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USER REACTIONS TO INFORMATION TECHNOLOGY: EVIDENCE FROM THE HEALTHCARE SECTOR

LES REACTIONS DES UTILISATEURS A LA TECHNOLOGIE DE L'INFORMATION :

CAS DU SECTEUR DE LA SANTE

Completed Research Paper

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Abstract

This paper examines the diverse nature of user reactions to information technology (IT) within the social-historical context of its organizational use. Employing activity theory as a conceptual framework, we conduct an interpretive analysis of physicians work, perceptions, and IT usage experience at a large community hospital to understand why some of these physicians were favorably disposed toward IT use while others were not. This study complements prior positivistic analyses of IT usage that explain similarities in usage patterns within a user population, by using an interpretive lens to explain differences in usage patterns. Further, we contribute methodologically to the literature by demonstrating a novel approach of quantitatively coding qualitative data that renders the coding amenable to further "drill-down" analysis.

Keywords: Activity theory, user reactions, individual differences, healthcare, interpretive analysis.

Résumé

Cette étude se fonde sur la théorie de l'activité pour réaliser une analyse interprétative du travail des médecins, leurs perceptions ainsi que leur utilisation des TI dans un grand hôpital communautaire. L'objectif de cette étude est de comprendre pourquoi certains médecins étaient favorablement disposés à utiliser les TI tandis que d'autres ne l'étaient pas.

Motivation for the Study

Information technology (IT) has long been credited with increasing productivity, efficiency, and effectiveness in the workplace. While such technologies have been successfully accepted by many user communities (Mekhijan et al. 2002), in others, they have encountered staunch resistance. For instance, in 2003, physicians at the prestigious Cedars-Sinai Medical Center at Los Angeles rebelled against a newly installed computerized physician order entry (CPOE) system, complaining that the system was too great a distraction from their medical duties and forcing its withdrawal after the system was already operational in two-thirds of the 870-bed hospital (Freudenheim 2004).

The expected benefits of IT cannot be realized if users are indifferent to or resistant to its use. New IT implementation often engenders significant organizational change by restructuring work procedures, job roles, and power distribution at work (Markus and Robey 1988). Entrenched user groups, unaccustomed to or unwilling to accept such change from the status quo may view organizational IT implementation in a negative light, and may therefore resist its usage. Hence, IT implementation initiatives that are not accompanied by proactive change management programs often result in implementation failures.

User reactions, in this context, refer to users' perceptions and general disposition about a given IT and its impact on their work within its socio-historical setting. Understanding such reactions is important because they usually provide an insight into subsequent user behavior regarding IT usage (i.e., whether they will accept or resist it or be indifferent to its use). Gauging IT usage is also usually the first step in designing appropriate change management strategies to facilitate IT usage in organizations. Prior IT usage research, which has been dominated by the positivistic paradigm, have led to the identification of numerous factors, including perceived usefulness, perceived ease of use, attitude, social norms, and facilitating conditions, that presumably influence voluntary IT usage within and outside organizations. This research has led to the development of theories such as the technology acceptance model [TAM] (Davis et al. 1989), the Unified Theory of Acceptance and Usage of Technology [UTAUT] (Venkatesh et al. 2003), and others, that explain generalizable patterns or similarities of IT usage within a user population. However, this research paradigm, by its very nature, cannot account for differential patterns in user reactions for the same technology or within the same population. Further, since this research focuses on voluntary IT usage, it is unable to explain user behavior where usage is mandated or coerced.

Among the few interpretive studies in this area, Lapointe and Rivard (2005) examined user resistance to IT implementation in three hospitals, noted five components of resistance (behaviors, object, subject, threats, and initial conditions), and found resistance to be a multi-level phenomenon caused when IT features conflict with individual or organizational-level initial conditions. Davidson and Chismar (2007) studied technology-structure alignment during CPOE implementation in a hospital, observed one technological trigger and two institutional triggers of organizational change, and found that role networks can influence the trajectory and outcomes of change. Likewise, Reardon and Davidson (2007) noted that a community-wide organizing vision can help influence physicians' perceptions and adoption of electronic medical records in their private practices. However, none of these studies delved into individual differences in IT usage or the divergent perceptions causing these differences.

The goal of this paper is to understand the varied nature of user reactions to IT-driven change in organizations, taking into account individual differences across the user population. The specific research question examined is: Why do some users have positive reactions and others hold negative reactions toward the same IT within the same organization? Because user reactions can be best understood through the eyes of the beholder (i.e., users), we adopt an interpretive approach to studying our phenomenon of interest. Though our research approach contrasts with the positivistic (theory-driven, hypotheses testing) approach employed in prior IT usage studies, we expect that the interpretive approach will complement extant positivistic approaches by extending IT usage research to areas that have not been sufficiently studied before (i.e., the issue of differential user reactions) and by helping extend current theories of IT usage to a wider range of implementation contexts.

The context of this study is physicians' usage of a CPOE system within a hospital setting. CPOE is an automated workflow system that physicians can use to enter, track, and access the results of orders for in-patient procedures (e.g., lab work such as blood culture or urine analysis, radiology work such as X-rays, ultrasounds, or computerized tomography scans, medications, and special procedures such as biopsy or bronchoscopy) using a computer. The system, which has seen significant resistance among many physicians, represents a drastic change from the erstwhile manual process where physicians entered orders using paper forms. We adopt an interpretive case research strategy, using data from 27 physician interviews at this site and historical contextual data, elicited from meetings with hospital executives and internal documentation.

To understand the subjective reactions of physicians within their social and historical context, we employed activity theory as a conceptual framework to structure our interpretive analysis. This technique also helped us glean quantitative estimates of qualitative physician reactions and generate additional insights through a "drill-down" analysis that is also a methodological contribution to the literarture.

The rest of this paper proceeds as follows. The next section describes activity theory and its relevance for studying user reactions to IT implementation. The third section presents our research methods, including case background, data collection, and data analysis. The fourth section describes the study's findings. The fifth section presents a

discussion of our study's findings, its limitations, and its implications for research and practice. The final section presents concluding remarks.

Activity Theory

Activity theory is not strictly a "theory" in the true sense of the word, but rather a conceptual, philosophical framework for understanding and interpreting human action within its social and historical context (Engestrom 1987). The historical roots of activity theory can be traced back to the work of the Russian psychologist Vygotsky in the 1920s. While mainstream Western thought at that time viewed human minds and societies as distinct dichotomies, Vygotsky suggested that they are interrelated in that human consciousness is shaped by social experiences (cf. Blackler 1995). Hence, human actions and psychological processes can only be understood via an appreciation of the socio-cultural factors that mediate them and the development processes connecting the individual and social realms (Kuutti 1995).

Activity theory treats activities as the basic unit of analysis. An activity includes not only human action, but also the social context within which that action is embedded. A classic example of an activity, described by Leontjev (1978), is that of primitive hunters who, in order to catch game, separated into two groups: bush-beaters, whose job was to frighten the game and move it in a desired direction, and catchers, whose job was to lay a trap and catch the game. When compared with the motive of hunting (i.e., catching the game), the actions of bush-beaters seem irrational; these actions can only be understood as part of a larger system of the hunting activity. Similar examples of activities can be observed within IT contexts, such as a group of software developers with distinct roles and responsibilities, such as requirements definition, analysis, coding, and testing, combining as a whole to create complex enterprise software customized for a specific client (Kuutti 1995).

The basic structure of an activity, as proposed by Engestrom (1987), is as follows (see Figure 1). An activity involves a *subject* (also called an agent) engaging in an *object* (e.g., a behavior, reaction, etc.) to achieve a desired *outcome* (e.g., task completion, social status, etc.). The transformation process is usually mediated by *tools* or artifacts such as instruments, procedures, or forms of work organization, which may themselves be created or altered during the activity or carried over from a previous activity. Tools may be enabling and constraining at the same time: they can empower the subject in the transformation process by crystallizing historically accumulated skills and experiences, while also restricting the subject's perspective or actions to those that are defined by the tool and rendering other features of the object "invisible."

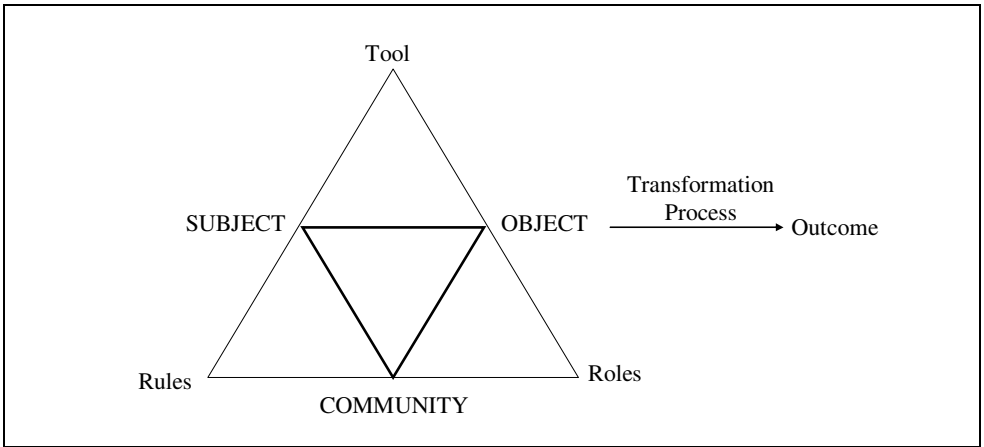

Figure 1. Activity Theory

The above structure describes activities solely at the individual level, without consideration of the socio-historical context within which activities are located. To incorporate this context, Engestrom (1987) proposed a systemic conceptualization of an activity by adding *community* as a third structure (in addition to subject and object). He also suggested that the subject-community relationship is mediated by *rules*, and the object-community relationship is

mediated by *roles*. Rules include explicit and implicit norms, expectations, and social relations held within a community, and roles refers to explicit and implicit organization of the community or division of labor among community members in relation to the transformation process.

In sum, an activity consists of three activity structures (subject, object, and community), and three processes (tools, rules, and roles) that mediate these structures. Each of these activity structures and mediating processes is historically and contextually defined and constantly evolving. For instance, what constitute acceptable rules and roles in one context may be unacceptable in another context or at a later point in time. Further, the object of an activity may change during the course of the transformation process, resulting in an outcome that is drastically different from what was initially expected. Hence, an activity is never static or rigid; it undergoes constant change in a relatively uneven and discontinuous manner. Although an individual may participate in several activities at the same time, each activity has its own history and context, and is therefore distinct in its own right. Remnants of older activities (such as rules or roles defined therein) may shape future activities, and hence, an historical analysis of the development of an activity is often needed to adequately analyze such activity.

The relevance of activity theory to the healthcare context is evident from Engestrom's (1991) study of a medical practice in Finland. Through observation, discourse analysis, and historical reconstruction, Engestrom observed that physicians (subjects) had varying conceptions of their work (object) in bio-medical, socio-medial, administrative-economic, and system-interactive terms, and hence, resulting in suboptimal medical care (outcome). While physicians were embedded within and governed by their health practice (community), their ability to work was constrained by the biomedical concepts and techniques (tool) mandated by their profession, the random allocation of patients to physicians in the Finnish healthcare system (rule), and the inflexible division of labor between physicians and other healthcare providers (role). These constraints forced physicians to treat all healthcare problems as biomedical problems with less consideration to variations in patient conditions. This study was conducted before the mainstream infusion of IT in healthcare, and hence did not examine the role of IT as a tool for altering and transforming healthcare practices. Our study augments and extends Engestrom's work by applying activity theory to examine IT-driven organizational change in healthcare settings.

Research Methods

Case Background

Our interpretive case study was conducted at Memorial Hospital (a pseudonym), a large 800+ bed regional medical center in the southeastern United States. This was a community hospital where physicians had practicing privileges at the hospital and its facilities, but were not salaried staff members. Because they earned no salary at this hospital, many physicians felt less allegiance to the hospital or its initiatives to standardize medical practice through the use of IT.

Memorial Hospital is a technologically sophisticated facility with a large IT support staff, and one of the earliest in the country to experiment with and implement CPOE technology. The first CPOE system was implemented here in 1997 as a packaged solution in the cardiology department. However, in the months that followed, numerous technical and implementation problems surfaced, including lack of job-relevant functionality, frequent drops in wireless connectivity, and training setbacks. Eventually, the system was discontinued in late 1998.

A new CPOE system was reintroduced in 2003, following 18 months of process reengineering. Learning from its disastrous experience with the previous CPOE project, the new system was rearchitected to include physician workflow support, integrated with electronic medical records (EMR), and incorporated new value-added features such as adverse drug alerts. The wireless network was also overhauled, training procedures were redesigned to work around physicians' busy schedules via one-on-one training and support, and key early adopters (physicians) were recruited as project champions (change agents) to spread the word about the system's benefits among other physicians. Additional structural changes were instituted to facilitate organizational change, including a CPOE steering committee staffed by members from the hospital's executive committee and physician representatives, a physician user group to represent physician concerns regarding the system and ensure that these concerns were satisfactorily addressed, and a physician clinical support group staffed by IT experts who worked with individual physicians to customize the system to their personal preferences.

The intended operation of the system was as follows. Physicians could log into the system from their hospital floor, home, or private clinics using a password-protected interface (the system tracked login date and time), access complete medical records of patients assigned to them, check real-time status on existing work orders such as laboratory or radiological tests, place new or follow-up work orders, dictate notes into the system (which were transcribed within 24 hours), and organize the orders or their results to their personal preferences. The system was fully integrated with a second system that stored digitized x-ray images, magnetic resonance imaging (MRI) scans, ultrasound images etc, which were available with a mouse-click from the CPOE system. Physicians could automate repetitive ordering of labs, procedures, and medications for common medical conditions (by ICD-9 code – a system of diagnosis codes) via "order sets," which could either be generic or customized to physicians' preferences. The system cross-checked physician prescriptions against patients' allergy records for possible unfavorable reactions or interactions, tracked patients' medication schedule and alerted the attending physician or nurse when new doses were needed, and flagged floor nurses when new results came in for forwarding to the ordering physician.

During our initial site visits to this hospital during late 2003, we observed several physicians as they used the CPOE system at work, and interacted with physicians who liked the system and those who hated it. One younger physician who liked the CPOE system (an early adopter), said that logging into the system from home every morning to check on patient charts and retrieving up-to-date results and status reports helped him optimize his hospital rounds, saved him time with paperwork processing at the hospital, and allowed him to spend more time with patients. However, other physicians hated the system and devised innovative strategies to avoid its use, such as "smuggling" in paper-based order sheets, calling in an order to a nurse (to avoid interacting with the system), requesting work assignments on floors where the system was not yet installed, and devising workarounds such as sticking "Post-It" notes to patient charts. Common reasons cited for system non-usage were that "it [the system] is new and difficult", "it takes too long to learn", "every patient is different, so a common system won't help," and "there was nothing wrong with what we had before [paper-based ordering]." This wide range of physician reactions toward the system portrayed a very complex and diverse pattern of IT usage.

In 2006, Memorial Hospital passed a "mandate" of CPOE usage among all physicians and abandoned all paper-based forms. The non-users grudgingly started using the system, with some physicians continuing to use nurses and interns to enter patient orders on their behalf. At the time of writing this paper, it seemed that the mandate was somewhat successful in forcing physicians to use the system. However, considerable resentment and dissatisfaction persisted, as evident from our interview data discussed next.

Data Collection

Our research team has followed CPOE implementation at Memorial Hospital since its reintroduction in 2003. Since then, we have had numerous meetings with the hospital executive committee members, CPOE steering committee members, early adopters, non-adopters, IT support staff, and nurses, examined implementation plans, presentations, and other documents provided by the hospital, and pored over public media reports regarding this hospital, its medical error incidents, and technology deployment initiatives. In 2004, we interviewed ten physicians and eleven nursing staff members to understand their usage or non-usage of the CPOE system. Although not discussed in this study, our intimate knowledge of this site and its prior IT implementation initiatives over five years helped us reconstruct the historical and social context surrounding the CPOE implementation and provided the contextual background for our activity theoretic analysis.

The primary data for our analysis of physician reactions was collected from 27 physician interviews, conducted during late 2007. The initial interviewees were arranged by our key contacts, the Chief Executive Officer and the Chief Medical Officer of this facility. Subsequent interviewees were identified using a "snowball sampling" technique, during which, we took care to ensure representation from a wide range of physician backgrounds, demographics, usage patterns, and opinions. Interviewed physicians practiced a wide range of specialties including internal medicine, pediatrics, cardiology, orthopedic surgery, neonatology, pulmonary medicine, emergency medicine, and psychiatry. They ranged in age from 28 to 65 (with a median of 50), had been in medical practice for three months to 39 years (median of 20 years), and had been at Memorial Hospital for 3 months to 33 years (median of 8 years). These respondents had been using computers in general for between 10 and 25 years (median of 20 years), and had used healthcare systems for between 1 and 25 years (median of 8 years). Interviewees represented the entire range of CPOE usage and non-usage, self-rating themselves from 1 to 7 of a seven-point Likert scale, with median usage of 4 and mean usage of 4.88.

Physician interviews were conducted by two research professors, one of whom had significant experience in interviewing techniques and qualitative research. One interviewer was responsible for primary questioning, while the other took notes and sought clarifications when needed. All interviews were tape recorded, with the interviewee's permission, and transcribed. Interviews followed a semi-structured protocol, where interviewees were asked a series of questions regarding their usage or non-usage (or proxy usage by nurses or other personnel) of the CPOE system, their perceptions of the system's benefits and drawbacks, how their opinions of the system evolved with time, how these opinions were influenced (or not) by key referent others within and outside the hospital (e.g., professional associations), their perceptions of how the system was implemented and whether their input was taken into consideration, and what they would like to see changed in the system. Interviews ranged in duration from 30 to 75 minutes, averaging approximately 45 minutes. The interview protocol and data collection procedures were reviewed and approved by the institutional review boards at the researchers' university and at the study site.

Data Analysis

Transcribed interviews were entered into QSR's N6 software for qualitative data analysis. We attempted to code the interview responses using the two dimensions of the activity theory framework: (1) activity structure: subject, object, and community, and (2) mediating process: tools, rules, and roles, into a 3 x 3 coding grid.

Our initial strategy was to distribute the coding workload among three independent coders with diverse perspectives of the project: one research professor who was involved in the original data collection process, and two others (a second research professor and one doctoral student) who did not participate in data collection. All coders were provided with definitions of the six components of an activity (subject, object, community, tools, rules, and roles), and asked to categorize salient interviewee comments simultaneously into one of the three activity structures and three mediating processes. Since subjects' perceptions of tools, rules, and roles were both positive and negative, the mediating processes were each divided into "positive" and "negative" categories to capture the valence in subjects' responses. Following one practice training round involving two randomly selected interviews, coders were asked to independently code a second set of five interviews representing a diverse range of physician reactions (two physicians in favor of the CPOE systems, two opposed, and one neutral), age (from 41 to 59 years), and medical specialties (orthopedics, internal medicine, cardiology, cardio-electric physiology, and pulmonary care).

Though there was some general agreement in code counts and patterns, the coders experienced considerable confusion in classifying individual interviewee comments into specific activity structures and mediating processes. To alleviate this confusion, the research team decided to split the "community" structure into two categories: hospital and profession, since subjects viewed themselves as simultaneously being members of their hospital community and their larger professional organization of practicing physicians. Likewise, the "object" structure was separated into patient care and process improvement categories, to reflect the fact that physicians viewed their primary objective as delivering the best possible medical care, in contrast to process improvement goal held by CPOE implementing team. A "neutral" category was added to the positive and negative categories for the "tools," "rules," and "roles" processes to account for ambiguous or non-directional responses.

Since the N6 software is designed for unidimensional rather than two-dimensional coding, the process of coding each piece of text simultaneously into activity structure and mediating process dimensions was found to be particularly cumbersome. To simplify the coding process and to automate the process of tabulating codes, we developed a multi-dimensional coding frame using Microsoft Excel. Pre-formatted interview transcripts were imported into Excel as text, and two drop-down lists were created in which the coder could select an appropriate activity structure and mediating process for each line or block of text. Macros were created to automate the counting of activity structure and mediating process codes and populate a 3 x 3 grid for each physician. This approach also allowed us to automate the generation of roll-up statistics based on physician specialty, age, and tenure, or all physicians in general.

To further minimize subjectivity and coder biases in the coding process, we decided to code in three rounds. In the first round, all 27 interviews were coded by a single coder. In the second round, a second coder independently reviewed the interviews and their assigned codes, identified areas with unclear or unassigned codes, and assigned new codes to those areas if needed. In the third round, a third coder (the research professor with qualitative research experience who conducted the initial physician interviewers) went over the inconsistent codes between the first and second coders, and reconciled them based on first-hand knowledge of the interviewee and the social-historical context of their reactions. Between each round, the coders met as a group to discuss areas of inconsistencies and

decide on future courses of action, which enriched our overall understanding of the context of CPOE implementation at this facility.

Although the three rounds increased our coding workload substantially, it helped compensate for potential subjectivity during the coding process, reconciling coding variations across coders by closing the hermeneutic circle (Klein and Myers 1999), and allowed for intersubjectivity (Lincoln and Guba 1990) to emerge. Inter-coder agreement was 75.2% following the first two rounds of coding, which increased to 100% (consensus) after the third round. The results of this analysis are presented in the next section.

Findings

The overall distribution of physician reactions by activity structure and mediating process dimensions is summarized in Table 1. The 27 respondents in our sample provided a total of 1212 reactions. Among the three activity structures (community, object, and subject), the majority of reactions focused on the object of physician activities (578 or 48%), followed by subject (422 or 35%) and community (212 or 17%). This suggested that physicians viewed the CPOE system as primarily influencing their practice of medicine, and to lesser extents, their own personal preferences and predispositions, and their community. The majority of these reactions related to the object of process improvement (442 or 73%), suggesting that subjects perceived CPOE as a tool for reshaping work processes at Memorial Hospital, compared to the delivery of patient care (132 or 23%). Since physicians viewed their primary role as delivering patient care rather than streamlining work processes, these figures suggest that the majority of physicians did not view the CPOE as contributing to their central goal (or *object*) of delivering the best possible medical care, and were therefore biased against its usage. Further, comparing the reaction count between the two types of community, i.e., hospitals (127 or 60%) versus profession (85 or 40%), our findings suggest that physicians perceived the CPOE system to be driven by the hospital community (administrators, nurses, etc.) more than by their professional community of physicians within and outside the hospital.

Table 1. Overall Physician Reactions

		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	15	8	11	18	26	23	3	4	19	127
	Profession	6	1	1	32	13	10	4	6	12	85
Object	Patient care	65	8	19	5	31	2	0	3	3	136
	Process imp.	217	7	94	57	42	14	4	5	2	442
Subject	Physician	161	25	104	20	32	16	20	24	20	422
TOTAL		464	49	229	132	144	65	31	42	56	1212

Examining reaction counts by mediating processes (tools, rules, and roles) in Table 1, the majority of physician reactions (742 or 61%) were related to the tool (the CPOE system), followed by rules (341 or 28%) and roles (129 or 11%). Most tool-related reactions (464 or 63%) viewed the CPOE system in a positive light (e.g., they found it useful) rather than negatively (229 or 31%), and 49 reactions (7%) were neutral. In contrast, the impact of CPOE on physicians' rules of work was mostly ambiguous (144 or 42%), rather than being positive (132 or 39%) (e.g., it benefited their work) or negative (65 or 19%). The effect of the system on their work roles and responsibilities was mostly negative (56 or 43%) (e.g., physicians saw the system as degrading their work) rather than positive (31 or 24%) or neutral (42 or 33%). These findings collectively suggest that even when IT systems are viewed as beneficial by a majority of the physician population, they perceived the system to have an ambiguous impact on work rules and negative impact on organizational roles. The overarching ambiguous and negative perceptions of rules and roles may explain why many physicians were resistant toward CPOE usage, despite its instrumental benefits. This finding also demonstrates that organizational IT are socio-technical in nature and can be simultaneously viewed as being technically superior and socially inferior, and that IT designers and organizational managers who ignore the social aspects of IT may potentially risk its rejection by the user population.

It may seem from common logic that the CPOE system would be favored by younger physicians, by those who had more experience with healthcare IT, and by those who had been working at Memorial Hospital for a shorter period of time. To explore any systematic differences in physician reactions by age, healthcare IT experience, and hospital tenure, we conducted a "drill-down" analysis by grouping users based on a median-split on these variables and compared user responses between the "high" and "low" groups. The median age of physicians in our sample was 50 years, the median healthcare IT usage experience was 8 years, and the median tenure was 8 years, which were the bases for our grouping criteria.

The results of the drill-down analysis by physician age (see Table 2) show that younger physicians (below the median age of 50) had an overall reaction count (569 or 47%) that was roughly comparable to that of the older physicians (643 or 53%). Most of the reactions of younger physicians related to the impact of CPOE on the object of work (264 or 46%), followed by its impact on themselves (205 or 35%) and on their community (110 or 19%). These figures were roughly comparable to that of the older physicians: 314 (49%), 217 (34%), and 112 (17%) respectively. Likewise, the younger physicians elicited a total of 342 (60%) reactions toward the CPOE tool, 170 (30%) reactions toward their work rules affected by the system, and 57 (10%) reactions toward their system-influenced organizational roles. The corresponding figures for the older physicians were 400 (62%), 171 (27%), and 72 (11%) respectively. Drilling down further from aggregate perceptions into specific valences (positive, negative, neutral) of these perceptions, we find that younger physicians viewed the tool positively 244 times (75%) and negatively 80 times (25%), while this gap was much narrower for the older physicians: 220 positive (60%) and 149 negative (40%). However, the CPOE system's impact on work-related rules was viewed mostly positively across both groups: 66 positive (71%) versus 27 negative (29%) among younger physicians, and 66 positive (63%) versus 38 negative (37%) among older physicians. Likewise, the system's impact on organizational roles was also viewed mostly negatively across both groups: 13 positive (33%) versus 27 negative (67%) among younger physicians, and 18 positive (38%) and 29 negative (62%) among older physicians. Hence, despite our expectation of age being a significant correlate of IT usage, our drill-down analysis indicates that this effect was much less salient, if at all, in our physician sample.

Table 2. Physician Reactions by Age

Age < 50 years (Median = 50 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	8	1	5	10	14	9	1	2	9	59
	Profession	3	0	0	17	8	4	1	2	6	41
Object	Patient care	38	2	9	4	16	1	0	1	2	73
	Process imp.	100	3	33	25	22	5	0	3	0	191
Subject	Physician	95	12	33	10	17	8	11	9	10	205
TOTAL		244	18	80	66	77	27	13	17	27	569
Age >= 50 years (Median = 50 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	7	7	6	8	12	14	2	2	10	68
	Profession	3	1	1	15	5	6	3	4	6	44
Object	Patient care	27	6	10	1	15	1	0	2	1	63
	Process imp.	117	4	61	32	20	9	4	2	2	251
Subject	Physician	66	13	71	10	15	8	9	15	10	217
TOTAL		220	31	149	66	67	38	18	25	29	643

Comparing physicians by their healthcare IT usage experience provided another perspective of their reactions toward CPOE systems. The overall count of reactions in Table 3 shows that physicians with more healthcare IT

experience (equaling or exceeding 8 years) had more than twice the number of reactions (820) compared to physicians with experience under 8 years (392), suggesting that prior IT usage experience may be a more robust discriminator of user reactions than age. For the less experienced group, the distribution of reactions across mediating processes is as follows: 246 reactions (62%) related to the tool, 104 reactions (27%) to rules, and 42 reactions (11%). Those proportions are very similar to that for the more experienced group: 496 (61%), 237 (29%), and 87 (10%) respectively. However, drilling down further by the valence of experience reveals a significant variation in physicians' reactions to CPOE's impact on their roles. Less experienced physicians viewed this change in their roles positively, with 17 positive (40%) versus 7 (17%) negative reactions (and the rest neutral), which contrasts sharply with that of the experienced physicians: 14 positive (16%) versus 49 negative (56%). However, we did not observe any similar variation in the valence of physicians' reactions regarding the CPOE tool and its impact on their rules of work. For instance, less experienced physicians viewed the tool more positively (171 or 70%) than negatively (57 or 23%), somewhat similar to more experienced physicians: 293 positive (59%) versus 172 negative (35%). Likewise, less experienced perceived CPOE's impact on their rules for work more positively (48 or 46%) than negatively (14 or 13%), similar to that of more experienced physicians (84 or 35% positive, and 51 or 22% negative reactions). Based on this analysis, it appears that more experienced physicians viewed the CPOE system as an affront to their organizational roles, and were therefore more predisposed to resisting it than less experienced physicians. Note that this finding contradicts the general expectation that more experienced physicians tend to have a positive predisposition toward healthcare IT usage.

Table 3. Physician Reactions by Healthcare IT Usage Experience

Experience < 8 years (Median = 8 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	6	2	3	7	9	4	3	1	3	38
	Profession	4	1	0	12	3	1	2	3	0	26
Object	Patient care	22	3	4	1	8	0	0	2	1	41
	Process imp.	81	2	27	22	12	1	4	3	0	152
Subject	Physician	58	10	23	6	10	8	8	9	3	135
TOTAL		171	18	57	48	42	14	17	18	7	392
Experience >= 8 years (Median = 8 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	9	6	8	11	17	19	0	3	16	89
	Profession	2	0	1	20	10	9	2	3	12	59
Object	Patient care	43	5	15	4	23	2	0	1	2	95
	Process imp.	136	5	67	35	30	13	0	2	2	290
Subject	Physician	103	15	81	14	22	8	12	15	17	287
TOTAL		293	31	172	84	102	51	14	24	49	820

Table 4 compares physicians' reactions based on their tenure at Memorial Hospital. The upper and lower halves of the table, relating to those with tenure less than and greater than the median of 8 years, generally mirror each other, with one significant exception. Physicians' perceptions of the CPOE tool varied greatly when considered in the context of themselves as agents or subjects of clinical activity. We see that physicians with longer tenure viewed the CPOE tool more negatively (76 or 49%) than positively (64 or 40%). For those with shorter tenure, this picture was quite different: 97 (78%) positive versus only 28 (21%) negative. It is possible that senior physicians with longer tenure were too entrenched in their prior work arrangement to appreciate the value and utility of the new CPOE system as readily as their less entrenched junior (shorter tenured) colleagues. Though both groups viewed the tool's impact on their work rules more positively than negatively and its impact on their job roles more negatively than positively, the magnitude of this difference is different across these groups. For instance, physicians with shorter

tenure viewed the tool positively 260 times (75%) versus negatively 71 times (20%). This margin is much narrower for those with longer tenure: 204 positive (52%) versus 158 negative (40%). Corresponding figures for rules were 71 positive (43%) versus 24 negative (15%) among shorter tenured physicians, and 61 positive (34%) versus 41 negative (23%) among longer tenured physicians. For roles, these figures were 13 positive (27%) and 18 negative (27%) among shorter tenured physicians, and 18 positive (23%) and 38 negative (48%). This data shows that while the CPOE implementation effort at this hospital was generally successful in garnering more positive reactions than negative across all physician groups (of shorter and longer tenure), those with longer tenures (representing the "old school") still viewed the tool and its structural impact on work rules and job roles more negatively than their colleagues with shorter tenure. On the other hand, shorter tenure physicians did not perceive such negativity as they were at an earlier stage in their careers and might have been more open to structural changes.

Table 4. Physician Reactions by Hospital Tenure

Tenure < 8 years (Median = 8 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	7	3	4	10	13	7	0	3	4	51
	Profession	3	0	1	20	7	2	2	1	2	38
Object	Patient care	37	2	5	4	13	0	0	1	2	64
	Process imp.	116	3	33	27	20	5	1	2	1	208
Subject	Physician	97	10	28	10	16	10	10	11	9	201
TOTAL		260	18	71	71	69	24	13	18	18	562
Tenure >= 8 years (Median = 8 years)		Tool			Rules			Roles			
		Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	Pos.	Neutral	Neg.	TOTAL
Community	Hospital	8	5	7	8	13	16	3	1	15	76
	Profession	3	1	0	12	6	8	2	5	10	47
Object	Patient care	28	6	14	1	18	2	0	2	1	72
	Process imp.	101	4	61	30	22	9	3	3	1	234
Subject	Physician	64	15	76	10	16	6	10	13	11	221
TOTAL		204	31	158	61	75	41	18	24	38	650

Discussion

Using activity theory as an organizing framework, we developed a coding frame that allowed us to classify and understand physicians' reactions to a new CPOE system. This coding frame was organized along three activity structures (subject, object, community) and three mediating processes (tool, rules, roles), which allowed us to derive quantitative estimates of physicians' reactions from qualitative interview data. Tables 1 through 4 summarize the results of our classifications in increasing depth.

Clearly, the most significant mediator of clinical activity in our study was the CPOE tool. Table 1 shows that 61% (742 out of 1212) of physician reactions elicited were attributable to the CPOE tool. This finding highlights the importance of instruments, tools, and artifacts in organizational work. Our analysis shows that such tools often have intentional and non-intentional influences on work rules and organizational roles, which may have far-reaching consequences on how they are perceived by their intended users. In our specific case study, the social consequences of CPOE implementation weighed heavily on the minds of physicians, despite its technical superiority and instrumental benefits, causing many physicians to harbor resentment toward the IT.

The professional social network that evolved through working as part of a clinical team was directly affected by the CPOE system, particularly its means of intra- and inter-specialty communication. Physicians' positive reactions to this enterprise-spanning IT was summarized by one physician as,

> "… I can read the doctor's handwriting, you can track notes better so it is easier to communicate with physicians, cardiologists and orthopedic surgeon and I order an x-ray and if they are in the office they can access it from the office and we can make a more expedient decision with the availability of that."

However, other physicians were not so enthusiastic about the system's capacity to integrate their work activities. Some saw the accompanying changes to procedures and forms of work organization as undermining the integrity of the clinical process and the clinical profession. One physician quoted,

> "[CPOE] … has been a deterrent to the effective functioning of the primary care physicians and or coordinators of care if you want it to say that just because you are not alone in knowing all the information that is in that chart and so everybody has access to everything that is in that chart and people have carved out different areas of interest in order to influence the care of that patient based on the data that they have available to them. So what's happening is that you can go the way of either responsibility of the primary care for coordinating the care plan, which in past has always resided with the physician."

As a tool, the CPOE system is highly visible to clinicians. Its physical presence and screen/keyboard interface are obvious physical changes to the previous paper-based and verbally driven work practices. Less tangible are the system's impacts on interactions and role relations between the physicians (subjects) and the wider medical community. Hidden impacts of these types are characterized as mediating processes (rules and roles) in activity theory. Table 1 shows that 28% (341 of 1212) reactions were mediated by rules (explicit and implicit norms, expectations and social relations) within the community. CPOE also affected physicians' perceptions of their roles (explicit and implicit division of responsibilities) in clinical work, frustrating many users. One respondent commented,

> "Sometimes I want to order things the way I want to order things, which is to say it is the way I was trained. I am trying to input that into the computer and it forces me to enter it the way it wants me to. Ultimately it ends up being the same thing but it just has to be in the format that the computer understands. So I have to figure out how to speak the same language as the computer to get what I want done."

It appears from these findings that physicians' reactions to CPOE extend beyond perceptions of the IT system as merely a tool. To that end, our study extends prior research in this area (e.g. Lapointe and Rivard, 2005) by providing insight into the ways that physicians make sense of the system not only in terms of its functionality and instrumentality, but also in terms of its indirect effect on their work and distribution of roles. Categorization of physicians' reactions based on their locus and consideration of three mediating factors highlight the complexity of organizational change that is engendered when a new IT is introduced that fundamentally alters the nature of organizational work.

Although differentiating our data by respondents' age (Table 2) did not reveal any significant relationship to IT adoption and use, Table 3 suggested a more significant relationship between everyday IT usage experience and acceptance of a new system than that by age. This point is well illustrated by one respondent as,

> "I practiced 30 something years and what I learned to do is based on paper I am very good at doing paper. I can go through a chart and pick up all the salient features in the data in a heart beat, I've probably done it 50 thousand times. It takes me a lot more time to get the same information reading an electronic chart because you have to go through different screens and different fields."

The above comment resonates with the conceptual framework of activity theory: the respondent articulates his reaction to healthcare IT in the context of his own personal and professional work and organizational role, providing insights that extend understanding of the phenomenon surrounding user acceptance of technologies such as CPOE.

Limitations of the Study

The findings of our study should be interpreted in light of its limitations. The first limitation is that issues or comments that respondents mentioned repetitively in their interviews (e.g., the usefulness of the system or how much it hindered their work) were coded repetitively, as they appeared in the interview transcript. Doing so may have magnified the frequency of codes in some of the categories in Tables 1 through 4. However, we also felt that if

respondents wanted to emphasize certain issues repeatedly, we should preserve that emphasis in our coding outcomes, however redundantly.

Second, our coding did not distinguish between respondents' perceptions, as long as they belonged to the same activity structure and mediating process. For instance, if subjects suggested that the CPOE system helped them in their work, made them more productive, and was easy or convenient to use, these perceptions were all coded within the "Tools–Positive" and "Subject (Physician)" categories, even though these comments presumably referred to different perceptions regarding the target IT. This was because the theoretical framework that structured our coding process (activity theory) did now allow distinctions between individual perceptions. In order to remain faithful to our guiding theory, we chose not to deviate from that coding structure.

Third, interpretive coding is always subject to the criticism of coder subjectivity. We attempted to overcome this problem by employing a three-round coding procedure, with initial coding of all interview transcripts by one researcher, followed by cross-checking by a second researcher, and reconciliation by a third reviewer. Inconsistencies between coders were resolved through discussion, with input from researchers who were present during the actual interviews and had first-hand knowledge of the socio-historical context of subjects' responses. Though this procedure helped us achieve consensus and intersubjectivity in coding, coders in the later rounds may have been influenced by coding already done in prior rounds, possibly leading to lack of coding independence.

Implications for Research

Our interpretive analysis complements and expands prior understanding of IT usage research that has been primarily positivistic in nature. While positivistic analyses seek "similarities" in usage patterns, our interpretive analysis sought to understand "differences" in user reactions, i.e., why some physicians held negative reactions and others had positive reactions toward the same IT in the same hospital. Positivistic analysis would suggest that physicians at our study site were generally in favor of the CPOE system. However, our interpretive analysis found a more complex and nuanced pattern of reactions, not only regarding the target IT, but also regarding its impact on users' work and role relations, that varied with age, IT usage experience, and hospital tenure. Our interpretive analysis filled a gap in the IT usage literature by generating new insights into the nature of user differences that is not available from mainstream positivistic IT usage research.

Second, current positivistic theories of IT usage, such as TAM and UTAUT, are designed to explain voluntary IT usage, and as such, will have limited explanatory power in settings where users are mandated or coerced to use an organizational system, such as ERP use in a firm. In such settings, users may be forced to use the target IT, but still harbor negative reactions and resentment toward it, which may be manifested in unanticipated ways. In order to advance IT usage research from voluntary to mandated usage settings, it will therefore be important to understand the diverse nature of user reactions, as shown in this study.

Third, this study demonstrates the utility and viability of activity theory as a conceptual lens or organizing framework for structuring interpretive analysis. As noted earlier, this theory is particularly relevant for studying complex, evolving problems that are embedded within and cannot be isolated from their socio-historical contexts, such as IT implementation. Being one of the earliest papers in the IT implementation area to use activity theory, this study provides a comprehensive description of the core concepts and an illustrative example of how to conduct interpretive research using this theory.

Finally, this study contributes methodologically to the literature by illustrating an innovative method for converting qualitative interview data into quantitative estimates for further (e.g., drill-down) analysis. The data shown in Tables 1 through 4 not only indicate the salience or magnitude of different activity structures and mediating processes, but also compares user reactions based on age, IT usage experience, and tenure, which may be otherwise difficult to decipher from a pure qualitative analysis.

Implications for Practice

This study also has important implications for practitioners. First, managers should understand that IT implementation is not simply a matter of buying and installing a new IT, but a complex process of orchestrating organizational change. Technologically sophisticated systems with clear organizational benefits may still be resented by users if it causes unfavorable changes in organizational rules and role relations. Given their socio-

technical nature, new IT often engender unanticipated user reactions that are embedded within the organization's socio-historical context, and hence, such context should be taken into account in any analysis of user reactions.

Further, the nature of user reactions toward a new IT may not necessarily be uniform, but may vary based on the unique circumstances faced by a given user. Hence, a "one size fits all" intervention strategy may not be optimal for overcoming the divergent nature of user reactions, and managers may need to customize their strategy to the specific needs of users and user groups. Toward that end, managers must first recognize the diverse nature of user reactions engendered by a new IT. Our study provides a conceptual framework and a methodological technique for realizing that goal.

Conclusions

This study examined physicians' reactions to CPOE systems within their social-historical context in a hospital setting. Using activity theory as an interpretive lens, we analyzed interview data from physicians regarding their perceptions and usage of CPOE systems. We found that physicians' reactions toward this system are widely divergent in nature, and even though most physicians found the system to be technically superior, they were concerned abut the system's impact on their work rules and professional roles in the workplace, which caused them to harbor resentment toward the system and not use it as expected. We also found interesting patterns among physicians' responses, when respondents were grouped by age, IT usage experience, and hospital tenure. This interpretive analysis complemented prior positivistic analysis of IT usage by explaining differential patterns of IT usage across a given user population, demonstrated the use of activity theory as a valuable tool for interpretive analysis, and illustrated a unique approach of coding qualitative data quantitatively for drill-down analysis.

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