "You start coding, and I'll go get the requirements"). While it might be argued that a decline in user participation activities reflects greater efficiency among the participants rather than learning per se, the learning would in fact be the factor facilitating the more efficient user participation activities, e.g., through better communication due to improved absorptive capacity.

The concurrent improved net benefits *and* diminished user participation activities are both necessary to support the overall proposition that the experienced IT worker can become the integrating mechanism for IT and business knowledge. The two propositions, empirically distinct, logically bound, serve together as the proposition to test.

## Data Collection Setting

### *Site Attributes*

As the propositions concern changes in performance over time, the data collection setting needed to offer multiple IS implementations occurring in the same business process domain. In addition, the same set of IT workers would need to remain intact, migrating to each implementation. The site from which the data was collected possessed these as well as other beneficial characteristics. First, each set of implementations was performed in a geographically and managerially distinct subsidiary of a single organization, thus at each implementation a new set

of business users in the same business domain were engaged. It seems reasonable to attribute the learning that occurred to the IT workers.

A second advantageous setting characteristic was the relationship between the IT workers and the organization. Finding a setting where the IT workers remained intact is difficult as IT departments are frequently managed as cost centers, resulting in higher personnel turnover and the use of virtual, rotating team members, practices that may preclude experiencing learning opportunities. We turned instead to IT consultants, who as revenue generators are often managed with greater attention to learning opportunities. The IT consultants all possessed at least one business degree and previous IS experience, but no prior experience in the health care domain (with a single exception). None of the IT workers had previous experience with the client, any of the client personnel, or the system to be implemented. Given that the IT workers and the system to implement were the only consistent factor across centers, changes in net benefits across implementations can reasonably be attributed to the IT workers. As the only immediately evident change to these IT workers across implementation was the experience they obtained from the prior implementations, their experience is the most reasonable independent variable to consider. The group of IT workers included four workers across the implementations, with the identity of a fifth member changing over the course of the implementations.

### ***Site Description***

The client organization from which the data was collected was a holding company of outpatient diagnostic imaging centers, sponsoring a two year effort of radiology information system (RIS) implementations across all its subsidiaries. Like most health care organizations, this organization was addressing the compelling need to control costs. According to a McKinsey Global Institute (2007) study, the U.S. spends on average 15% of GDP on health care as opposed to 8% for other OECD countries, a difference attributed not to higher quality care but in part to higher administration and insurance costs. Diagnostic imaging centers were under even further cost containment pressures. The Deficit Reduction Act of 2005, effective for services beginning in 2007, reduced the reimbursement amount for Medicare patients for imaging services. At the same time, the Centers for Medicare and Medicare Services (CMS) changed its reimbursement policy, paying only half of the costs of imaging procedures involving contiguous body parts. In addition, insurance companies increasingly began requiring pre-approval for imaging services (Tynan, Berenson, and Christianson, 2008).

The client organization employed over 2,000 personnel at sixty centers, and performed more than 1.5 million procedures a year. The client grew to this size through the aggressive acquisition of independent, smaller diagnostic imaging centers, reflecting a health care trend of cost containment through consolidation. At the time of the implementation project, the client had eight subsidiaries (one of which did not own stand alone centers and was not included in this study), each with its own history, systems and procedures. The subsidiaries were each based in a specific geographical region, and had almost no interaction with one another. Each subsidiary consisted of several centers usually serving a metropolitan statistical area.

Diagnostic imaging centers do not have a direct relationship with patients. Instead, a patient sees a primary care physician or specialist who identifies the imaging services required for the patient, usually writing a "script" detailing the needed procedure. The patient schedules the visit based upon the needed services as detailed by the script, arrives at the center on the scheduled day, has a procedure performed, and an image is generated. A radiologist then examines the medical images produced during the visit, usually dictating impressions into some form of recording system. The resulting sound file is forwarded to a transcriptionist, who types the comments, then sends a written transcript back to the radiologist for approval. The radiologist does not interact with the patient but rather issues a diagnosis for the referring physician. The referring physician receives the diagnosis, then shares the results with the patient and determines the next course of action. The diagnostic imaging centers earn revenue through the patients' payments for services, and also through the management and administrative services offered to the radiologists, who are typically not employed by the centers.

The organization was implementing the RIS with the intent of improving process times and patient flow, automating and simplifying workflows, standardizing processes and protocols, improving the capture of front-end data, providing more timely digitized images to referring physicians, reducing errors (e.g., incorrectly scheduled dates, times, and procedures), and reducing film and storage costs. The RIS software was a workflow solution, designed to manage the processes of the patient visit. The RIS first accommodated the scheduling in advance by a patient or referring physician on behalf of the patient. Two days before arrival, a patient service representative (PSR) is

alerted to contact the patient's insurance company to verify that the insurance covers the requested procedure; if it does not, the PSR must secure payment in advance from the patient. The day of the visit, the patient arrives on the premises and checks in at the front desk. A technician (tech) is then alerted by the RIS, and the tech escorts the patient to the appropriate modality and performs the requested procedure. An image is generated, and the workflow queues the image into a radiologist worklist. The radiologist reviews the subsequent images and dictates the diagnosis. Upon completion of the dictation, the transcriptionist is alerted to the existence of a new voice file in the queue. The transcriptionist types the radiologists' recordings into the RIS and marks the report as complete, which then alerts the radiologist that a report is ready for approval. The radiologist approves the report, and the results are then typically sent to the referring physician. If the radiologist rejects the report, the transcriptionist receives an alert from the RIS requesting that the voice file be transcribed a second time.

The RIS software provided extensive options for configuration, covering choices for billing, center and room assignment, modalities, procedures, medical codes, fees, physicians, patients, insurance, security, alerts, transcriptions, and worklists. Other operational decisions included how long patients could be "wait listed," how many days prior to an appointment a patient would be contacted for confirmation, how many days out patients must wait to schedule an appointment if their procedure required precertification, and what worklist options needed to be excluded (e.g., a mammography procedure should not allow the selection of the body part to be scanned as "elbow"). Subsidiary specific processes that had to be accommodated included an allowance for "outside reads" (the viewing and diagnosis of digital images by offsite physicians), the display of a patient's insurance for the radiologist (certain insurance companies would not provide reimbursement for reads by radiologists not pre-approved), the accommodation of differences in state laws (e.g., worker's compensation required different supporting documents across states), the capture of information at check-in regarding the in-patients' hospital room or nursing home contact information, and the use of existing mammography systems and picture archival systems (PACS). Each center also had different modalities both in type and kind. For instance, nearly all centers provided X-ray services, while fewer provided fluoroscopy services. Some CT modalities were more advanced than others, and as a consequence the procedures that might take ten minutes at one center could take twenty minutes at another center. The prep instructions for each modality at each center might also vary, for instance, regarding how the contrast was to be administered.

While nearly sixty centers were implemented over the two years, several of those centers were specialized centers residing in a larger health care facility, and patient visits were infrequent. Data from forty-seven "free standing" centers, representing seven subsidiaries, was collected and analyzed. Each center was represented during user participation activities, and center specific configuration and specialized solutions were required. Regardless of the center differences, each center within a subsidiary "went live" at the same time.

### ***Independent Variables***

Experience as the predictor variable is traditionally represented through the measurement of the accumulation of the product or service produced. For instance, having produced 100 widgets would reflect more significant experience than having produced 50 widgets. In the case of the IT workers under study, the RIS implementation effort is the predictor measure representing experience. The RIS implementations were a collective effort, reflecting learning on the part of the collective group. Learning at the level of the analysis of the group, while a commonly researched phenomenon (Bettenhausen, 1991), has not traditionally been examined through learning curve methods (Schilling, Vidal, Ployhart, and Marangoni, 2003). The number of centers implemented is one logical candidate for the measure of experience. An alternative independent variable measure that will also be examined is the cumulative number of hours worked by the IT workers at the point of time of each implementation. The number of hours is not necessarily a linear function of the number of centers implemented, and may more accurately capture variation in learning across subsidiaries.

Because of the clustering of center implementations by subsidiary, the learning that occurred at the first center was of no benefit for the fourth center implemented, as they were implemented at the same time under the same subsidiary. The fifth center implemented will benefit from the learning that occurred at the prior four centers as it belongs to a different subsidiary, whose centers were implemented afterward. In contrast, for the second independent variable, the hours worked for the implementation of a specific subsidiary's centers' RIS were credited for those centers in addition to the hours for previous centers' implementations.



### ***Dependent Variables for Learning***

The dependent construct is net benefit, and the expectation is that, as the IT workers learn the business, they will implement the RIS in a manner that will be of greater benefit for the organization. Of the several benefits that the organization aspired to achieve in implementing the RIS, the best candidates for measurements are process times and errors. As some subsidiaries had different demands and staffing models, an averaged metric, per patient process times will be used. The process times for the first month after the RIS implementation was selected for measurement, as the learning that occurs in the latter implementations could benefit all subsidiaries, but not retroactively.

The errors will be measured through the cancellation of an exam. While there is a consistent baseline of cancellations that is not related to the deployment of the new system (e.g., due to patient illness), in addition the PSR in recognition of an issue in the system for patient scheduling and registration also canceled the visit (and later recreated the visit when the issue was resolved). The dependent variable measures then to be used as evidence of learning are:

- Average per patient process times by center for a month (22 working days) from go-live
- Average number of canceled exams per patient for a month (22 working days) from go-live

### ***Dependent Variables for User Participation***

Hartwick and Barki (1994) proposed the use of three user participation variable categories for research: the user/IS relationship (via informing and reviewing), user responsibility (via signing-off and selecting), and user hands-on activities (via defining and creating). In the organization's implementation environment, the nature of the responsibility of business users did not change across subsidiaries – there was a common set of forms that the users signed to acknowledge having received training, loaded appointments, and tested; for each subsidiary the sign off tasks were mandatory.

The informing, reviewing, and defining activities will be measured through the weekly aggregation of hours spent in meetings between the IT workers and business users. The meeting measure is weekly duration normalized by total hours spent at each subsidiary. There was a lower bound to the number of meetings for each subsidiary, as the implementations followed a methodology that dictated that a certain number of meetings be held. There is no such upper bound. The IT workers could call additional meetings as deemed necessary, and could seek to delay the go-live date for a subsidiary if more time was needed for analysis and design. It is expected that a decrease in meetings will be found as the IT workers achieve their own business process understanding of the centers.

### ***Control Variables***

Not all subsidiaries presented the same degree of challenge to the IT workers. The participants of the implementations shared that the order of subsidiary implementation was determined through anticipated difficulty, with the most difficult subsidiaries scheduled to be implemented last. In lieu of an ad hoc measurement “adjustment” for the process times to accommodate this ordering, the IT workers were asked to indicate whether the subsidiary presented routine or significant, unique challenges. For instance, one identified challenge was a subsidiary ownership of a unique system for which interfaces needed to be developed. The “difficulty” control variable was assigned a value of 1 for the routine subsidiary implementation and 0 for those subsidiary implementations that required the IT workers to overcome a unique challenge. To capture differences across centers that may impact the net benefits that arose apart from the IT workers' learning, control variables for general complexity and size of the subsidiaries were added. Specifically, center size, as measured by patient volume, and complexity, as measured by number of modalities offered by center and number of centers by subsidiary, were added. The list of variables to be examined is provided in Table 1.

**Table 1 - Listing of Model Variables**

<u>Independent Variables</u>	<u>Dependent Variables</u>	<u>Control Variables</u>
<i>Experience</i>	<i>Net Benefits</i>	<i>Degree of Implementation</i>
Sum of number of centers implemented	Average daily patient process times for first 30 days after initial center go-live	<i>Difficulty</i>
or	Average daily visit cancellations for first 30 days after initial center go-live	The existence of a unique difficulty as identified by the IT workers
Sum of hours worked by IT workers		<i>Complexity</i>
	<i>User Participation</i>	Number of subsidiary centers
	Average weekly duration of meetings relative normalized by hours allocated to subsidiary	Number of modalities by center
		<i>Size</i>
		Number of patient visits by center

Given the identified variables and measures discussed, the proposition will be operationalized through the following hypotheses:

**As the IT workers' number of implementations/hours increase, the RIS process times will decrease**

**As the IT workers' number of implementations/hours increase, the duration of user meetings will decrease**

### *Sources of Data*

The data used for the process times and canceled exams was collected from the implemented RIS from which a data set of over 16,000 records was retrieved. The meetings data was collected from the IT workers' on-line scheduling/calendar software and contained detailed records of 94 weeks of meetings (the first three weeks of the project were not captured). There were 1220 meeting records, which included such information as subsidiary identity and the date and time of the meeting. Not all meetings could be characterized as user participation driven; for instance, training delivered shortly before go-live to staff was not included as a user participation meeting. As the meeting records included titles and notes on purpose, filtering was performed upon meetings that could not be characterized as user participation. The control variable data was captured through direct queries to the center administrators.

### **Analysis**

The two hypotheses will be tested through two distinct methods. The first hypothesis will be examined through ordinary least squares learning curve regression, a common approach used in the learning curve literature. We chose to employ change-point methods to examine the second hypothesis, a method commonly used with longitudinal data. Through change-point, it is possible to identify points in time when the data fundamentally changed, rather than uncover a general relationship between variables.

### *Learning Curve Analysis*

The learning curve model allows the representation of changes in the measure that can be improved through learning (the dependent variable) as a function of the measure of the initial effort of production weighted by a measure of the total experience (the independent variable) raised to a power reflecting the learning rate. The learning curve model as an exponential production function is designed to capture the limits to continued increases in improvement, and is modeled as

$$y = ax^b \quad \text{or} \quad \log y = \log a - b \log x$$

The full model for this paper, using the variables enumerated in Table 1 is

$$\log(\text{process times}_i) = a - b_1 \log(\text{cumulative centers implemented}_i \text{ or cumulative hours worked}_i) - b_2 \text{routine implementation challenge} + b_3 \text{number of subsidiary centers} + b_4 \text{number of center modalities} + b_5 \text{patient volume by center} + e_i$$

To test the first hypothesis, two model variations were examined. For the first model, the log of the cumulative number of hours worked was regressed over the log of the average process time over the first month after implementation (Model 1a). For the second model, the independent variable was changed to the log of the cumulative number of centers implemented, which was regressed over the same dependent variable (Model 1b). The models were then extended by adding the first control variable, difficulty of implementation, (Model 2a and 2b), and then by adding the remaining control variables: number of centers for each subsidiary, number of modalities for each center, and volume of patients by center (Model 3a and 3b). The results are provided in Table 2.

**Table 2 – Estimated Coefficients for Process Time Learning Models (Standard Errors in Parentheses)**

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
<b>log (Cumulative Hours Worked) (b<sub>1a</sub>)</b>	-2.54*	-	-5.03***	-	-3.49**	-
	(0.05)	-	(0.05)	-	(0.06)	-
<b>log (Cumulative Centers Implemented) (b<sub>1b</sub>)</b>		-3.85***	-	-5.22***	-	-3.7**
		(0.05)	-	(0.05)	-	(0.06)
<b>Difficult Implementation (b<sub>2</sub>)</b>			-4.58***	-3.68**	-4.54***	-3.73**
			(0.07)	(0.06)	(0.07)	(0.06)
<b>Number of Subsidiary Centers (b<sub>3</sub>)</b>					-1.27	-1.28
					(0.01)	(0.01)
<b>Number of Center Modalities (b<sub>4</sub>)</b>					-0.37	-0.36
					(0.72)	(0.01)
<b>Center Patient Volume (b<sub>5</sub>)</b>					-0.14	-0.15
					(0.00)	(0.00)
<b>R<sup>2</sup></b>	12.50%	24.73%	40.79%	42.42%	43.88%	45.45%

**Dependent variable: log(Average Process Time Per Patient)**

\* Standard errors are shown in parentheses

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

The coefficients for both independent variables (the cumulative number of centers implemented and the cumulative number of hours) are significant and carry the expected negative value, indicating the achievement of learning. The cumulative number of centers implemented (-3.85, p < .001) provides a slightly better fit than the cumulative number of hours (-2.54, p < .05). One possible explanation for this difference is that the learning that occurs is of the “experience” of implementation rather than the accumulation of repeated, daily tasks. A second difference between the two measures is that the subsidiary’s current cumulative number of hours was included in the independent variable measure, while the current cumulative number of centers was not, also indicating that the IT workers were learning with respect to an overall “experience” that cannot be reduced to minute daily tasks. When the average process times were captured at the subsidiary rather than the center level of analysis, then regressed across the cumulative number of centers implemented, the R-squared value is 77%. However, the resulting population size is seven, requiring the use of small sample size methods outside the scope of this paper.

The significance of the learning variable coefficients increases once the degree of difficulty control variable is added to both models. Consider that, as the overall project was designed to implement those subsidiaries with greater anticipated implementation difficulty last, even no empirically measurable change in process times across subsidiaries could indicate improving performance. Both independent variables, cumulative number of centers implemented (-5.03, p < .001) and cumulative number of hours (-5.22, p < .001), registered as more statistically significant with the addition of the difficulty control variable.

The control variables of size (as measured by patient volume) and complexity (as measured by number of modalities by center and number of centers by subsidiary) added little to the models explanatory power, though being relatively more correlated with the learning independent variables than the degree of difficulty variable, the control variables impacted the independent variables' coefficient values. An additional control variable, the number of hours worked per site, was not significant for the cumulative number of centers implemented model, and introduced collinearity issues for the cumulative hours worked model.

To further examine the validity of the propositions, the average number of cancelled exams, serving as the dependent variable, was substituted for process times as a performance metric in the models. The results are provided in Table 3.

**Table 3 – Estimated Coefficients for Cancelled Exam Learning Models (Standard Errors in Parentheses)**

	<b>(4a)</b>	<b>(4b)</b>	<b>(5a)</b>	<b>(5b)</b>	<b>(6a)</b>	<b>(6b)</b>
<b>log (Cumulative Hours Worked) (<math>b_{1a}</math>)</b>	-0.97 (0.04)	-	-2.9** (0.04)	-	-2.4* (0.05)	-
<b>log (Cumulative Centers Implemented) (<math>b_{1b}</math>)</b>		-2.02 (0.04)	-	-3.01** (0.04)	-	-2.47* (0.05)
<b>Difficult Implementation (<math>b_2</math>)</b>			-3.51** (0.07)	-3.05** (0.06)	-3.49** (0.08)	-2.96** (0.07)
<b>Number of Subsidiary Centers (<math>b_3</math>)</b>					0.61 (0.00)	0.48 (0.00)
<b>Number of Center Modalities (<math>b_4</math>)</b>					0.24 (0.01)	0.25 (0.01)
<b>Center Patient Volume (<math>b_5</math>)</b>					0.41 (0.00)	0.39 (0.00)
<b>R<sup>2</sup></b>	2.20%	8.86%	24.80%	25.70%	26.51%	27.05%

**Dependent variable: log(Average Cancelled Exams Per Patient)**

**\* Standard errors are shown in parentheses**

**\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001**

While experience is not significant in the univariate models (4a and 4b), experience is statistically significant once the control variable for difficulty is added (Models 5a and 5b). The results of the cancelled exam models, while weaker, are consistent with the first hypothesis. The weaker relationship may be due to the RIS independent, consistent cancellations that occur in the natural course of operations that do not vary with improvements in the RIS.

### Diagnostics

While models (2a) and (5b) provide the best fit for the first hypothesis, we ran diagnostics on all models. As evidenced through the results of the Breusch-Pagan / Cook-Weisberg tests, models 1a (p=.0027), 3b (p=.0421), and 4a (p=.0409) exhibit heteroskedasticity. A possible explanation for this result is a change in the scale of the process times – as the centers improve the process times, the variation in the process times also becomes less severe. Neither further data transformations (e.g., inverse) nor weighted least squares methods (UCLA, 2008) significantly improve the presence of heteroskedasticity in the three models. However, unless the heteroskedasticity is severe, the standard errors can still be treated as efficient (Long and Ervin, 2000). Breusch-Godfrey tests revealed that no model exhibited autocorrelated residuals, the closest being model 1a (p=.0525), model 1b (p=.134), and model 4a (p=.2973).

As both independent variables reflect the same phenomenon of learning, the similar results across model variations provide construct validity support. To test discriminate validity, performance measures not expected to change with the IT workers' learning, the number of addendums and the number of aborted exams, were examined. This data was obtained from the same RIS data. Addendums are radiologist changes and additions to the reading of an image, and aborted exams occur when an exam cannot continue, for example, when a patient is too heavy for the modality.

The RIS did not directly impact the occurrence of such instances, and would not be expected to vary with the learning of the IT workers. The coefficients for these alternative dependent variables when regressed over the two different independent variables for experience were not statistically significant. The empirical evidence is consistent with the first hypothesis: As the IT workers' number of implementations increases, the user process times decrease.

### Change-Point Analysis

Ordinary linear regression models do not allow the identification of a change in the parameters of the data, or identify a point in time at which the changes occur, questions germane to the identification of changes in user participation activity. To remedy this shortcoming, the proposed decrease in the need for user participation activities was examined through change-point methods. Change-point methods are used to "...detect if there is a change in the sequence of random variables observed...and estimate... their corresponding location" (Chen and Gupta, 2000: 2). In using change-point techniques, experience is implicitly represented through the elapsed time. Through change-point methods, changes in the nature of the normalized weekly meeting duration can be identified.

The meeting data (see Figure 1) was analyzed through Change-Point Analyzer (version 2.2). This software uses serial bootstrap sampling (with replacement, mean squared estimate method of estimation) to identify potential changes in data. The bootstrapping technique involves a random reordering of the data (in this case, 1000 times) to establish a baseline with which to compare the original ordering of the data. Through the change-point algorithm, thresholds are set and persistent changes in the original data sequence that fall outside these thresholds are identified.

Two statistically significant decreases in the meeting data were detected. The average cumulative weekly time spent in meetings decreased after the first implementation, at week thirteen ( $p=.05$ ), and later at week sixty-three ( $p=.001$ ). The first decrease may reflect the nature of the progression of the overall project, as time may have been committed the first several weeks to overall project planning (for instance, determining how to maintain project calendars). The second statistically significant change occurs before the final three subsidiary implementations. These results are consistent with the second hypothesis that the user participation activities decrease as the IT workers' experience increases.

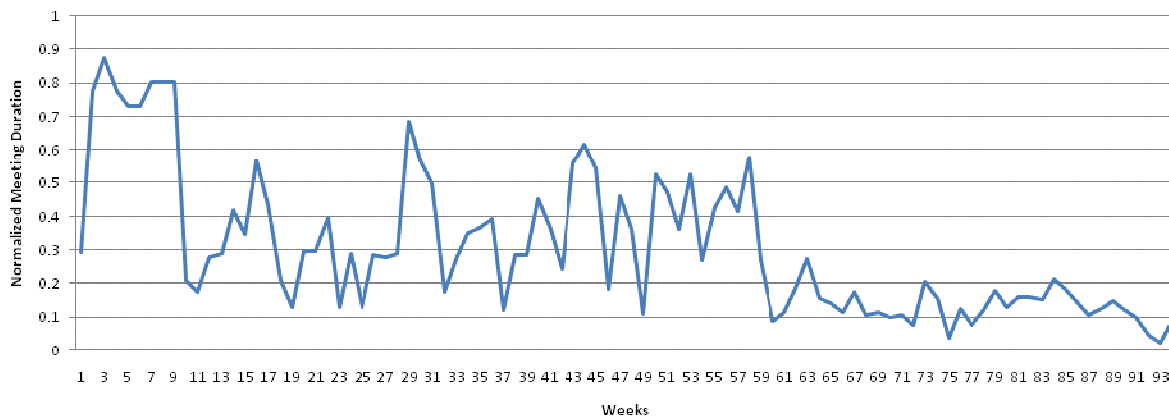


Figure 1 – Average Normalized Weekly Meeting Duration

### Diagnostics

The change-point error terms were independent, the primary assumption that must be fulfilled for the Change-Point Analyzer algorithms. To examine discriminant validity, travel activity data was examined through change-point methods. This data was obtained through the IT workers' time and expense reporting system, and included more than 2500 time records and 1500 records on expenses. All IT workers lived in the same city, and none of the centers were located within this city. The business process users never traveled to meet the IT workers, but the IT workers made frequent trips to the centers of each subsidiary. While the meetings only concerned user participation activities by the design of the data collection (e.g., design meeting times were included, training sessions were not), there were many reasons to travel outside the scope of user participation activities, such as data center set up,

training, and ceremonial go-live support. As such, visits would not be expected to reflect the changes in learning. The collected visit data was calculated as the cumulative weekly count of visits by the IT workers normalized by hours worked for the subsidiary. Change-point analyses revealed several statistically significant changes which included increases and decreases. These changes were in part due to the punctuated nature of travel, where the IT workers traveled heavily for several weeks then not at all. Removing from the data set weeks where no travel occurred resulted in three statistically significant changes in visit frequency, with two of the changes indicating an increase. This absence of consistent pattern suggests that not all IT worker activities were in the same decline as meetings, and then serves as a means of assuring proper discriminant validity.

The results of the change-point analysis with respect to the meeting activities provides support for the second hypothesis – as IT worker experience increases, user participation activities decline. Together the two hypotheses are logically consistent with the proposition that experienced IT workers through business/IT domain learning gain a self-sufficiency in integrating the two domains, making user participation activities less necessary.

## **Discussion**

The need for business users to provide business domain knowledge for IS implementations has been assumed from the earliest days of information systems research. “User participation is critical to the success of MIS projects” (Powers and Dickson, 1973), “Participation by those who will be affected by the system is essential” (Dickson and Simmons, 1970), and “...(MIS personnel) should not dominate...companies would do well to give more responsibilities to operating managers” (Thurston, 1962). Yet subsequent empirical research findings provided mixed support. In this paper, we propose that the experience of the IT workers in the business context influences the need for and value of user participation. As IT workers gain experience applying IT solutions in a business domain, they learn the business, and then become the means through which IT and business domains can be applied. These findings are straightforward, and abstractly could be stated as the following – a set of workers (IT workers) need a resource (business knowledge) from another set of workers (business users) unless the first set of workers already has the resource. The significance of this research is that it breaks from prior research in explicitly rejecting the premise that the first set of workers could not possess the desired resource, and instead recognizes the learning that occurs on the part of the IT workers. Consider that, without this recognition, the results of this research would indicate a deleterious impact of user participation. As the inexperienced IT workers undertook the first subsidiary implementations, user participation was relatively higher; later, the IT workers found greater success even as user participation activities waned. Without incorporating the understanding of learning, the correlation could lead to the assertion that user participation is counterproductive.

Boundary conditions for these research findings include the context of design and implementation of information system activities. Alternatively, the selection of an information system or the choice of strategic direction concerns alignment of a different nature (Kearns and Sabherwal, 2006) and involves more abstract questions than those asked in the system implementation setting. As the intent in strategic alignment endeavors tends towards discovery, the IT workers may complement but would not serve in lieu of the business users. This research also does not address user involvement, defined as the emotional engagement of the users arrived at through design and implementation activities (Hartwick and Barki, 1994). In the setting under examination, the business users had little discretion whether to adopt the system, so user engagement may not have been a significant concern relative to other IT projects. For projects involving systems with greater business worker discretion of use, user involvement benefits may be an intractable benefit of user participation activities.

Limitations for this research include the setting of a single organization (though each subsidiary had its own management team and history), a single set of IT workers, and a single system. While measures for learning are grounded in existing learning curve methods and logically reflect the changes in performance, a more meaningful measurement would be the longitudinal changes in the IT workers’ cognitive categorization of the business. Though the level of analysis for this research is the group, there are many questions that remain to be asked about the interactions of the IT workers within the group. Perhaps the key limitation of this research is that the data collection was not developed through a traditional research design but collected from a practice effort. The benefits to this method of collection are significant, as discussed in other sections. However, the systematic manipulation of a priori identified variables is not possible, and construct validity under such circumstances is a concern, necessitating the discriminant validity tests.

## ***Practice Implications***

This research suggests that the value that the IT workers can deliver to an organization should be reexamined. As the IT workers necessarily learn the business in the act of IT efforts, they can make a hitherto underexploited contribution as the integrator of business and IT knowledge. Yet too often the tasks of the IT workers are characterized as routine and scriptable. Consider the popular media's presentation of IT work as seen in the comic strip *Dilbert* or the movie *Office Space*, or the *Harvard Business Review* staff voting Nicholas Carr's "IT Doesn't Matter" article the best of the year. A recent article about organizational alienation of the IT workers (Tynan, 2008) included the following passage – "Even more than wages, life/work balance, or job security, virtually everyone interviewed for this story says what IT workers want most from their employers is respect - for both their expertise and for the value they bring to the organization."

Once the routine, mechanical view of the IT workers had been established as representative of the "universal" IT worker, the organization implements decisions that reinforce this perspective, and IT worker instances possessing qualities not characterized as innate in the universal preclude an instance from belonging to the universal. In other words, the development and acceptance of a category becomes self-fulfilling, as the instances are managed to meet the selected properties of the category. Thus the IT worker who does manage to acquire business knowledge is not acknowledged for this development. Brown and Duguid (2001) write that the context in which learning occurs not only shapes the acquisition of knowledge but the acquisition of identity. Others in the environment must acknowledge the legitimacy of claims of knowledge – possession is not sufficient.

The characteristics of the IT workers' tasks, perceived as routine and scriptable, imply commodity-like and undifferentiated skills. As such, the IT worker as perceived in many organizations is best managed in terms of costs. Consequently, an organization's staffing philosophy for IT projects may not allow for the IT workers to serve in a consistent business context. Human resource policies may set retention rate goals that do not reflect the contributions that the experienced IT worker can make but instead assume the interchangeability of IT workers. As time passes, the purposeful organizational design that removes the responsibility for business acumen from the domain of the IT workers becomes interpreted as exogenous evidence for the support of these definitions, further enforcing the marginalization of IT workers (Colvin, 2007).

There are two central recommendations that follow from this research for those organizations that recognize their practices in the descriptions just provided. First, those in practice should acknowledge and expect that the IT workers can learn the business processes that they support. From this acknowledgement comes the realization that the role of IT worker needs to be understood as one that creates value through an understanding of technology in the context of a business process. This understanding in turn must involve new responsibility and accountability on the part of the IT workers towards the business function. "Control of an object appears to be a key characteristic of the phenomena of ownership," and the higher the discretion exercised by IT workers on the business side, the more likely that they "will invest more of their own ideas, unique knowledge, and personal style" in the knowledge, thereby making it theirs (Pierce, Kostova and Dirks, 2001: 301-302). In short, organizations should seek not only to acknowledge but facilitate IT worker learning through, for instance, staffing IT workers in consistent business domains across projects when possible. The IT workers might even be assigned to the business department rather than the IT department, with a "dotted line" report to the IT department. Through this assignment, the IT workers would have the opportunity for deep immersion into the business process, ready access to information regarding the changes occurring in the business, an appreciation for the concerns of the business, and accountability to the department.

A second recommendation concerns changes in human resources staffing practices for IT workers. A reading of many IT worker internet bulletin boards will quickly reveal the widespread anxiety that IT workers possess regarding their relationship with their employing organization. The chief concern is their replacement by those identified by the organization as less costly, i.e., younger or offshore IT workers. While there may be cases where using costs as the sole criteria is an appropriate decision, without the recognition of the IT workers' potential contributions arising from their business knowledge, organizations will systematically undervalue the IT workers. To borrow a common example from the economies of scope literature, consider that a shepherd, in the act of butchering a lamb, must remove its wool. Both products have an economic value, but the marginal costs of producing the wool in the act of producing the mutton are negligible. Conversely, the shepherd who only sells mutton and discards the wool is not leveraging the potential value of the lamb. Similarly, the organization that does not leverage the IT worker business learning that necessarily occurs through their work efforts is not reaping the

value that it otherwise might. Staffing models that recognize the value the IT worker can provide, combined with the proper organizational design, will create a new channel of value for the organization.

These recommendations may not fit every situation. By rotating IT workers on an availability basis across business domains, the IT worker may have the opportunity to develop specialized depth within a specific niche IT domain. In addition, the rotation of IT workers across business domains may result in a leaner IT department which on the whole requires fewer personnel. However, these benefits and savings, recognized today, must be considered in relation to the less recognized costs of project failures that arise from poor IT knowledge and business process knowledge integration on the part of less experienced IT workers. By recognizing the IT workers' learning and capabilities, new opportunities of value will arise for both the IT workers and the organization.

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