Soft Innovation as Data-driven Process Improvement Exploited via Integrated Hospital Information Systems

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Abstract

Soft innovations are regarded as insightful, useful ideas originating from stakeholders within the organization. This study takes a new approach to examining the origins of soft innovations within an open systems environment from an organizational context perspective. Based on a 30-month longitudinal study at a 990 registered-bed large teaching hospital, this paper shows that the complexity of technological change dynamics from radical innovation is a main factor that gives rise to process improvement as soft innovation. Theoretical and practical implications of this study are also discussed.

1. Introduction

Organizational information represents core competencies composed of business processes, existing technologies, and organizational values. Hofstede [16] described organizational culture as "the way things are done," and information systems (IS) provide the metrics from which to measure performance against organizational goals. Additionally, the ability to exploit business process performance over infrastructure, customer-relationship, and innovation distinguishes an organization from its competition [13]. Therefore, organizational IS and information technology (IT) are increasingly important as organizational strategies depend on the capabilities of specific underlying IS and IT [27].

Similarly, IS and IT have taken increasingly central roles within the healthcare industry [25]. Conner, Ponte, and Conway [6] noted how an integrated IS facilitates multidisciplinary approaches to reducing error and risk in patient care. Garg et al. [11] noted how integrated decision support systems have improved practitioner performance. However, Wears and Berg [33] note that IS or IT only yield high-quality healthcare when its use patterns are tailored to knowledge workers and the knowledge worker's environment. Hence, an IS or IT acquisition and implementation trajectory yields opportunity for organizational change.

In contrast to its strategic importance, the inability to share information across IS and between health care groups is a major barrier toward efficiency and cost-effectiveness [12]. Organizational units operating autonomously create redundancies, hoard resources, and complicate organizational efforts [14]. Herzlinger [15] also noted how technology itself, across the healthcare industry, becomes a barrier to innovation. As an alternative approach, the application of integrated information reinforces strategies, information sharing, synergy, and improvement [18], [27], [37]. This alternate perspective views soft innovation as process improvement where organizational information influences process innovation [29]. Thus, the availability of integrated organizational information poses opportunity, justification, and confirmation for soft innovations.

This paper investigates the impact of soft innovations from empowered [35] and integrated individuals possessing integrated information. The investigation method was conducted through a longitudinal study of a hospital's perioperative services that underwent radical innovation. The organization of this paper is as follows. The next sections review previous literature, addressing integrated individuals, integrated IS, and soft innovation. A holistic approach for soft innovation is identified, thereby helping prescribe an a priori environment to foster its occurrence. Following the literature review, we present the methodology, results, and analysis of our longitudinal case study illustrating the observed effects of integrated organizational information on soft innovation. Implications and limitations of this study are discussed in the conclusion.

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2. Integrated Information, Individuals, and Innovation

Holistic rather than reductionistic views are fundamental to systems theory and open systems use when describing IS and individuals within organizations [4], [5], [21], [22], [28]. Churchman [5] described a system as a set of interrelated elements (subsystems) oriented to accomplish a set of common goals. Andrew [2] introduced the concept of a goal state system, where self-regulation with the environment through interactions, feedback, and responses maintained or achieved a stated goal. Ackoff [1] reinforced embedding feedback loops within IS as a control measure (self-regulation) to avoid management misinformation. More recently within a healthcare paradigm, Waldman [32] noted how a complex adaptive system (CAS) has goals separate from survival, has the capability to learn via feedback, and innovates purposefully. Through all of these concepts, holistic views of overall objectives stated as common goals drove individual system functions.

Individuals and IS are both physical systems, which nest within an organization as subsystems to form a composite architecture. An organization chart denotes the architecture of organizational authority, responsibility, and workflow by grouping individuals by level and function. Similarly, IS architecture is the road map for information flow where sub-components receive perspective, specific functionality, structural relationships, and defined dynamic interactions [24]. With respect to IS architecture within the organization, integration is a realization of Belady's and Lehman's 1st and 2nd laws of program evolution dynamics, where integration is an attempt toward renovation [31]. With respect to individuals in the organization, integration is a cross-functional task group.

Unfortunately, many organizations have inherited architecture and organizational structure that lack subsystem integration necessary for self-regulation. Within the healthcare industry, the basis for the American physician model is largely an 18th century tradition of professionalism, American hospitals are based largely on English designs that originated in the mid-19th century, and models for American health insurance and managed care plans originated in the 1930s and 1940s [30].

Huber [17] observed that organizational decision-making is political in nature and impacts IS use. Integrating disparate IS often cuts across political boundaries, where information is a valued resource, and whose redistribution through integration affects group interests, manipulates organizational structure, and alters the distribution of organizational power [3], [19], [26]. Moreover, Kim and Michelman [20] detailed how an informed top management arbitrates political issues to maintain a holistic organizational perspective. Without self-regulation, individuals, organizations, and IS are influenced by environmental noise that attenuates and distorts strategic goals. Within the healthcare industry, insurers tend to analyze their costs in silos, so hidden reductions in hospital labor costs yield only visible new technology costs responsible for the improvement [15]. Nonetheless with adherence to strategic goals, empowered individuals with integrated IS can drive change through organizational power structures and processes. A closer look at systematic innovation reveals a similar open systems perspective.

Narayanan [23] noted that radical innovation is a consequence of technological change and radical innovation disrupts an organization and/or its environment. During the disruption and until stability is achieved, innovation may be classified as undergoing change dynamics where the technology emergence leads to incremental change. Both phases are examples of self-regulation yielding both hard and soft innovations. Seth Godin [10] differentiated hard innovation from soft innovation where hard innovation is organized research and development efforts characterized by strategic investment in innovation, be it high-risk-high-return radical innovation or low-risk-low-return incremental innovation. Soft innovation is the clever, insightful, useful ideas that anyone in the organization can originate. Innovative organizations seek value through repeated soft innovations, looking at every facet of their industry, and at every opportunity to seek out and satisfy a customer need [30]. Integrated individuals, when empowered with common goals and integrated organizational information, originate soft innovations and implement them as process improvements.

3. Research Method

The objective of this study was to investigate the impact of soft innovation, within a hospital environment, from empowered and integrated individuals driven by integrated information. Case research is considered to be particularly appropriate [7], [36]. An advantage of the positivist approach [34] to case research allowed concentrating on a specific hospital service undergoing disruptive, radical innovation in a natural setting to analyze the associated qualitative problems and environmental

complexity. Hence, our study took an in-depth case research approach.

As the research site, we selected a large teaching hospital (University Hospital) that is licensed for 990 beds and located in the southeastern region of the United States, which allowed us to more fully investigate the research question and to collect longitudinal data. This study started in October 2004 and concluded in March 2007, with particular historical data available from 2002 through 2006. During the 30-month study, we conducted field research and gathered data from multiple sources including interviews, field surveys, site observations, field notes, archival records, and documents reviews.

4. Results

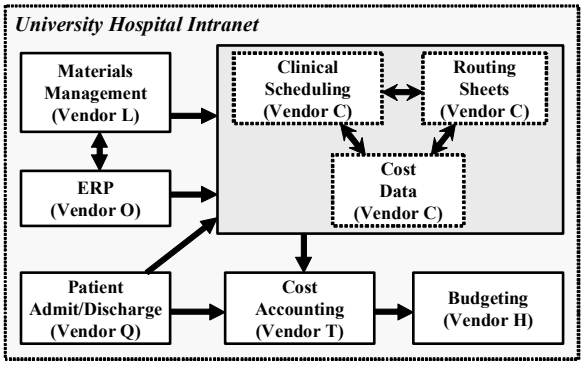

Figure 1 - IS architecture (October 2004)

Figure-1 depicts University Hospital's IS architecture for perioperative services as of October 2004. University Hospital had six main IS: (1) a large-scale hospital materials management IS, which included pharmacy, material and medical device management (Vendor L); (2) a large scale enterprise resource planning IS (Vendor 0); (3) a patient record Admit/Discharge IS (Vendor Q); (4) a cost accounting IS (Vendor T); (5) a financial budgeting IS (Vendor H); and (6) a clinical scheduling IS (Vendor C) that included three modules for clinical scheduling, routing sheets, and cost data. All IS were integrated with uni-directional constraints placed on sensitive information. The institutional intranet served as portal access to extend each of the six IS. User authentication via the intranet was single entry with particular user-IS rights and privileges negotiated upon authentication.

4.1 November 2004

Perioperative services provide surgical care for inpatients and outpatients. The multidisciplinary, cross-functional surgical team maneuvers within a complex, fast-paced environment caring for surgical patients during immediate pre-operative, intra-operative, and immediate post-operative time periods. University Hospital opened a new diagnostic and surgical facility in November 2004, which covers three-fourths of a city block rising 12 stories. Perioperative services were relocated into three floors, with operating rooms (ORs) located over two floors and Central Sterile Supply (CSS) located separately on the third.

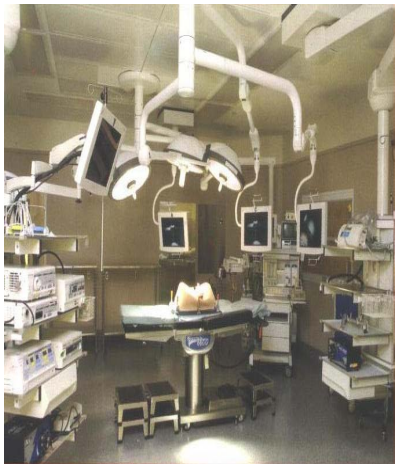

Figure 2 – New OR suite (1 of 32)

Figure 3 –Command center (1 of 2)

The move expanded perioperative services to cover an additional floor and nine additional ORs. The new facility housed 32 state-of-the-art OR suites, each equipped with new standardized equipment. Groups of service specific OR suites categorized a surgical specialty, with each particular room among the group containing specialty equipment. Figure 2 above depicts one of the new OR suites.

University Hospital's new building was technology-rich. Perioperative services' OR facilities, covering two of the three floors, formed a quarter mile loop, with the 32 operating rooms and eight cardiovascular units operating 24/7. A broadcast-studio-like central command center on

each OR floor, with a wall of video screens, enabled perioperative staff to see into every OR or cardio unit remotely from their desk. A signal feed from any OR camera could be monitored from microscope video feeds to hemodynamic monitoring. OR video feeds could also be broadcasted locally or off-campus for surgical consultations, which enabled new consultation opportunities and negated sterile field issues. Also, patient blood pressure, heart rate, or any other anesthesia metric was remotely viewable by the perioperative staff over multiple monitors. Figure 3 above depicts one of the command centers capable of monitoring perioperative services on either floor.

The technology-rich environment also included an interface to the Clinical Scheduling IS, distributed over wall-mounted monitors throughout the perioperative facilities, with anesthesia and perioperative staffs' schedules dynamically linked. Color-coded displays on the monitors instantly informed all stakeholders when a case was completed or shifted from one room or scheduled time slot to another. The data generated within the Clinical Scheduling IS also fed a real-time patient charting system, which was combined with qualitative data from standard observations.

4.2 Disruptions from radical innovation

The new perioperative facilities expanded OR capacity by 33%, which required additional surgeons, nurses, anesthesiologists, nurse anesthetists, and other perioperative staffing. Shortly after start-up of the new facility, the newly expanded perioperative services' resources had reached capacity. Unfortunately, there was no way to simulate how key departments like Central Sterile Supply (CSS), the ORs, the post anesthesia care units, and the preoperative and feeder processes would be affected by the expansion and capacity limitations.

CSS was ill-prepared to handle the shift in caseload. CSS had not anticipated the major changes in space, supply storage, and instrument needs. Also, a new case cart system was deployed with the relocation. A case cart is a vehicle stocked in advance with a prepared list of instruments and supplies designated for a single surgical procedure within an OR suite. Used items are reloaded onto the cart and sent back to CSS for disposal or reprocessing. CSS lacked sufficient staff to decontaminate, prep and wrap, sterilize, and return instrumentation via the case cart for the next day's caseload. Incomplete case carts impact first case starts, subsequent case schedules, staff satisfaction, surgeon satisfaction, and overall departmental performance.

Despite the new facilities, the interim Director of Perioperative Services felt that the work environment was near implosion. She stated "everything we did was old...you cannot keep adding physicians and ORs and not change the way you practice." Operational policies developed in the old perioperative facility were no longer applicable. The lack of staff preparedness to cope with the relocation was apparent in the operation of new equipment. Technology discontinuity was rampant. Basic OR suite set-ups were chaotic, beginning with each OR's first surgical case each morning. Elements as basic as patient flow had drastically changed. The perioperative staff's learning curves were steep. Insufficient educational efforts had been provided to support the radical innovations to facilities, practices, or processes.

Perioperative staffing was insufficient due to the capacity increase. Staff was unavailable to open rooms, which indicated personnel were unavailable to oversee patient flow, provide break relief, or provide lunch relief. Poor work-life balance, mandatory over-time, uncertain schedules, unpredictable work hours, and declining moral were influencing efficiency, throughput, and accelerated staff turnover. When reflecting on the situation, the interim Perioperative Services Director stated, "If we hired new staff, then we could not keep them. The staff was unhappy and the moral was awful, almost like being in prison."

Within six weeks of occupying the new perioperative facility, scheduling metrics reflected the chaos within the new facilities and indicated how existing operating procedures and policies were not effective. On-time surgical case starts plunged to 18% during December 2004. Within a highly competitive hospital industry, having only 18% of scheduled surgeries start on-time was unacceptable. Within the complex and fast-paced environment of perioperative services, having 82% of scheduled surgeries backlogged could risk patient care and safety.

4.3 Integrated, data-driven, and empowered individuals

Facing a continuous nursing shortage, staff insufficiencies, technology discontinuity, and facility-transition chaos led the interim Operating Room Director/Information Systems Manager and the interim Perioperative Services Director to appeal to upper management and surgeon champions. Problems were laid out before a quickly convened

executive committee that included the CEO, the chief financial officer, the chief information officer, the chief nursing officer, and top representatives of physicians, anesthesia, and CSS. Perioperative staff voices delivered a message of desperation, resulting in a changed management structure and the formation of a cross-functional, multidisciplinary executive team who was empowered to evoke change. The executive team and numerous task forces formed to address specific problems and/or opportunities were chartered to focus on patient care and safety, attack difficult questions, and remove 'sacred cows'.

The executive team was commissioned by executive officers to employ a SWOT approach to problems, looking at what were the underlying issues and the overall strengths of each issue. The team consisted of surgeons, nurse leaders, anesthesiologists, and perioperative management. The executive team and task groups were challenged to systematically identify the issues and enlist those working managers for solutions that would facilitate change and minimize departmental chaos. No issue was considered off-limits. If an issue was affecting operations and its analysis was conclusive, then a plan was formulated for improvement. All initiatives were data-driven. Supporting data were gleaned from the existing integrated IS. Supporting data demonstrated problem areas, strengths to highlight, and provided the direction for continual change. Each identified benchmark presented a new goal proposal, along with a strategy for implementation.

4.4 Soft innovation examples

First, the executive team looked at what kept patients from getting to the OR on time. Information from the online patient charting IS identified problems behind daily OR first-case late starts: admitting delays, patient transportation to holding, surgical site markings, lack of patient histories, lack of physical exam entries, and proper consent signatures. The data-driven problems were reviewed by the chief of surgery, chief of anesthesia, and other departmental heads. Each department took ownership of the problems where they could contribute process improvement. Task groups were formed, pulling together individuals who had the ability to affect change. Identified bottlenecks ranged from late surgeons to insufficient admitting staff. Each bottleneck was addressed, analyzed, and resolved across all functional areas.

Another problem area was OR scheduling. University Hospital allocated OR suites by surgical specific scheduling blocks from 7 a.m. to 4:30 p.m., regardless of the caseload. The method did not reflect actual surgical specific cases within the scheduling blocks. As a Level I trauma center, University Hospital must also accommodate trauma patients 24/7. Operating hours were examined and block assignments were adjusted to match operations. Surgical specific block release rules were established with consideration to the individual service patient population. Similar to marketing segmentation among demographic groups, surgical specific needs were analyzed to establish predictable surgical specialties having patients with prearranged surgery conditions. Surgical specialties with wide variability in scheduling were given consideration and a reduction in the number of early release blocks of OR suites.

An analysis of the data from the Clinical Scheduling IS showed a clear mismatch between OR staff assignments and the time required by surgeons to complete cases, which yielded unscheduled staff overtime and unpredictable work hours. Nurse retention in today's market requires a work-life that supports the employees' quality of life. Hence, mandated five day-a-week eight-hour staffing shifts were changed to more flexible three 12-hour or four 10-hour shifts. Furthermore, the data analysis also justified incentives to address the registered nurse (RN) staff shortage. Staffing was augmented with incentive tiers for in-house RNs. Also, relief to the RN shortage was provided by hiring temporary RN staff as 'travelers'. However, the practice was communicated as a quick fix for staffing relief to prevent unsettling existing full-time staff.

The soft innovations in nurse staffing allowed the recruitment of additional nurse educators, bringing that staff up to five, who focused on process improvement in the orientation and education processes for new hires. A full week of basic process orientation was developed for new hires. Also, an important educational process improvement was the development of situational simulations, where new perioperative nurses could practice and learn procedures in a lower paced and lower stress environment. The interim Perioperative Director stated, "New hires can now perform the task before being called on stage."

Professional behavior and staff interaction paced the perioperative work environment. Nursing management had staff responsible for patient flow as well as practice and behavioral issues. Anesthesia had a similar responsibility function for management of anesthesia staff. Just as important is the surgeon's behavior with the team, which when left unchecked could become a human relations nightmare. The institution of "surgeon of day" (SOD) gave daily operations a "peer check". A SOD was a physician

leader and peer in the medical facility community who completed the balance of professional staff to address daily operational issues. The professional staff monitored interaction among surgical team members across all professional levels with methods of escalation to address any undesirable interaction, keeping checks and balances in place.

Other problem areas associated with the relocation were identified and addressed with similar soft innovations. Examples included the impact on CSS, equipment maintenance, and repair costs. In each scenario, the executive team or task group focused on a multidisciplinary approach by analyzing each situation and allowing data-driven measurement and information to affect change or determine the outcome.

4.5 Improvement over the next 24 months

The management structure and methodology developed within perioperative services allowed data-driven soft innovations to improve processes. Two years after the executive team's charter, management reorganization resulted in continuous improvements among metrics of on-time OR starts, increased OR suite utilization, and RN staff vacancies. These metrics offered confirmation of soft innovation management within a rapidly changing healthcare environment. Comparatively, patient satisfaction and nursing satisfaction metrics also continued to climb for perioperative services during FY2005 and FY2006 with departmental survey scores also above the overall intuitional mean.

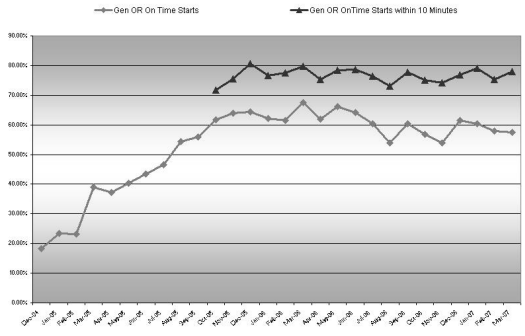

Figure 4 – General OR on-time starts

Figure 4 depicts a graph of the on-time OR starts from December 2004 through March 2007. Figure 4 clearly identified the benefits of data-driven soft innovation to the on-time OR starts metric. Soft innovations contributed to moving on-time OR starts from 18% up to 55% in less than nine months (September 2005). All scheduled surgical cases since August 2005 have had a 55% chance of starting on-time. Furthermore, all scheduled surgical cases since October 2005 have had a 70% chance of starting within ten minutes of their scheduled start times. These on-time start metrics also included an average 8% annual growth in University Hospital's OR cases.

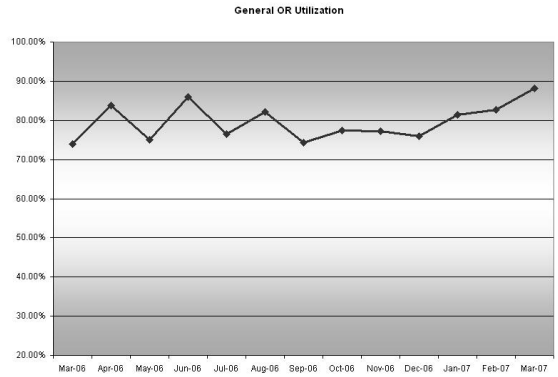

Figure 5 – General OR suite utilization

Figure 5 depicts a graph of OR suite utilization between May 2006 and March 2007. The OR suite utilization metric is a function of OR suite use during available scheduling blocks between 7:00 a.m. to 4:30 p.m.. Utilization rates prior to May 2006 were not reflective of caseloads and were considered irrelevant to soft innovations applied to the OR scheduling process. Since May 2006, roughly all OR suites have been used between 75% and 85% of their available scheduling blocks. For the first quarter of 2007, the graph also shows an upward trend in OR suite utilization. Should this trend continue, then this metric would be a driver to analyze broadening the existing scheduling block time parameters.

Figure 6 depicts a graph of University Hospital's annualized perioperative RN vacancy rates from FY2002 through FY2006. U.S. Government statistics in 2001 reported the national average for RN vacancies ranged from 12% to 20% [9]. Likewise, University Hospital's institutional vacancy rate averaged 21% during similar periods. The spike for FY2004 coincides with the planned and actual relocation of perioperative facilities. However, the prior FY2003 also had an upward trend three times larger than FY2002. Soft innovations in OR suite scheduling, flexible work shifts, and perioperative nursing education reduced nursing staff vacancies from over 40% in FY 2004 to an average vacancy rate of 7.6% over FY 2005 and FY 2006. Soft innovations contributed to lowering perioperative

nursing staff vacancy rates below the University Hospital's institutional rate and the national average.

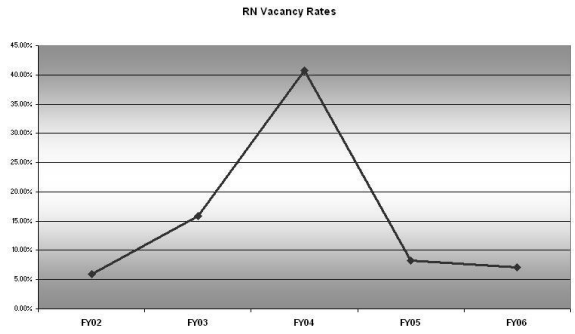

Figure 6 –RN staff vacancy rates

4.6 Summary of outcomes

In summary, outcomes from the relocation were classified by the perioperative staff as *what was done right* or *what could have been done better*. What was done right included: (1) Planned scavenger hunts to familiarize staff with supply locations and facility layout; (2) Anticipated case cart system needs to deliver OR supplies for each case; (3) New decontamination, wrapping ,and sterilizing areas along with space to stage and prepare new case carts; (4) Budgeted additional employees to staff new ORs; (5) Established a governance model for multidisciplinary review and policy creation; (6) Utilized data to analyze processes for soft innovations; and (7) Benchmarked against previous months metrics to establish trends for tracking improvement and/or targeting areas for improvement. Also, what could have done better included: (1) Examined processes and created a future state document; (2) Walked the new path for patient flow to identify pitfalls; (3) Established benchmarks prior to relocation for progress measurement; (4) Involved patient care staff in every detail and not just end-result to-do lists; (5) Hired additional staff prior to relocation; (6) Reconsidered planning to add staff as needed after the relocation; (7) Realized the reality of orienting staff during a "planned change" placed additional strain on a stressed environment; and (8) Planned for staffing orientation to occur in a controlled environment for optimum learning and retention.

5. Analysis and Discussion

The following narrative summarizes our case in context to open systems theory. The relocation of perioperative services provided University Hospital with a technology-rich environment having new capacity, facilities, and staff. The new perioperative services were radical innovations when compared with previous facilities. However, prior planning activities had not perceived the potential process disruption. Existing perioperative processes were found to be disparate within the new environment. Furthermore, visible disruption to the perioperative process placed patient care and safety at risk. Perioperative administration appealed to top management. Top management rallied to charter and to empower a cross-functional team as governance, which drove improvement through the perioperative process. Acting as CASs, surgical teams and perioperative staff task forces used data-driven methodology to provide soft innovations as self-regulation control that integrated new or revised processes within their environment.

University Hospital's Perioperative Services over the 30-month study maintained holistic goals. Communications, feed-forward, and feedback among and between organizational functions had sufficient self-regulation to adjust the new or existing disparate process. Over-all common organizational goals directed the cross-functional executive team, task forces, and surgical teams yielding optimal organizational integration. IS architecture provided each team and task force with integrated data generating soft innovation that drove continuous process improvement. The following sections offer plausible explanations for process improvement among University Hospital's perioperative services.

5.1 Team integration

Our study found that University Hospital's organizational structure was hierarchical and organized by specialized function, similar to Churchman's [5] description of a system. Perioperative staff, anesthesia, and surgeons all performed different functions and each group had different reporting channels. Typically within hierarchical organizations, the lack of communication among various functions yielded poor self-regulation of organizational goals [8]. However, the three groups also comprise a surgical team and work together to accomplish the common goal of safely completing the surgical case while providing patient care. Surgical teams act as CASs that integrate the multidisciplinary functions within perioperative

processes. Similarly, the executive team and task forces were also CASs that integrated the approach to addressing issues and generating soft innovation.

5.2 Top management's support

University Hospitals' top executives provided two critical success factors to the Perioperative Administration at the initial meeting during January 2005. (1) Top management empowered perioperative services to change their governance, which provided the executive team an opportunity to create a cross-functional management structure, outside the hierarchical reporting channels and similar to the work environment within the perioperative process. In the new management structure, any issue that influenced the perioperative process was a legitimate topic. This permission allowed soft innovations to be evaluated from all disciplines rather than a quick dismissal from a non-stakeholder. (2) Top management chartered the executive committee with the authority to evoke change in the perioperative process, which was interconnected and nested among and between other hospital departments. With this charter, top management gave the executive committee the ability to speak and act with authority within any process that negatively influenced the perioperative domain.

5.3 Integrated IS architecture

University Hospital's IS architecture was fully integrated to support data and information requests as needed for soft innovation SWOT analysis, metric identification, benchmarking data, and/or monthly improvement indicators. The clinical scheduling IS was instrumental in collecting and distributing perioperative data for analysis. As an operational data store, the data and information was quickly accessible and distributed to all interested stakeholders.

Disparate IS architecture would not have provided a holistic approach to data analysis. Data from the clinical scheduling IS held the pattern of embedded overtime for OR staff due to the mismatch between OR staff assignments and surgeon case time. Likewise, the OR scheduling methodology was modeled from historical patterns and trends. Also, the clinical scheduling IS held the online charting information which was used to pinpoint late-start cases. Each member of a team or task force could view the information, data point by data point.

5.4 Soft innovation methodology as a CAS

The soft innovation methodology also resembled a CAS, having an environment, boundary, common goals, process, input, output, feedback, and feed-forward. The executive team and each task force were separate systems that addressed issue specific problems affecting perioperative operations, patient care, and safety. Teams and task forces consisted of individuals, individuals who consistently work together in a team atmosphere. Given that no issue was off-limits, team and task force members could readily brainstorm within known comfort zones as the system environment, with limitless boundaries.

The executive team and task groups were challenged to systematically identify issues and enlist managers for solutions that would facilitate change and minimize departmental chaos. The executive charter became the common goal for each soft innovation.

If an issue was affecting perioperative operations or patient care, then an organized initiative (CAS) evaluated if the issue's analysis was conclusive. This sequence of events was the CAS that evaluated the saliency of an issue, which could yield a soft innovation.

All initiatives were data-driven and supporting data were gleaned from the existing integrated IS. Integrated IS data was the input for soft innovation. Supporting data demonstrated problem areas, strengths to highlight, and provided the direction for continual change. Conclusive data analysis was feedback to implement the soft innovation. Un-conclusive data analysis was feed-forward to the next input. Finally, each identified benchmark was a soft innovation output.

The CAS formed through each initiative used perioperative process information as input and process improvements with benchmarks as output. As each CAS's output was a soft innovation, each soft innovation's process improvement nested within the overall perioperative process, which was measurable over a given benchmark and metric.

6. Conclusions

As radical innovations disrupt organizations, integrated individuals, integrated IS, and soft innovation can influence innovation change dynamics toward stability while providing incremental process improvement. Traditionally, integrated individuals within teams or task groups do not have the organizational authority to evoke change required for soft innovations. However, high-level executive positions can transfer their authority to the integrated

team as an agent of process improvement to provide the influence needed to achieve the required process stability or equilibrium.

Lack of process data as input for soft innovation methodology would stop, stall, or limit the output of a soft innovation. Lack of feed-forward would waste time on non-conclusive initiatives. Lack of feedback would fail to identify a soft innovation. Lack of benchmarking would leave the process improvement of the soft innovation immeasurable. Too many forces in the environment will exhort too much influence and crush the soft innovation. Too tight a boundary from off-limits issues will limit the soft innovations' effectiveness. .

Integrated, accessible data is paramount to the success of data-driven soft innovation. The organizational IT function, lead by the CIO, must take stewardship for IS architecture that spans the organization, housing functional data and information used to meet organizational objectives. The IT function has to exert its limited influence toward maintaining an integrated IS architecture as an organizational directive and escalate IS development issues and their consequences to top management for arbitration. The CIO position within the organization must develop a trusted relationship with top management to succeed in this responsibility.

The organization is a political arena. With limited organizational authority, soft innovations must be championed, marketed, and/or lobbied. The soft innovation champion must educate management on the benefits of applying soft innovations as continuous process improvements. Influence with soft innovation through communication and education as organizational interaction can stimulate self-regulation and prepare top management for informed arbitration. The case study of University Hospital illustrated the continual process improvement through data-driven soft innovation.

Our case study contributed to IT literature within healthcare through investigating the impact of soft innovations from empowered and integrated healthcare knowledge workers possessing integrated information, with a prescribed a priori environment to foster their occurrence. This study was limited to a single case, where future research should broaden the focus to address this issue along with others that the authors may have inadvertently overlooked. The case examples presented in this study can serve as momentum for healthcare soft innovation comprehension and extension, while the results should be viewed as exploratory and in need of further confirmation. Researchers could choose to further or expand the investigation; while practitioners could apply the findings to minimize the disruptions of radical innovations or achieve process improvement.

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