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The challenge of knowledge management systems

Analyzing the dynamic processes underlying performance improvement initiatives

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Abstract *Knowledge management systems and related initiatives have become a popular focus in many firms, yet many knowledge management systems initiatives fail to achieve their goals. Focuses on systems that are implemented to achieve deliberate performance improvement objectives in organizations, rather than to support discretionary communication. Employs constructs from system dynamics – a discipline that recognizes that the relationships between complex organizing technologies and human behavior are dynamic, evolving, and interconnected. Drawing from recent studies employing system dynamics, proposes a framework to analyze the implementation challenges posed by know349ledge management systems adopted as part of a deliberate performance improvement program. Illustrates the framework with a case study of an initiative within a university "help desk" department where conflicting incentives hindered employees' efforts to leverage the systems. The framework underscores the complex and interdependent effects triggered by managers' actions and cognitions, in conjunction with users' actions and cognitions. Offers insights for practitioners and researchers to recognize the downward spiral that can occur when conflicting incentives thwart the behavioral changes required for performance improvement initiatives to succeed.*

Introduction

The transition to a knowledge-based economy has increased the importance of managing organizational knowledge. Current strategic management theory highlights the value of firms' knowledge assets – including both intellectual property and other forms of know-how (Barney, 1991; Teece, 2000). Firms that expect to survive and prosper in the twenty-first century must implement effective processes for managing organizational knowledge. While there exists tremendous interest in knowledge management (KM) and knowledge management systems (KMS) today – which Teece labeled "the present cacophony on KM" (Teece, 1998, p. 55), we believe this emerging literature

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lacks integration with our cumulative knowledge of other complex process innovations.[1] This paper study seeks to fill this gap by drawing analogies between KMS and other complex process innovations in organizations. We explore this analogy using system dynamics as our theoretical lens. Based on insights that system dynamics researchers have generated from studying other types of deliberate change initiatives, we propose a framework to explain the social, cultural, and political factors that enable or constrain organizations' efforts to manage their knowledge assets.

In reviewing recent system dynamics studies, we identify several constructs that we combine to form a conceptual framework to explain the process and outcomes of KMS implementation. We introduce this framework, and then employ it to analyze a case study of a failed KMS initiative within a university "help desk" department. Although managers established clear goals for improving customer service quality by implementing a KMS, the department failed to leverage its capabilities for three reasons: management's short-term focus, conflicting rewards and incentives, and employee short-cuts in using the KMS. By introducing concepts and models from a domain external to the IS field (system dynamics), we assert the need for "tools capable of capturing the processes… time delays, and other sources of dynamic complexity" (Sterman, 2001, p. 17). The contribution of our work is first, to recognize similarities between KMS and other deliberate organizational change initiatives (e.g. reengineering), and second, to propose novel frameworks and modeling tools that IS researchers can employ for studying KMS and other implementation processes. The frameworks and tools we introduce are especially relevant for studying complex organizing technologies (Repenning, 2000). Below, we introduce system dynamics and focus on several relevant constructs for understanding complex organizational change initiatives. We then present a conceptual framework that incorporates these elements, which we employ to analyze a failed KMS initiative in a university's "help desk" unit.

Literature review

We adopt a definition of KMS as "IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application" (Alavi and Leidner, 2001, p. 108). While KM initiatives have the potential to unleash high levels of innovation and productivity, they also have unique costs. Studies have identified various costs associated with implementing KMS and changing employees' behavior to utilize them effectively. Beyond the tangible costs of buying and implementing a KMS, users bear certain costs in deciding whether to contribute their knowledge, or whether to seek and reuse information stored in these systems. The specific costs and the question of who bears them – whether the knowledge-generator, the knowledge-seeker, or a third-party – depend on the system's objectives and features. KMS that are primarily document-centred

(*Information Technology & People*, 2001) or document-driven (Hansen *et al.*, 1999) have different cost patterns from dialogue-driven KMS (e.g. bulletin boards). In document-driven KMS, the knowledge generators who codify and input their knowledge bear some costs, while knowledge seekers – those who search for stored knowledge and adapt it for their own use – bear other costs. By contrast, for dialogue-driven KMS, researchers have identified a different pattern of costs and incentives borne by information requesters and responders (Goodman and Darr, 1998; Gray and Meister, 2001; Von Hippel, 2001). Such cost/benefit patterns are relevant in shaping human behavior, as we show in our case study, that examines a specific document-centred system.

Common problems in implementing KMS

Several studies suggest that achieving critical mass is an important concern when implementing a KMS (Dennis *et al.*, 1998; Damsgaard and Scheepers, 2000). KMS exhibit positive network externalities similar to other technologies, whose value increases with the number of adopters. It is not merely the number of users that matters in creating value, but also the amount of content that they create for other users to access. Achieving a critical mass of content is often problematic during early adoption. Even if technology champions convince enough users to initially adopt the KMS, users will likely be discouraged and abandon the system if they find a paucity of useful content. A second problem, generally subsumed under the label of "culture barriers" (Hayduk, 1998; King, 1996), is that KMS require that employees be willing to share their knowledge with others. Considerable attention has focused on identifying the attributes of firms where employees will readily share information, including case studies illustrating the obstacles to adoption within competitive firm cultures (Davenport, 1996; Orlikowski, 1993). It is conventional wisdom that a KMS must fit the organization's existing culture, norms, and incentive schemes; lacking such a fit, the outcome is highly uncertain (Gallivan, 1997).

Many studies have been conducted to date of KMS that support discretionary communication, (e.g. discussion databases, newsgroups, chat rooms) (Constant *et al.*, 1996; McLure-Wasko and Faraj, 2000). In contrast to such discretionary systems, firms also adopt KMS to promote deliberate knowledge-sharing and reuse. Such initiatives are often undertaken to enhance productivity, customer service quality, coordination, or – in some cases – to reduce costs by allowing less-skilled employees to serve as "front-line" customer service personnel to replace more experienced, costly employees (Gray, 2001; Markus, 2001). While we acknowledge the value of systems to support discretionary knowledge sharing, we believe that their collective insights do not generalize well to the context of KMS implemented to support deliberate performance improvement programs (PIP). These initiatives often occur in business functions as diverse as technical support (El Sawy and Bowles, 1997; Orlikowski, 1996), customer service (Davenport and Klahr, 1998;

Goodman and Darr, 1998), and management consulting (Davenport and Hansen, 1999).

Here we focus on KMS that support deliberate knowledge sharing as part of an organizational PIP – regardless of whether the goal is to increase efficiency, service quality, or coordination, or to achieve cost-savings. These efforts have much in common with other PIPs – such as TQM and process reengineering. Although the specific toolsets may differ across these types of initiatives, they share many common features: they seek to improve organizational performance but their success depends on making changes to the firm's structures, incentives, norms, and "patterned interactions in the activity system" (Nidumolu *et al.*, 2001, p. 116). Repenning (2002, p. 111) articulates that "the types of innovations under consideration are those which, to be effective, require that members of the organization change their behavior in significant ways".

Next, we describe two examples of successful KMS initiatives that fit our definition of "KMS for deliberate PIP". El Sawy and Bowles (1997) examined KMS implementation within the customer support unit of Silicon Valley manufacturer Storage Connect, demonstrating various benefits, including higher customer and employee satisfaction. Orlikowski (1996) also studied KMS implementation in a high-tech firm's customer service unit, where technical support representatives created a Lotus Notes repository to document callers' problems and related solutions. While she characterized the firm's implementation strategy as improvisational (Orlikowski and Hofman, 1997), the KMS initiative itself was intentional. These examples fit our definition of "KMS for deliberate PIP" since, in each case, the firm intentionally sought to improve productivity, service quality, and other metrics. Although there exists a large body of IS research examining technology implementation (Leonard-Barton, 1988; Robey and Boudreau, 1999), we believe that valuable insights may be generated by considering frameworks that take into consideration feedback loops, non-linear effects, and other effects that are difficult to envision. We believe that such models may benefit IS researchers in understanding the process and outcomes of KMS implementation – as well as other complex technologies that must be adopted at both the organizational and individual levels in order to succeed (Gallivan, 2001). Below we introduce system dynamics and summarize research conducted on other PIPs, in order to generate insights into the challenges associated with implementing KMS.

Overview of system dynamics

System dynamics is a sub-field of operations management that examines complex "systems" featuring positive and negative feedback effects among interdependent variables. Although related to cybernetics, system dynamics has often been applied to study organizational change processes, including Senge's (1990) pioneering work on the "learning organization". It originated with Jay Forrester (1961) at MIT and continues to be strongly associated with MIT today. While system dynamics research has not focused on IT adoption per se, researchers have modeled implementation processes and outcomes for other PIPs. We believe this approach provides insights that facilitate our understanding of KMS implementation, especially issues related to behavioral norms, learning curve effects, usage incentives, and politics.

System dynamics explains the behavior of complex systems by focusing on nonlinear, recursive relationships among variables, explicitly modeling how these variables interact and influence each other. Beyond specifying the constructs and direction of influence (as do most positivist models), it also models feedback effects, time delays, attribution errors that people make, and changes in the stocks-and-flows of assets (Sterman, 2001). System dynamics researchers typically use a host of tools, first gathering empirical data from field studies – based on interviews, observation, and archival data – and then create mathematical models and employ computer simulation to explore their behavior. Researchers use causal loop diagrams to explicitly model feedback loops to "provide a convenient and precise technology for articulating a process theory describing how a system evolves over time" (Repenning and Sterman, 2000, p. 6).

System dynamics has been infrequently employed in IS literature (Abdel-Hamid, 1992), but it is more prevalent in management literature, where studies examine changes in technology, business processes, and HR policies by modeling their reciprocal effects on such outcomes, productivity, defect rates, employee commitment, and turnover (Masuch, 1985; Sastry, 1997). In order to develop a vocabulary of key concepts, we summarize research from MIT's Center for Innovation in Product Development which examined implementation processes and problems of various PIPs, including TQM and process reengineering. We believe these PIPs share many commonalities with KMS – as reflected in the term organizing technologies, which describes the class of PIPs examined:

> The types of innovations under consideration are, thus, not purely technical in nature – the firm cannot simply purchase them. Instead, they involve a combination of organizational methods and technical tools that allow workers to utilize their accumulated expertise more effectively (organizing technologies in the language of Wruck and Jensen, 1994). A key feature of these tools is that, once used, the knowledge they generate becomes available to the firm (Repenning, 2000, p. 1390).

Although Repenning was referring to TQM above, his characterization captures the challenges associated with KMS implementation. We summarize Repenning and colleagues' research with the goal of defining key concepts, which we use to construct our conceptual framework, below.

Explaining the "improvement paradox". Sterman *et al.* (1997) identified a paradox associated with many PIPs: Despite proven success in high-profile firms, few organizations adopt these initiatives. Moreover, in firms that do adopt them, these initiatives often fail. Ironically, such PIPs often exacerbate poor performance, undermining the very outcomes they sought to improve. Studies of high-tech manufacturer analog devices identified the factors responsible for this paradox. Using causal-loop modeling to incorporate feedback effects, Sterman found that when TQM increased productivity, this triggered several negative outcomes (e.g. layoffs, low morale, employee resistance). These results were by-products of the fact that when TQM triggered higher productivity, management believed there was insufficient market demand for the volume of goods produced. Given this supply/demand disparity, the firm's accounting systems actually reflected declining performance. Despite being artifacts of its accounting metrics, Analog's managers considered layoffs as a solution to this "problem". The mere threat of layoffs, in turn, caused production problems, resistance to TQM, low morale, higher costs, and eventually precipitated a real financial crisis that subsequently required analog to reduce headcount.

Sterman *et al.* (1997) developed simulation models to show that such paradoxical outcomes could indeed occur. In subsequent studies, they documented this syndrome at a host of leading firms. In their study of "overcoming the improvement paradox", Keating *et al.* (1999, p. 120) conclude that TQM and other PIPs are:

> … tightly-coupled to other functions and processes in the firm, and to its customers, suppliers, competitors … Failure to account for the feedbacks among these tightly-coupled activities leads to unanticipated and often harmful side effects.

The effects of PIPs on employee productivity can be problematic, either when increased productivity occurs or fails to occur. When productivity improves, managers must determine whether sufficient market demand exists to absorb the increased production capacity. Managers often choose lay-offs or redeploy workers elsewhere to exploit the productivity enhancements, yet the threat of lay-offs can trigger a host of problems that undermine the very objectives the PIP sought to achieve. Conversely, when PIPs fail to generate anticipated improvements, managers lose faith and abandon the initiative, despite the fact that sustained efforts will eventually produce the desired outcomes. These outcomes are often latent, becoming apparent only after time-lags lasting several months or years. For complex process innovations, there is always a trade-off between incurring short-term costs and achieving long-term benefits, owing to learning curve effects (Argote *et al.*, 2000). It is common for PIPs whose goal is to reduce costs or improve productivity to produce exactly the opposite short-term effects. Repenning and Sterman (2001) call this the worse-before-better dynamic. Despite the ubiquity of this dynamic, when visible and measurable improvements fail to appear quickly (Fine, 1986), firms often prematurely abandon their efforts. Repenning (2002) claims the appropriate response is for the PIP champion to provide sufficient short-term incentives and normative pressures to close the commitment gap. Mere verbal encouragement is often insufficient to motivate employees; instead, stronger incentives are needed, perhaps "instituting reward systems based on usage and promoting compliance via direct surveillance" (Repenning, 2002, p. 113). Such normative pressures are needed, particularly if the behavior changes required of employees are difficult to learn or conflict with existing incentives and norms. Managers should also "drive out fear" (Deming, 1986) to allow employees to experiment with new routines, without fear of repercussions for mistakes.

The need for sustained commitment. Repenning (2002) showed that managerial support for a PIP must be sustained for a considerable period of time if it is to stand a chance of succeeding – even if the PIP fails to produce visible benefits in the short term. He found that the time required to assimilate new processes associated with TQM averaged 12-18 months and ranged as high as 30 months. Management must sustain its commitment beyond this initial gestation period when the PIP yields no visible returns. If managers prematurely reduce their commitment or the level of normative pressure on employees, then compliance will wane, momentum will "fizzle out", and any latent potential inherent in the PIP will be forfeited. To avoid this outcome, champions must actively promote the PIP during the gestation period by sustaining rewards and normative pressure on employees to persevere, in effect closing the commitment gap, despite a lack of visible benefits in the short run.

Cognitions are critical: trust between managers and employees. Beliefs that managers and employees hold about each other matter too. In studies at Ford, Repenning and Sterman (2003) showed that managers' beliefs about the causes of performance problems and employees' beliefs about managers' intentions toward them were both critical in explaining TQM's success or failure[2]. They found consistent but surprising findings from both their Ford studies and simulation models:

> … managers who believe people are the cause of low performance take actions that embed those beliefs in the physical structure of the organization and force employees to act in accordance with those beliefs…. Over time the physical environment adapts to both reflect and perpetuate these self-reinforcing attributions. Managers who come to believe that production pressure is an effective way to improve [performance] will often resort to technology to further increase their control over the workforce… So … initially erroneous attributions about [employees'] … capabilities and motives … can soon become embedded in the routines, culture and … physical structure of the organization, thereby perpetuating the cycle (Repenning and Sterman, 2003).

The outcomes of PIPs are thus dependent on the co-evolution of managers' beliefs about employees, managers' actions to empower or control employees, and in analogous fashion, employees' beliefs about managers' intentions, and their subsequent actions. Ironically, each party's initial attributions about the other group are strongly self-confirming, whether or not they were initially valid – a classic self-fulfilling prophesy (McGregor, 1960). This co-evolutionary model was illustrated with data from two Ford TQM initiatives (one successful and one failed). As predicted, the unsuccessful project revealed that when managers distrusted employees and took steps to control them, employees subsequently exhibited shirking behavior that justified management's prior lack of trust in them. When implementing a PIP, managers may seek to exploit the potential benefits in two different ways: They may try to exploit employees through control tactics, but then employees will distrust them and shirk (one self-fulfilling prophecy). Conversely, managers may seek to empower workers – giving them autonomy to determine how best to leverage the PIP to achieve the firm's goals. This creates a self-fulfilling prophecy of another type: Employees will trust management and behave in ways that justify managers' prior trust in them. Such empowerment liberates employees to be autonomous and creative, allowing them to discover adaptations that can best leverage the PIP (Leonard-Barton, 1988; Tyre and Orlikowski, 1993; Tyre and Von Hippel, 1997).

Conceptual framework

We have summarized relevant findings for understanding organizations whose norms, processes, and culture are in a state of flux, owing to PIP implementation. These results constitute the building blocks of a conceptual framework that helps to explain the dynamic processes that occur during implementation. Figure 1 depicts these forces with three feedback "loops". The three loops demonstrate the complex and interdependent nature of managers' and employees' beliefs and actions, and their interaction with market forces. The loops interact with and reinforce each other, owing to the common nodes (i.e. constructs) that appear at the intersection of loops[3]. These nodes are confluence points where one loop may reinforce or undermine the other. Changes in a variable on one loop may trigger unforeseen consequences

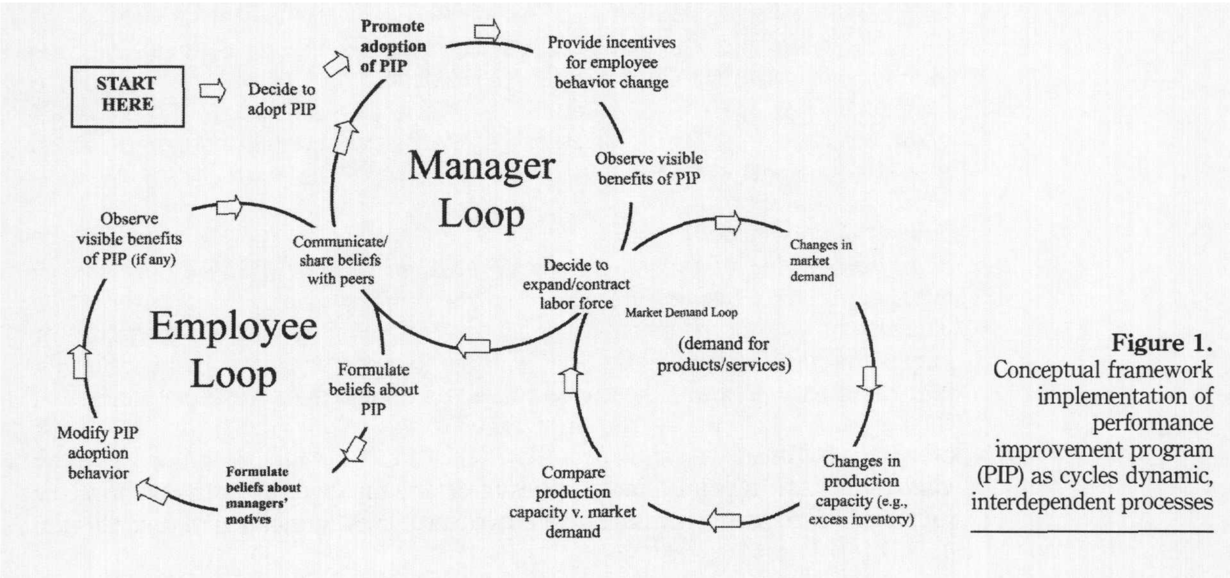

Figure 1. Conceptual framework implementation of performance improvement program (PIP) as cycles dynamic, interdependent processes

elsewhere, owing to nonlinear dynamics (Sterman, 2001). We describe the loops individually, explain their interactions, and then employ the overall framework to analyze a case study of a failed KMS initiative.

Manager loop

The six nodes of this loop denote managers' cognitions and actions: decide to adopt PIP, promote adoption of PIP, provide incentives for behavior change, observe visible benefits of PIP, decide to expand/contract labor force, and share beliefs with peers. The loop repeats over time, with managers iteratively deciding what incentives or pressures are necessary to encourage employee adoption, observing outcomes to date, and then revising their implementation approach (e.g. deciding whether to sustain, escalate, or reduce normative pressures). Over time, managers' commitment level will become self-reinforcing, either accumulating or deteriorating.

Employee loop

The five nodes of this loop denote employees' cognitions and actions: observe visible benefits of PIP, communicate with peers, formulate beliefs about PIP, formulate beliefs about managers' motives, and modify PIP adoption behavior. This is an iterative loop without a fixed starting point. When a PIP is adopted, employees are constantly observing and formulating beliefs about the PIP and, in turn, sharing them with peers. Their cognitions may begin to take form even before the PIP is adopted, based on management communication, training, or even hearsay (Orlikowski, 1993). As employees formulate cognitions about the PIP, they also develop cognitions regarding managers' motives for implementing it. Based on these two sets of cognitions, employees may alter their behavior: adopting or resisting the PIP; embracing the required behaviors or eschewing them. The manager and employee loops iterate independently, but they also interact owing to their confluence point. This intersection signifies opportunities for managers to influence employees' beliefs about the PIP, and vice-versa. It is possible for both groups' cognitions to change in the same direction (e.g. both positively), so they reinforce each other; it is also possible for their cognitions to diverge, thus conflicting with each other.

Market demand loop

The third loop, market demand, iterates as well. As the PIP becomes assimilated into the organization, managers may observe that production capacity has improved or declined (e.g. inventories may increase or decrease). Depending on whether market demand for its products/services is sufficient, managers may confront the decision to expand or reduce the labor force.

Sample illustration

Using KMS as the specific PIP, we offer a sample illustration of how the "system" in Figure 1 may evolve. One scenario is that KMS adoption initially leads to lower productivity. More time is required to codify employees' knowledge and enter it to the KMS. Initially, with no wealth of data in the system to reuse, employees perceive they are less efficient. As described above, the worse-before-better dynamic is common: The time/effort required to perform the task will initially exceed the prior levels, thus reducing productivity (Fine, 1986). Beyond their individual experiences with the KMS, employees engage in collective sense making, sharing their cognitions with peers, and also their skills and knowledge associated with the PIP. Employees may criticize the PIP overtly. These sharing processes exhibit social contagion effects: Over time, employee beliefs diffuse and become more uniform (Repenning, 2002). Dominant beliefs will propagate throughout the group – either beliefs strongly-held, or those held by opinion leaders. Moreover habits, norms, and routines will also converge over time, as employees share "tips" and advice related to the PIP.

As implementation progresses and employees observe managers' words and deeds, employees will formulate and share their cognitions about managers' intentions toward them – specifically, whether they believe managers seek to empower them to act in the firm's best interest, or alternately, whether managers seek to coerce and control them (Gray, 2001). Without normative pressure or incentives to alter their natural behavior, employees may shirk by reducing their commitment to learn and properly use the KMS. Employees may take short-cuts, find other work-arounds to proper use, or even sabotage the system. If managers anticipate the initial productivity decline, they may inform employees that this effect is natural, and may offer them sufficient incentives to persevere in learning the KMS and following prescribed guidelines of use. If employees persevere, they become more comfortable with the KMS over time. As they continue to codify their knowledge, eventually a critical mass of both users and content accumulates (Dennis *et al.*, 1998). At this point, it becomes easier for employees to leverage the system for positive gains, for two reasons: First, the volume of content in the KMS offers greater opportunities for knowledge reuse; and second, employees will have more experienced peers to help them hone their skills and assimilate the KMS (e.g. sharing tips). If managers anticipate the early phase when no visible performance benefits appear, they may also provide extra service capacity by increasing manpower. If managers create sufficient incentives to close the commitment gap, KMS usage will become positively reinforced over time, and the overall "system" will reach a successful regenerative state (Repenning, 2002). This is, of course, is an optimistic scenario. In the next section, we examine these interacting loops with a case study.

Research study

Sample and methods

To examine KMS implementation processes, we conducted a longitudinal study of the computer help desk function (later renamed the "computer service center" or CSC) at a large US university. We followed an embedded case design

(Yin, 1994) focusing on the help desk unit within the IT department within the university. We collected data at all three of these levels, employing case study methods: interviews with employees, managers, and users; participant observation; direct examination of IT artifacts; and review of archival records. We selected respondents to interview based on their roles, seeking users with specific insights and experiences (e.g. heavy users, advisory committee members, and leaders of campus groups). We reviewed archival records, including organization charts, CSC department reports, metrics, procedure manuals, consulting reports, and minutes of meetings. We observed the CSC at different times of the day, week, and semester, focusing on the types of problems that users reported to the CSC and the tools and procedures that CSC workers employed. We looked for similarities and differences in order to determine whether employee behavior was consistent or varied, paying particular attention to how knowledge about callers' technical problems was created, captured, and re-used during problem solving.

We analyzed the data in an iterative and emergent fashion, avoiding pre-specified categories or codes (Glaser and Strauss, 1967). We constructed event histories of the CSC and the parent IT department and collected quantitative data on the volume of calls received, problem categories, and their disposition over a 17-month study period. As findings accumulated, we searched for recurring patterns, rival explanations, and disconfirming evidence. We employed both researcher and data triangulation (Patton, 1987).

Research setting

The university's computing environment is large, complex, and dynamic – encompassing diverse hardware platforms, networks, and software. During the mid-1990s, the university migrated from centralized mainframes to a client/server environment, and both the number of users and network traffic grew dramatically owing to the rise of the Internet and declining cost of computing. The university's IT department (hereafter simply ITD) also began a project to migrate financial systems from mainframes to Oracle client/server software. This initiative consumed an ever-larger portion of ITD's staff, resources, and attention, with an ITD Director complaining, "I call it the black hole because we put every resource in it. We've spent something like $11 million on it . . . We don't do anything in ITD except support Oracle work".

There was no centralized control over IT standards or budgets among users. Departments made autonomous purchase decisions and, consequently, there was tremendous variety in hardware, software, and network configurations. This complex environment was initially supported by a "help desk" staffed with part-time student workers who fielded customer calls. If they were unable to resolve a problem, they referred it to the full-time staff in ITD. Student employees either graduated or found higher paying jobs, leading to high turnover and a lack of cumulative expertise. Campus users who called with technical problems were frustrated by the poor quality of service and many complained loudly. Callers perceived the help desk to be open too little, slow to respond, and generally unhelpful. When our study began in mid-1995, user complaints were so strident that the university hired consultants to evaluate the function and offer recommendations. While that study was underway, the ITD Director closed the help desk, concluding that performance was so bad that its operation could not be justified until improvements occurred. The consulting report produced an action plan, stating that the unit should be reorganized, staffed with full-time employees, and separated physically and culturally from the parent, ITD. When the newly christened CSC re-opened in late 1995, it was separated from ITD and staffed with ten full-time employees who had transferred from other departments. The goal of the physical separation was to nurture a strong customer service culture distinct from what was perceived to be a "civil service mentality" in ITD. The CSC director reflected on the mental adjustment required:

> I attempted to manage a change in culture and created a physical move away from ITD to inspire these folks that they were part of a new customer-focused organization. It worked and others in ITD saw that it was working and treated us as a pilot program [for making culture change elsewhere].

Four distinct technology support requirements were identified in the plan:

(1) an integrated multi-function KMS to combine a call tracking system and a knowledge repository of problems and solutions;

(2) a private branch exchange (PBX) with automated call distribution to route calls among employees;

(3) pre-packaged knowledgebase modules; and

(4) an expert system to search for patterns in the KMS data.

Of these technologies however, only the first one was implemented, a KMS named HelpQ.

Standard work processes. When the CSC re-opened, it adopted new, standardized work processes. Because the recommended PBX was not purchased, the CSC was still limited to two incoming phone lines. Two employees answered incoming calls, with the staff member taking a call becoming the problem "owner" responsible for its resolution. Given the limited (two) incoming phone lines, employees perceived tremendous pressure to end every call as quickly as possible, to minimize the chance that additional callers would be put on hold. The quantity and quality of information that employees could capture suffered owing to this time pressure. During busy times, CSC employees often preferred to move on to the next call before they had gathered complete information from the previous one. A tiered system of problem escalation rules was implemented: Unresolved problems were assigned extra resources based on the problem's priority and the length of time it was open[4].

When a user called for help, the problem owner recorded basic information about the caller, problem description, and a priority rating. CSC employees were instructed to record such descriptive information during the call. If they were unable to resolve the problem immediately, the problem was escalated to tier two. Tier two problems could be designated as either "internal" (remaining with the problem owner) or "external" (referred to another department). If there was no resolution of external tier two calls in a few days, they were escalated to tier three (vendor referral). Callers' problems were classified into six main categories: general, hardware, software, network, security, and other. New sub-categories were added over time and, by the end of our study, the complete taxonomy of problems reached nearly 200. Call volume fluctuated depending on the time of the semester and user adoption of new technologies. For example, Windows'95 was released in late 1995. As users bought new PCs, the fraction of software problems related to Windows'95 increased from zero to 35 percent by April 1997. One employee commented:

> You can look at the Internet craze. Everyone has an e-mail ID; every business has a Web site ... That's [only] been ... a couple of years, and that really dramatically changes [the technical environment], and. adds a layer of complexity to technical support.

From October 1995 to January 1996, CSC employees possessed only simple tools for tracking call volumes and recording caller details. Each employee kept a log of problems opened and closed. Periodically, these logs were aggregated and entered into a spreadsheet. The spreadsheet created reports summarizing total call volumes, but offered no functionality for storing problem-related knowledge. In January 1996, CSC employees created an informal call-tracking system in Lotus Notes, which they used to input, manage, and track their calls. Each call was documented as a separate "memo", with a structured format containing caller information, problem description, and resolution. The Lotus Notes-based system provided some basic search capabilities: Employees could search records by caller name, date, or name of problem owner. The ability to locate prior records allowed employees to see problems in a larger context, including the caller's history, or similar problems the employee had encountered previously.

The Notes application facilitated process tracking, so managers could measure CSC call volume by counting entries in a specific date range. Such tracking was critical to management, since employee performance was based on the number of calls resolved and average elapsed time between initiation and resolution. Because Lotus Notes only provided the raw data for these measures, the spreadsheet tracking system was retained for monitoring individual and overall CSC performance. The key performance criteria for employees were thus quantitative: volume of calls and time-to-resolution.

Recognizing the limitations of the Notes application, and in accordance with the action plan, management purchased a dedicated KMS application, HelpQ, in July 1996. HelpQ provided distinct advantages over Notes, including functionality to capture and retrieve problem-related knowledge, as well as reporting volumes and related metrics. Each call record required basic information about the caller, problem category, description, resolution, and key dates, and could be enforced by referential integrity rules. The integration between HelpQ and work processes was sophisticated: "For closure, you must have a solution – either one that you found in the solution database and transferred, or … you have to come up with your own solution". HelpQ was flexible, easy-to-use, and offered several ways to search the knowledgebase. Problem category was selected from a taxonomy of codes that was periodically updated, and was indexed to support rapid searches. During a call, a CSC employee could quickly view lists of other HelpQ records and drill down to locate matching symptoms and solutions. It supported free-form text search to support keyword searches. The system was flexible, allowing users to browse records using different schema for viewing records.

CSC management immediately began to generate summary reports, such as total call volumes and frequency by problem type, which they used to identify common problems, determine staffing needs, and refine the problem taxonomy. HelpQ generated key performance metrics, including the critical measures of call volumes and average time-to-resolution. These were even published openly on campus, in support of a marketing effort to improve the CSC's image. The director commented on the potential for process improvement:

> This information can change the way we do business, the way we establish policies. It could influence what we decide to do with the future of this operation.

HelpQ also generated useful reports for ITD, including information on the impact of new technology initiatives. The director explained that the CSC was first to feel the effects of any technology upgrades:

> Any time [there are] changes, we feel it here first. We are big advocates of change control and change announcement. I have gone so far as to ask ITD for the authority to approve all changes before they are released.

Perceived performance improvement. CSC management had undertaken a significant PIP to improve customer service; however, results were mixed. Users were pleased with the change from student workers to full-time staff. Early on, a follow-up survey of help desk callers was instituted, asking callers for feedback on perceived service quality and value. While the survey's intent was to measure the CSC's overall performance, the survey items focused on the specific CSC employee who handled their call[5]. The transition to full-time employees generated immediate improvements in customer satisfaction. These survey results were consistent with our observation of CSC employees "in action". Ironically, the rise in customer satisfaction was not related to improvements in actual service levels. Despite better technical capabilities to capture, store, and reuse problem knowledge, standard call center performance metrics showed no improvement. The ratio of calls resolving during the initial phone call actually declined over time – from 77 percent (using manual logs) to 69 percent (using HelpQ). Nor did the use of HelpQ improve the CSC's ability to solve more challenging problems faster. Resolution time for tier two problems fluctuated, with generally slower resolution time after HelpQ implementation in mid-1996.

Table I shows new call volumes, the percentage solved at tier one, and average resolution time for tier two calls. The performance data reveal cyclical demand patterns and the creation of problem backlogs. Call volumes roughly doubled at regular intervals corresponding to the start of academic terms (August and January). These demand spikes were followed by performance declines in two key metrics shown in Table I. Since HelpQ had been purchased to improve the CSC's performance, we closely examined how employees used it to capture and reuse knowledge, in order to understand why there was no apparent benefit. Although CSC policy mandated capturing problem and solution information, we found significant variation in the amount, timing, and quality of this information. As described above, employees felt pressured to end each call quickly, to free the incoming lines for other callers. This created incentives opposite to those required to capture full and complete information in HelpQ. The accuracy and completeness of information both declined because of this time pressure. During busy times, CSC employees preferred to move on to the next call before completing the HelpQ record for the previous call. The tendency to move on without documenting complete information was even more pronounced for difficult or time-consuming problems. To keep the call brief, employees would classify problems as tier two, defer completion of the HelpQ record and then instead, plan to call the customer back at a later time. During busy times, this meant that employees could continue to take other new calls, but they often neglected or forgot the details of these prior calls (which they had escalated to "tier two"). This pattern hindered the overarching goal – to capture information in the HelpQ record that might be later reused. Such delays in entering records meant that employees had to mentally juggle information from several calls, and then try to remember certain details hours after the initial call. They engaged in phone tag with customers, at which point they had to re-start problem description and diagnosis from scratch.

Table I.
CSC statistics following HelpQ implementation

	1996 July	Aug.	Sept.	Oct.	Nov.	Dec.	1997 Jan.	Feb.	March
Volume of new calls	865	1,948	1,645	1,550	983	756	1,147	1,180	861
Percent of calls resolved during initial call	74	83	74	70	67	67	63	53	68
Average resolution time for tier two calls (in days)	2.55	3.73	5.65	9.84	9.6	5.7	7.1	8.5	7.4

These problems were reflected in our review of records in the HelpQ database, where many records were incomplete. For problem incidents that required escalation externally (external tier two or tier three), information in the knowledgebase was even less complete. Employees outside the CSC but within ITD had access to HelpQ but did not use it, so that HelpQ contained the least amount of solution details for the most difficult and time-consuming problems and no effective way to learn about them. Having documented knowledge of these difficult problems would likely have allowed CSC employees to solve them directly the next time they occurred, rather than having to again escalate and refer them elsewhere.

Despite the variety of search options, employees did not leverage these capabilities fully. Our observations revealed that CSC employees generally used only two of the many search options: search by caller name and by problem owner (to view prior calls they themselves had handled). Rarely did we observe the employees searching by problem symptoms or problem categories. Our interviews revealed that each CSC employee had a mental map of the contents of the knowledgebase. Most surprising to us was that, because each CSC employees handled so many calls, they believed that they knew what types of problems were already documented in the knowledgebase and, conversely, what problems were not documented. Employees consistently believed that a problem that was unfamiliar to them was also a new problem to the entire CSC department. We often observed CSC employees neglecting to search HelpQ to locate similar incidents and instead, searching other information sources, even when the same problem (and its solution) had been previously documented in HelpQ. In one instance, we questioned an employee about his neglecting to search HelpQ, and he exclaimed: "Oops – my fault. I should have searched for it [using HelpQ] but I've been here so long that I figure I already know what's in there". While each CSC employee handles hundreds of calls, there were thousands of records in HelpQ that other employees had input. It thus seems highly unlikely that any single CSC employee would have an accurate mental map of the full contents, unless they spent considerable time actively searching through it. We did not observe any browsing or examination of HelpQ except during specific problem solving instances.

Shifting management priorities. Near the end of our study, two factors diverted resources and attention away from the CSC: university budget problems and escalating problems with the Oracle system implementation in ITD. Given the budget crunch, and over the objections of CSC management, the Director of ITD proposed a 30 percent reduction in CSC staff. He had reasons to justify that such a reduction was feasible: The CSC was already recognized as a "bright spot" within ITD by campus users, given the CSC department's greatly improved customer satisfaction ratings. He believed the CSC's investments in new staff, facilities, and KMS technology were to thank – and specifically, that greater efficiency and effectiveness resulted from using HelpQ. While this perception seems plausible, it was incorrect. The rise in CSC's customer satisfaction ratings had occurred long before any investments in HelpQ, and was directly attributable to the hiring of full-time staff when CSC re-opened in October 1995.

Case summary. Despite the implementation of a then state-of-the-art KMS, the contents of the knowledgebase were of poor quality. CSC employees worked under tremendous time pressure, which led them to take short-cuts and work-arounds in recording information in HelpQ. CSC management evaluated employees' performance with simple efficiency metrics that reinforced the sense of time pressure, and the focus on quantitative performance metrics, and encouraged short-cuts. Although the CSC successfully implemented a KMS (at least from a technical standpoint), we note that this was only one part of the four-pronged strategy in their action plan. Shifting management priorities resulted in indefinite postponement of the three other recommended technologies[6]. Finally, we note that our research team was the first to aggregate the call statistics and analyze time series performance data (see Table I). Without this longitudinal information, it is not surprising that CSC management made different attributions about underlying causes of increased customer satisfaction than we did.

Discussion

At the time of our study, HelpQ was a state-of-the-art KMS designed to support the knowledge creation cycle and enabled CSC employees to capture and reuse existing knowledge. It also featured reporting capabilities for CSC management to document quantities, rates, and trends, thereby enhancing their ability to recognize patterns of recurring problems. Unfortunately, HelpQ's capabilities were not well-leveraged – either to document information from new calls, search existing records in HelpQ, or reuse knowledge generated from past problems. Returning to the framework introduced above, we interpret these events and underscore the framework's value for IS researchers and managers. We interpret events at the CSC using Figure 1 as our conceptual lens, analyzing first the constructs within each loop, and then examining their interactions.

Market demand loop

Although the CSC was not concerned with selling its services on the open market, there existed an "internal market" for its services. CSC managers had to consider supply-and-demand issues, such as the volume of customer calls (and their fluctuation patterns) and the required number of employees to hire and staff for certain times of the day, week, and semester. The number of phone lines should also have been considered in evaluating supply-and-demand since the two incoming phone lines posed a bottleneck to productive capacity.

Manager loop

At the advice of external consultants, CSC management reorganized the former "help desk", and adopted a series of applications to support KM. After initial attempts to "kludge" KMS functionality using spreadsheets and Lotus Notes "memos", management purchased HelpQ and promoted adoption with training classes where CSC employees learned to enter call data, perform online searches, and generate reports. Following adoption, there was little visible benefit – at least no positive impact. Moreover, the decline in performance that CSC management should have anticipated in advance, and then later observed in practice, was curiously absent for reasons explained below.

Employee loop

Initially, employees believed the goal of the PIP was to improve customer service quality, facilitate access to information, and reduce the amount of time/effort required to process customer calls. Once they began using HelpQ, however, they found they were actually spending more time on each call, in part because they were not yet familiar with the system (the learning curve effect) and also because there was no offsetting benefit in terms of a critical mass of content to reuse. This realization negatively influenced their attitudes toward HelpQ, so that without normative pressure to use it properly to enter and search for records, employees would likely abandon it, or shirk. Employees also formulated beliefs about managers' intentions for adopting KMS – to improve productivity, using simple metrics such as number of calls processed and average time-to-resolution. Management did not emphasize to employees the other possible benefits that could accrue to the CSC from having complete and accurate data about prior problems in the knowledgebase.

The tightly-coupled character of the three loops becomes apparent when we consider feedback effects, interactions, and self-confirming attributions. When deciding to adopt HelpQ, CSC managers needed to consider the productivity changes that should occur and make necessary adjustments to their hiring and staffing practices. If CSC management had anticipated that HelpQ would initially decrease productivity, they should have made allowances for more incoming phone lines and staff.

While this short-term decline in productivity should have been anticipated in advance, and recognized when it occurred, CSC employees masked the extra time required, using two mechanisms that together shielded CSC management from recognizing the performance issues. First, employees began taking short-cuts – failing to enter complete information about call details; second, they perceived time pressure to complete the call and free up the phone line, so they designated more calls as "tier two" problems, which enabled them to defer the call and solve it at a later time. These tactics relieved the immediate time pressures, since they permitted employees to move to the next call, but created a backlog of more complex problems that also needed attention. By delaying and possibly forgetting some information about these earlier calls, employees had to spend more time playing "telephone tag" to reach the customer, and then start the process of problem-identification over again. Thus, began a vicious cycle of employees actually needing more time to enter complete call records in HelpQ, but using short-cuts (partially-complete records) and work-arounds (deferring calls), to maintain the façade of stable productivity levels, while undermining the intent of the KMS initiative. Given management's emphasis on simple productivity metrics, it is not surprising that employees sought to avoid noticeable productivity declines or the censure that surely would accompany it.

The result was that CSC managers failed to recognize the serious productivity challenges posed by HelpQ, so they neglected to allocate the necessary increase in manpower to ensure adequate service capacity. CSC managers believed that productivity levels were stable or improving and that HelpQ was achieving its intended benefits. These performance results were, at best, a façade, and at worst, highly detrimental to KMS implementation. This deception, in turn, allowed the time pressures to persist, further reinforcing the new short-cuts, workarounds, and generally slack discipline. Despite this general decline in the completeness of records documented in the KMS, employees made every effort to maintain the appearance of consistent productivity levels by ensuring that they achieved their numbers.

This vicious cycle was nearly identical to one described in Oliva and Sterman's (2001) study of a bank's customer service department. There, the quality of customer service deteriorated gradually during every period of high customer demand. Owing to normal fluctuations in demand, bank employees allowed their service standards to erode when demand for services exceeded available manpower, yet subsequently, when customer demand returned to normal levels, the lower service level became the new norm. Such "slippage" in service quality happened imperceptibly but repeatedly, and was only detectable over time by periodic customer satisfaction surveys. Oliva and Sterman (2001, p. 912) describe results analogous to our own:

> Employees, in an effort to meet throughput goals, absorb small variations in workload by reducing the time spent with each customer … The reduction in time per customer, while enabling an immediate increase in throughput, gradually erodes service norms … In the absence of direct and reliable measurements of customer satisfaction, and consistent with their imperative to control costs, management interprets the reduction in time per [transaction] as a productivity gain and reduces the labor force. The drop in service capacity further increases the workload, so service personnel are forced to [cut corners] still more. These factors interact to generate the potential for significant, ongoing quality erosion …

At the CSC, not only were employees negligent in fully documenting calls, but they also lacked discipline in searching the existing database for potentially relevant cases. Here too, they developed habits and norms that were directly contrary to the goals of the KMS initiative (e.g. "I only search for problems in the knowledgebase that I personally remember entering"). The irony of employees' behavior was that they assumed that a problem that was new to them would not have already been experienced by other CSC employees, and thus was not searchable in the knowledgebase. We believe the events of this study clearly illustrate the dynamic and interconnected nature of managers' and employees' beliefs and actions.

The three loops in Figure 1 show the processes leading to this downward spiral, which would account for the mediocre outcomes we observed at the CSC. Each of the three loops constantly iterates, and the variables identified along each loop influence each other over time. Based on our interview, observation, and archival data, it was clear that CSC employees were not using the system as envisioned. Without sufficient information being entered into the KMS and without other tools to analyze patterns in the data, there was little opportunity for employees to use it as a springboard to higher productivity or quality.

We note that the case study results from the CSC differed greatly from the two earlier studies of KMS implemented in customer service departments. In contrast to the CSC, we believe that at both Storage Connect and Zeta, management took a long-term view of the sacrifices required to achieve the desired benefits. Moreover, they each provided incentives to promote positive norms and habits. At Storage Connect (El Sawy and Bowles, 1997), management instilled commitment and discipline among employees for achieving its goals (as revealed by use of terms like "unwavering management commitment", "passion", and "company-wide effort"). At Zeta Corporation, there existed a strong workplace culture of information-sharing among employees, predating implementation of its KMS (Gallivan, 1997; Orlikowski, 1996). Another difference was that Zeta's management explicitly modified the performance evaluation criteria to incorporate new metrics like "completeness of call records entered", and "reuse of data from the system". Even then, the most important benefits emerged only after two years of continual use and adaptation at Zeta. In both cases (and contrasting with CSC), employees were subjected to much greater levels of normative pressure to use the system as they had been trained, and they developed their own norms supporting consistent usage.

One commonality, however, between our case study and prior results of KMS implementation in an insurance firm (Vandenbosch and Ginzberg, 1997) and a consulting firm (Orlikowski, 1993) was that user training focused only on the mechanics of using the system, while ignoring the more complex behavioral issues of changing users' information-sharing practices. Researchers have repeatedly argued that new technology, by itself, is unlikely to alter social and cultural factors within organizations – such as the level of information-sharing (Davenport *et al.*, 1999; King, 1996; Orlikowski, 1993; Robey and Boudreau, 1999).

Remedies to avoid vicious cycles

Had CSC managers truly recognized that, when adopting any complex process innovation, performance declines during the early stages, they could have better prepared employees by downplaying their traditional focus on productivity metrics, and instead, emphasized the need for employees to become comfortable using HelpQ and develop strong norms promoting accuracy and completeness of the data they input. As part of user training, managers could have emphasized that the overarching objective was to accumulate a large volume of records in HelpQ that accurately documented problem symptoms and resolution details, and which could be searched to solve future problems more efficiently and effectively. For employees to change their behavior required a leap-of-faith which they were not yet ready to make. Management should have taken steps early to alleviate performance pressures on employees, thereby interrupting the vicious cycle and ending dysfunctional behavior before it began. Instead, everyone feigned "business as usual". The result was that employees grew slack in adhering to guidelines for using HelpQ, the required critical mass of records failed to accumulate, and the likelihood of achieving any long-term benefits of the system became remote.

If managers had been serious about making the appropriate short-term investment in order to reap the long-term rewards, they would have done several things differently. First, they would have changed the criteria employed to evaluate CSC workers' performance – evaluating the quality and completeness of their entries to the database, rather than continuing to use simple efficiency measures of productivity. Second, managers would have followed through on the external consultants' recommendations to purchase and implement the other three components of the initial action plan. Not only did CSC managers choose to defer these other purchases, but when the CSC found itself in the university's budget squeeze, the ITD director announced his intention to reduce the CSC's service capacity through lay-offs. When budget problems required cost reduction, the CSC was perceived as an obvious candidate for cuts. Not deterred by the reality of how the KMS had altered the actual work processes in the CSC (depressing actual productivity), both CSC and ITD managers believed that HelpQ had indeed generated the intended process improvements. They incorporated this belief into their justification for reducing the CSC workforce. ITD department managers based their decisions on indicators showing performance improvements at CSC, but those indicators represented improvements that pre-dated the KMS implementation by nearly two years, and were unrelated to changes in work processes.

Research contributions

We have demonstrated that system dynamics is one valuable source for novel ideas about implementing KMS – one that, until now, has been largely neglected by IS researchers. System dynamics recognizes that many principles associated with complex systems must be explicitly studied and modeled if we are to understand behavior of variables that are nonlinear and reciprocal (Sterman, 2001). We have introduced a novel conceptual framework that can sensitize other IS researchers to the benefits of incorporating system dynamics concepts and assumptions. While we believe that IS researchers have made considerable progress in creating rich theories, explaining how KMS initiatives influence organizational capabilities, we believe there is merit in seeking new insights from beyond the boundaries of the IS discipline. It is not our intention to slight the many valuable theories and frameworks that have emerged from IS research over the past decade. Nevertheless, we argue that a deeper understanding of the process and outcomes of deliberate KMS initiatives is possible by interjecting novel concepts into our existing models to explain how KMS initiatives contribute to firms that undertake them.

Beyond contributing to researchers, we also see the need to sensitize practitioners to these issues. One goal articulated by system dynamics researchers is to leverage their insights in order to develop management flight simulators that challenge and prepare future business leaders (Sterman, 1992). Likewise, we believe that it is important for managers to examine models explaining how organizational change outcomes may be influenced by feedback loops and nonlinear effects that may be easily overlooked. We believe that an open discussion of challenges unique to KMS implementation is critical, particularly the problems related to creating initial incentives to use the system so that a critical mass of content may be generated. We strongly support the following advice that Hayduk (1998, p. 591) offered to practitioners:

> … if the time to participate in knowledge-sharing activities must be taken during the traditional workday, traditional performance measures should be altered to recognize that time spent on knowledge-sharing activities is a legitimate, business-enhancing activity. If the expected output from employees is expected to remain constant, and knowledge-sharing activities are expected in addition to the current level of output, then … incentives must be created to recognize and reward the increased level of output from each employee.

Limitations and implications for future research

Our study represents the first use of system dynamics principles to study KMS implementation in the IS literature. Although we have introduced a framework and underscored the advantages of incorporating novel principles into IS research, we have not explicitly used several common system dynamics tools, such as mathematical modeling and computer simulation. Moreover, our study applies the framework to understand events of a single case study; clearly, these outcomes may not be generalizable to other firms. Yet, it was not our objective to prove that the framework we introduced is correct or valid, but rather to sensitize IS researchers to the merits of assuming such a philosophical stance. Other IS researchers will wish to build on our efforts, by not only incorporating our framework, but also choosing to deploy specific methods associated with system dynamics (e.g. computer simulation).

Building on our efforts, it may be valuable for researchers to contrast the explanatory power of our framework with other theories that consider the interaction between technological innovations and their context of usage

(Leonard-Barton, 1988; Orlikowski, 1996; Robey and Boudreau, 1999). We believe that our efforts to incorporate these novel constructs and frameworks from system dynamics hold promise for future inquiry by IS researchers who seek greater understanding of the processes and impacts of KMS initiatives. Future research should examine whether our framework provides useful insights into KMS adoption scenarios very different from our own – for example, success stories, or in cases where employees and managers have consistent beliefs about the KMS, either both positive or both negative.

Conclusion

We have introduced a novel conceptual framework that is grounded in studies of other PIPs from a host of manufacturing and service organizations (e.g. Ford, AT&T, Harley-Davidson, Analog Devices). We have employed this framework to illustrate the dynamic and interdependent nature of employees' and managers' cognitions and behavior when implementing an organizing technology (i.e. a complex process innovation) within a customer service department. In our field study of the CSC of a large university, we showed that this framework can be helpful for interpreting the iterative and interconnected cycles that produced mixed implementation results. Our field study highlights the reasons for the mediocre results we observed, and stands in marked contrast to other empirical studies that have praised the successes of KMS introduced into other customer service departments (El Sawy and Bowles, 1997; Grover and Davenport, 2001), or into contrasting environments, such as management consulting (Davenport and Hansen, 1999; Savary, 1999).

Despite the divergence of our results from these other studies of KMS implementation in customer service environments – or specifically because of this divergence – we believe that the framework we introduce has value for specifying and analyzing the forces that contribute to successful or failed implementation. We believe that a careful application of our framework to analyze events from these earlier KMS "success stories" will also underscore its merits by demonstrating the interdependent and reinforcing causal loops that occur among managers' actions and cognitions, employees' actions and cognitions, and changes to the level of market demand for the organization's products or services.

In closing, we reiterate our prior statement that it is important to distinguish KMS with different objectives. We believe that IS researchers must be cautious about accepting the experiences and insights of researchers studying entirely different classes of KMS (e.g. discretionary communication-oriented KMS), since they may not generalize well to implementation of documented-centred KMS initiatives, particularly where the objective is to achieve deliberate improvements in organizational performance.

Notes

1. This includes recent special issues of academic journals: *California Management Review* (Spring, 1998), *Journal of Management Studies* (Fall, 2000), and *Journal of Management Information Systems* (Summer, 2001).
2. The construct "employees' beliefs about managers' intentions" refers to whether employees believe that managers seek to empower them to act autonomously, or conversely, seeks to exploit and control them (Gray, 2001).
3. The construct "communicating and sharing opinions with peers" occurs on both the manager and employee loops; similarly, "decisions to expand/contract labor supply" appears on both the manager and market demand loops.
4. Priority ratings ranged from low to critical, depending on the number of users affected and the problem's severity. Standard response and resolution times were specified for each priority category, ranging from 24 hours (for critical problems) to one week (for low priority issues).
5. The survey items focused on employee courtesy, interpersonal skills, responsiveness, competence, reliability, etc.
6. The complementary technologies that were recommended, but not purchased by the CSC included the following: a PBX system (to add capacity and distribute incoming calls), knowledgebase modules (to populate the KMS), and an expert system (to discover patterns in the knowledgebase). Investment in any of these technologies may have improved the effectiveness of HelpQ for knowledge capture and reuse.

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