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AN EXPLORATORY STUDY ON HUMAN, TECHNOLOGICAL AND ORGANIZATIONAL INTERACTIONS WITHIN HEALTH CARE

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Abstract - This paper examines interactions between humans, technology, and organization within health care based on a case study exploring the process and outcome of implementing an electronic error reporting system in a large health care organization. By applying a within-case triangulation of qualitative data from three studies at a regional Norwegian hospital, this paper identifies eight interactions that influence the process and outcome; of these identified interactions, six were of a negative character compared to one positive and one partly positive. In light of these results, it is evident that early awareness and the identification of interactions occurring during an organization's process of implementing a new technology or system can help target and break possible chains of negative influences as well as strengthen positive influences.

Key words: Human, technological and organizational interactions; identifying theoretical and empirical interactions; system implementation.

INTRODUCTION

Complex interactions between humans, technology, and organization characterize a health care organization (Kohn, Corrigan, & Donaldson, 1999; Gaba, 2000; Institute of Medicine, 2001). The level of complexity is apparent in the contrast between the non-standardized nature of health care work and the standard working modes required by electronic reporting and/or information systems (Berg, 2003). The complexity is also evident in the incompatibility between the traditionally applied reactive and punitive approach to deviations and errors in health care (Hudson, 2003) and the need to develop a reporting system and organizational culture that supports learning and reflection rather than punishes errors (Kaplan & Fastman, 2003). Moreover, previous studies have suggested that relations exist between the introduction of new reform processes in health care, the dominant mentality of increased efficiency among managers and employees, and the culture of silence and lack of reporting initiatives at the enterprise level (Wiig & Aase, 2007). Further chains of complexity result from those already described; for example, the absence of an individual and collective learning due to a reactive culture can be linked to new reforms and production goals shaping the everyday mentality of efficiency rather than safety among managers and employees within health care. This chain and others like it add to the impression of complexity when studying the health care organization, making it problematic to clearly isolate individual human, technological, and organizational influences on information technology and/or systems.

To address this difficulty, the current article focuses on identifying human, technological, and organizational interactions rather than individual influences by combining several theoretical perspectives on the human, technological, and organizational aspects of implementing information systems and technology. Together, these perspectives provide a selection of theoretical interactions used to identify and describe the nature of the

specific human-technology-organization interactions identified in a large health care organization and help explain the process and outcome of a particular implementation endeavor.

Two specific research objectives guide this exploration:

- understanding the particular combinations of human-technology-organization interactions that influenced *the implementation process* in the case organization (objective A), and
- understanding how these interactions can help explain *the outcome of the implementation process* (objective B).

THEORETICAL APPROACH

Literature currently available on system and technology implementation identifies theoretical interactions between humans, technology, and organization. Focusing on interactions clarifies that the human, technological, and organizational aspects of an implementation process are interrelated parts of the same outcome (degree of success or failure); in other words, instead of attempting to identify, categorize, and determine the influences of these three aspects individually, this article focused on identifying their relations. This approach is supported by both Dekker (2007) and Rochlin (1999), who argue that one should view the studied phenomenon as a product of the cultural, technological, and organizational context influencing the ideas, values, norms, and beliefs of the individuals and organization.

Human-Technology-Organization Interactions

Human factors are characterized as some of the most challenging and least understood barriers to the use of information technology and systems in health care (Institute of Medicine, 2001). More specifically, the diversity of health care personnel in addition to their variable experiences in the use of computers and applications can in itself be a barrier to the acceptance of technology. Often new technology also includes increased functionality with reduced user-friendliness and usability, adding to the already complex working environment of health care personnel (Reiman & Oedewald, 2006) and leading to health care personnel perceiving the technology as a safety obstacle rather than aid (Sittig et al., 2005). Specifically, in the case of electronic reporting technology, the combined effects of a varied user competency base and a user interface of a complex nature could result in a cultural unwillingness or even resistance to the use of a new electronic reporting system (low system acceptance). Many authors therefore suggest that efforts should be made to ensure feedback to those reporting as, some argue, feedback creates positive emotional and motivational responses (feeling of reward and meaning) among health care personnel (Sittig et al., 2005; Karsh et al., 2006). Others point out that timely feedback improves perceived local usefulness of the reporting system (Kaplan & Fastman, 2003). Feedback also travels the other way around, from users to designers and managers. In this respect, Karsh (2004) suggests making user participation in all phases of implementation a priority, specifically by including feedback from experienced clinicians, the involvement of designers in observing clinical practices (Ash et al., 2004), and the use of evaluation processes to monitor cultural reactions on technology (Berg et al., 2003). These efforts may provide important inputs into the design of a new reporting system. The significance of end-user participation in system design has also been documented in a study by Campbell and Ash (2006), in which participants demonstrated a preference for system interface over content in information technology products.

A recent study by Venkatesh et al. (2006) provides a particular interesting implementation aspect related to user perception and system use. The authors examined technology use in an organization implementing a new technology and concluded that the relationship between an individual's consciously formulated plan to perform a specific behavior (behavioral intention) and the individual's use of a particular technology (behavior) is strongest when anticipation is low and experience with technology is high. This finding implies that management plays a crucial role in the earlier aspects of the implementation process by signaling and shaping users' system expectations. Setting these expectations unrealistically high could result in perceptions of inadequacy among users, such as in a situation where the system requires lengthy reporting procedures that interfere with day-to-day work tasks (Karsh et al., 2006). Unless management clarifies these and similar challenges the organization is likely to face initially in the implementation process, this situation could escalate to the point that users avoid the system (behavior), consequently resulting in an early failure of the system.

In addition to the role of management in influencing expectations, the control of means (resources) and the decisional power (where to spend resources) to prioritize important design tasks or not suggest that management's commitment is crucial to the implementation process (Karsh, 2004). These design tasks include appointing people responsible and accountable for the project success, conducting pilot tests, responding to end-user recommendations via participation and feedback, and designing training programs that target specific user aspects

of relevance to perceived usefulness and ease of use. The degree of management resource commitment to these tasks represents an important part of the organizational response system intended to cope with the introduction and implementation of any new technology (Karsh, 2004). According to Berg (2001), a weak commitment could be a result of disregarding the mutual transformation process required when integrating a new system, which involves not only an investment in the particular electronic error reporting system, but also the use of resources to facilitate organizational change. One way of achieving this change is to create a supportive management response system incorporating the tasks described above. Such efforts will help improve users' system perceptions and, more specifically, feedback and communication among users, designers, and management during the implementation process (Karsh, 2004).

However, for management to mount a proper response system, it must gain the support of an organizational culture that values reporting initiatives. Several authors have emphasized that, in order for management to gain this cultural support, it should seek to increase motivation by giving health care groups with different backgrounds, cultures, and reporting preferences a voice of actual impact in the design and improvement of error reporting systems and reporting practices (Uribe et al., 2002; Berg et al., 2003; Ash et al., 2004; Escoto et al., 2006). Specifically, to strengthen reporting culture, Uribe et al. (2002) suggest the use of education efforts to create clear guidelines on what, where, when, and to whom to report as well as incorporate activities that increase users' perceptions of reporting importance and value, such as providing ongoing feedback and communicating reporting responsibility. Such improvement initiatives provide a counterweight to various individual, cultural, and organizational reporting barriers often discussed in literature. According to Uribe et al. (2002), one of the more significant barriers is time—in terms of the extra work involved in documenting and reporting an error. A similar finding is reported in a study by Coley et al. (2006), who identify the time barrier as the conflict between time involved in effectively identifying, verifying, and collecting information on a particular error and the inadequacy of time available and level of staffing. Thus, both time and staffing are important cultural reporting barriers. Other cultural barriers documented by Uribe et al. (2002), include resistance to report colleagues and fear of lawsuits, while unawareness of the usefulness of the report (low feedback) and what to report represent organizational barriers. These two latter barriers are clearly related to the complexity of user interface and the perception of system fit and user involvement, while the two former barriers are a product of the organizational culture favoring punishments over rewards (Kaplan & Fastman, 2003; Ash et al., 2004).

Based on the literature reviewed, this article identifies *six theoretical interactions* between humans, technology, and organization important to the successful implementation of a particular technology and/or information system:

- *Interface complexity and user knowledge base/experiences influence technology acceptance*
- *Feedback and user participation influence system design*
- *Signaled expectations influence system perceptions*
- *Management commitment and response system influence perceptions, feedback, and communication*
- *Reporting culture influences reporting guidelines, reporting responsibility, and feedback*
- *Time and staffing influence amount/frequency of error reporting.*

Relations can also occur among these six interactions, given their interrelated nature; other interactions are also possible to interpret from the literature.

CONTEXT AND METHODOLOGY

The analytical goal of the current case study is twofold: to capture the nature of interactions occurring between individuals, technology, and organization during the process of implementing an error reporting system and to determine the influence of these interactions on the implementation process and outcome. The goal requires an inductive approach of identifying patterns from details. To support this approach, this article includes a within-case triangulation design to identify both trends and details (Yin, 1994; Foss & Ellefsen, 2002). The case design allows in-depth knowledge of a complex research problem while the triangulation provides variety in data sources and thus multiple perspectives to elucidate the research problem. This triangulation approach consists of qualitative data from three separate studies: one on safety culture and reporting; one on human, technological, and organizational aspects related to error reporting practices; and one on management aspects related to the error reporting system and practices. All three studies represent different methodological angles that help understand the process and outcome of implementing an electronic error reporting system in a specific health care organization.

Case Organization

A large Norwegian health care enterprise employing 5,000 people was chosen for the case study. As in other health care organizations, errors occurring in operative procedures, medication, or other areas are handled through training, written procedures, and a system for error reporting. Traditionally, the reporting system involved primarily paper forms; a few years ago, the organization decided to test the viability of an electronic error reporting system as a possible replacement for the existing paper system. This decision resulted in a bidding round that attracted nine offers from various system providers, four of which were invited for demonstrations and further bids before the final choice of system was made. The organization then established a project group mandated to lead and manage the implementation process. Next, a trial run of the system occurred in a sample of departments; this pilot phase lasted for a total of six months, while the system adaptation was done both with regard to the project group involved and the pilot units. After the completion of the test phase, management decided to introduce the system as a common standard for error reporting throughout the health care enterprise.

The electronic error reporting system chosen by the case organization was designed to collect information on medical errors and incidents, thereby providing the basis for risk assessment with follow-up corrective and/or preventive actions. Important information collected by the system includes reporter's judgment of cause, contributing factors, and risk as well as comments regarding possible improvements. The system's functions, terminology, and structure were initially developed for the petroleum industry and later adapted to the health care sector.

DATA COLLECTION METHODS

Results and analyses in this paper are based on three studies conducted in the case organization: 1) qualitative comments from a safety culture survey (68 questionnaires); 2) a qualitative study of error reporting practices (32 interviews); and 3) a qualitative study of the electronic error reporting system (6 interviews). Study 1 is based on a validated instrument/questionnaire using 15 dimensions to measure safety culture (Nieva & Sorra, 2003; Flin et al., 2006). The questionnaire was distributed to all employees of the case organization and resulted in a response rate of 55 percent (N=1919) after follow-up activities (reminder letters, contact with leaders). The participants represent all departments and professions at the hospital. Of the 1,919 returned questionnaires, 408 contained written free-text qualitative comments based on item 17 in the questionnaire: "Please write your comments on patient safety, errors, reporting and similar." Comments on item 17 were registered in Excel and analyzed utilizing a categorization technique (Miles & Huberman, 1984; 1994) using "time, efficiency and resources" (175), "reporting system" (68), and "other/various comments" (165) as the main categories. The current paper further categorized the 68 comments on "reporting system" according to "system use," "training," "time/resources," and "user interface." The comments and quotations used in this paper derive primarily from the last categorization process and represent the 68 comments on "reporting system." Overall, Study 1 provided a number of qualitative data on the human, technological, and organizational aspects involved in the implementation of the reporting system, specifically representing the users' subsequent perceptions of the implementation process.

From the user perspective, Study 2 provided an in-depth understanding of the relationship between human, technological, and organizational aspects involved in the early implementation phases. For this study, two hospital divisions were selected based on recommendations from the management of the case organization within the two divisions. Furthermore, 4 of 16 wards were selected; the managers of each of the wards provided a list of 4 candidates for the study, resulting in a total of 32 participants made up of the following participant categories from each ward: 4 nurses, 4 senior nursing officers, 4 assistant residents, and 4 chief physicians. All candidates were asked to participate voluntarily; most accepted. Other participants volunteered on the day of the interviews to make up for the absence of selected candidates. The interviews used a structured interview guide that focused on how the departments and wards managed errors through the traditional paper-based system and the new electronic reporting system. Dimensions explored included the amount, frequency, and categorization of errors as well as the influence of human and organizational factors. All interviews were tape-recorded. Qualitative data in Study 2 were analyzed by transcribing summaries and memos with relevant quotations from all interviews performed.

Study 3 gathered information about the administration, design, and planning aspects of the system implementation from a management viewpoint to complement the user perspectives of the other two studies. A modified interview guide was created, focusing on various management aspects. A total of five managers and one system administrator—all of whom had played a central role in the implementation process—were asked to participate voluntarily; all agreed to be interviewed. A tape-recorder was used in all interviews. The qualitative data were analyzed by transcribing summaries and memos with relevant quotations from all interviews conducted.

Overall, data in study 3 provided additional insights into the human, technological, and organizational challenges of implementing the reporting system, explaining in detail many of the issues and concerns described by the users in the first two studies.

Altogether, the interviews from Study 2 and 3 and the comments available from Study 1 provide both trends and detailed information on the implementation process. In addition, the three studies were conducted in different phases of the system implementation, adding to the reliability of the results and conclusions. Study 2 represents the early implementation phase, when pilot testing took place in selected wards, while Study 1 and 3 represent the period following the actual implementation.

Methodological Considerations

This case study examined the *nature and influencing character* of interactions occurring during the process of implementing an electronic error reporting system. This research could have used quantitative methodology directed at measuring the magnitude or scope of interactions occurring during the implementation process; however, although a quantitative study provides numbers on the magnitude of interactions, it lacks the detail and depth necessary to understand the nature and influence of the interactions. In addition, given the rich data from interviews and commentaries used to determine interactions in the case study, it is also questionable to what degree a survey with predefined categories would be able to provide data to facilitate interpretations of interaction effects.

The main methodological reservation of this case study lies in the use of commentaries from Study 1. Given the large sample size and limited amount of commentaries from this study, it is possible to conclude that participants who have either major negative or positive experiences with the system will be overrepresented. However, during the analysis, the commentaries were controlled against data from Study 2 and 3 to determine interactions, thereby increasing data reliability. Another reservation concerns Study 2 and the selection of participants by the case organization, which resulted in parts of the selection process occurring outside of researchers' control and possibly influenced by any dispositions the case organization might have in regards to selecting certain interview candidates likely to shed a favorable and unrepresentative light on the implementation process and outcome. However, the researchers influenced the composition of the participant group by setting criteria related to age and profession dispersal. In addition, an examination of the data material makes it clear that negative comments were more pronounced than positive ones, suggesting that a favorable participant selection by the case organization was less likely to have occurred. Both these aspects limited the effect of possible dispositions. Furthermore, the absence of the intended participants on the days of the interviews led to the opportunity to pick participants randomly based on their expressed interest and age/profession variety. This helped further strengthen selection control.

RESULTS

First, results are presented according to human, technological, and organizational aspects of importance to the outcome of the implementation process; interactions regarding these aspects are subsequently identified and analyzed, focusing on how they contributed to the outcome of the implementation process.

Human, Technological, and Organizational Aspects

Data from Study 1 suggest that comments concerning use of the system and training often accompany views on available resources (economy) and the issue of time constraints:

“Training in the use of the reporting system began far too late. Because of this, almost no errors have been reported in our department during the last six months” (nurse).

“The reporting system seems ok, but there have been many technically and personally associated problems. The system was initiated too soon and training for employees and managers wasn't good enough” (senior nursing officer).

“If one is to achieve a reporting system of good quality, it is necessary to use resources on training. That one single person is offered a one day education—as a ‘super user’—and then is supposed to train all the remaining basic users in his/her respective department, is simply not good enough” (senior nursing officer).

“The reporting process should have been made easier. We do not have sufficient time to spend on complicated reporting procedures in an otherwise busy working day” (radiograph).

These comments suggest that a combination of several related factors influence users. First, participants expressed the need for resources and training to avoid the sole reliance on super users. More specifically, these super users, who simultaneously perform all their normal work tasks, are not capable of handling the education of the entire work force on their own. Second, participants commented on the need for a user interface design that makes the process of registering errors faster and more accessible. Too much time is spent understanding or “thinking like” the system. In addition, comments from the questionnaires in Study 1 suggested weak feedback on reported errors:

“The reporting system doesn’t work. I have never received feedback on my error reports” (nurse)

“No improvements are made, despite our error reporting. Feedback on reporting is weak. You often get a negative reaction from the managers when reporting” (nurse).

“Little feedback and training is given to me concerning other errors occurring in our organization” (nurse).

The results of Study 2 support several of the comments made above. For example, on the issue of time constraints, a clear majority of nurses and physicians spoke of how more time and less work pressure (stress) would increase reporting initiatives. Both groups stated that more time would influence when and how often one decided to report. Also of concern to reporting frequency was nurses’ expressed desire to report seemed to be counteracted by the many descriptions among both physicians and nurses of defensive collegial mechanisms (to protect one another), the fear of negative reactions (social unease), time constraints, and the impression of low feedback on reported incidents. Furthermore, several participants explained that organizational management on the one hand encouraged and welcomed error reporting and suggestions on improvements, but on the other hand focused actual everyday priorities on production and cost-efficiency in terms of increasing the number of patients passing through the system. It is reasonable to assume that this contradiction may have led to a reduction in time spent on reporting, a conclusion supported by an overall impression of widespread underreporting in the case organization. The focus on efficiency and production also seems to have affected the level of staffing, as expressed by a senior nursing officer and chief physician respectively: *“We are encouraged to save on temporary replacements, particularly during the weekends and holidays...we run a minimum staffing then”* and *“There is always inadequate staffing.”* Of further concern, both physicians and nurses considered the lack of follow-up on error reports and the limited change initiatives based on these reports as a weakness of the error reporting system. A specific technological aspect of the reporting system was also addressed by a nurse who pointed out the incongruity between the system terminology and health care terminology.

Study 3 elaborates on many of the concerns expressed in Study 1 and 2 from management and administration’s perspectives. According to several participants, the new error reporting system was introduced to health care personnel via super users who first attended a specific training course offered by the system provider and were subsequently expected to train the remaining personnel in their respective departments. This strategy was chosen due to the limited capacity of the staff intended to handle the enterprise-spanning support function of the program. One participant in Study 3 specifically questioned both the lack of cause-and-effect analyses and the competency of the organization and system provider. Particularly worrisome to this participant was the lack of attention directed at the transition from a petroleum-based reporting system to a large and complex health care enterprise, especially as it became the task of the organization rather than the system provider to sort out the illogical relationships within the system’s dialog boxes as well as clarify ambiguities in the system provider’s use of language and terminology. Another participant in Study 3 questioned the inclusion of a risk assessment in the reporting process itself, stating that this mentally complicates the process of reporting when, in fact, the ideal should be to make the process as accessible and user-friendly as possible. Participants also referred to an uncertainty in how much trust they could place in the “unqualified” risk evaluations of health care personnel. Furthermore, concerns were raised by several participants regarding the degree of power and dominance associated with the project group leader considering this person’s limited knowledge of the system. This issue resulted in a biased focus of the implementation process, thereby limiting input from other project members during the implementation process. One participant went so far as to question the competency of the entire project group since most members lacked the necessary understanding of the system.

In addition to the difficulties associated with the resources and design of the new system, one manager in Study 3 exemplified the more lurking impacts of the new system on established organizational routines. During the implementation process, a procedural change occurred; the existing practice of passing on reports of serious patient injuries from the respective head department managers, via the department of health, environment, and safety, to the Chief County Medical Officer changed into a new practice of passing these reports directly from head division managers to the Chief County Medical Officer. Since the design of the new error reporting system

was adjusted to the initial practice, reports continued to flow to the department of health, environment, and safety even after the procedural change. Consequently, reports on serious patient injuries ended up unaddressed at this department instead of being forwarded to the Chief County Medical Officer. Only recently has this situation been sorted out, and only after a complaint from the office of the Chief County Medical Officer. In other words, the combination of a particular procedural change and the automatic mailing function of the new reporting system, initially intended to aid in the processing of serious patient injuries, instead created a long-lasting “reporting standstill” in the organization.

Study 3 also highlighted positive aspects. Participants referred to a help function developed after the system implementation; the function was intended to facilitate updates and encourage repetition of knowledge among health care employees. Meetings with managers and employees were also held shortly after the implementation, accompanied by brochures informing health care personnel of both the intentions and the goals behind the new reporting system. In addition, participants described how the implementation process was characterized by a sincere belief in the system, an honest effort by many members of the support staff, few technical difficulties in the pilot phase, and a healthy maturity process after the first three months of the system test run. However, participants criticized managers in the organization and the time these managers made available to support the system: *“The managers were preoccupied with other economical challenges.”* This hampered the handling of error reports at the divisional level.

Several participants in Study 3 referred to high expectations in the abilities of the new reporting system to improve the quality of the existing safety work as the main motivational force for changing current practices. Another motivator was the desire to transform current practice into a leading “best practice” position among competing health care organizations. The choice of system was made based on a comparison of various system alternatives, weighted mainly based on criteria of high user-friendliness and overall completeness of software solution. The proximity of the different system providers to the organization (support-wise) also played an important role in the selection process according to one participant. Despite the high expectations, the strong intentions, and the preliminary work done in choosing the system, only a *limited* amount of resources were made available to a *small* project group responsible for the implementation process and follow-up tasks. The responsibility could be described as “left-hand work” according to one participant, who also described how the limits set on the available resources became even clearer during the transfer phase, when the close system provider-enterprise relationship changed into primarily an enterprise responsibility. In this process, several key individuals left the project group. At this point, it was also decided that only one part-time position for user support would remain.

As a result of the various changes and circumstances outlined, one participant in Study 3 spoke of the contrast between the promising introduction of the system and the realities the organization faced after the implementation process:

“The introduction was fancy: here you have the system. Then the persons responsible left, resulting in a lack of continuity in training and support. This is still a problem. In other words, one cannot simply throw an electronic error reporting system into an organization, without further consideration. I haven’t seen any training at all” (manager).

This manager perceived the lack of staffing and resources as a result of a weak implementation strategy. Specifically, the organization underestimated the challenge of converting from a paper-based system to electronic error reporting. Another participant described the implementation process in this way:

“The implementation of the reporting system was poorly prepared. The project group should have included more individuals to facilitate a system that on paper looks very promising. Instead, and as a result of other demands in the organization, the new reporting system has become faulty and difficult to change. Also, few resources were used to administrate the system” (manager).

The manager also commented on how the work with the system was colored by a certain degree of naivety in that people did not fully foresee the wide stretching implications of the system. For example, the participant described how the feedback from managers suggested that the process of handling error reports in the new system was difficult and time consuming. Participants explained this “handling difficulty” as a lack of safety knowledge and system understanding among responsible managers.

Another manager in Study 3 was particularly aware of how several cumulative factors could help explain the difficulties faced by the organization:

The low feedback from responsible persons (project group/support staff)

- The loss of several key individuals from the project group/support staff
- The employment of staff in lack of necessary knowledge of the health care organization
- The weak organizing of selected staff and time spent on the implementation process
- The weak involvement of the organization as a whole.

In a far more positive turn, this participant also spoke of how the organization recently hired new staff personnel with knowledge of both the technology in question and the specific needs and requirements of a health care organization. In addition, the organization has begun a process of exploring and analyzing what went wrong in the implementation process and how the current situation can be remedied.

Human-Technology-Organization Interactions

By applying the theoretical interactions identified earlier in this paper, the results from the three studies of the case organization and implementation process provide *eight empirical interactions* that closely correspond to the theoretical interactions, as evident from Table 1. Specifically, Table 1 illustrates the empirical interactions that were identified in the case organization (column 2) based on the mapped theoretical interactions (column 1). The table also shows how the empirical interactions influenced the implementation process and outcome, categorized as positive/negative influences (column 3).

TABLE 1 Nature of interactions and their influencing character

Interactions identified in the literature	Interactions identified in the case organization	Influence on process and outcome
Interface complexity and user knowledge base/experiences influence technology acceptance (Sittig et al., 2005; Reiman & Oedewald, 2006)	The complex user interface; inadequate system competency of provider, administrators, and management; and insufficient user training and system knowledge resulted in low technology acceptance (<i>Based on all three studies</i>)	<i>Negative</i>
Feedback and participation from users influence system design (Berg et al., 2003; Ash et al., 2004; Karsh, 2004; Campbell & Ash, 2006)	A low degree of feedback and user participation resulted in few improvements/changes in system design (<i>Based on all three studies</i>)	<i>Negative</i>
Signaled expectations influence system perceptions (Venkatesh et al., 2006)	Early raised and later unfulfilled system expectations resulted in initial positive impressions and subsequent negative system perceptions respectively (<i>Based on Study 3</i>)	<i>Positive & Negative</i>
	Several management aspects, including the choice of resources/project group size, the focus on efficiency and minimum staffing, and the inadequate system competency of administrators and managers, resulted in negative perceptions of the implementation process (<i>Based on all three studies</i>)	<i>Negative</i>
	The considerations involved in choosing the system and the early efforts by management and administrators resulted in initial positive system perceptions (<i>Based on Study 3</i>)	<i>Positive</i>
Management commitment and response system influence perceptions, feedback, and communication (Berg, 2001; Karsh, 2004)	A dysfunctional response system and weak management commitment resulted in low feedback, weak communication, and unfavorable system perceptions (<i>Based on all three studies</i>)	<i>Negative</i>
Reporting culture influences reporting guidelines, reporting responsibility, and feedback (Uribe et al., 2002; Berg et al., 2003, Ash et al., 2004; Escoto et al., 2006)	A dysfunctional reporting culture resulted in unclear reporting guidelines (lack of training), an absent reporting responsibility, and little feedback (<i>Based on all three studies</i>)	<i>Negative</i>
Time and staffing influence amount/frequency of error reporting (Uribe et al., 2002; Coley et al., 2006)	Insufficient time and staffing resulted in low frequency of error reporting (<i>Based on all three studies</i>)	<i>Negative</i>

Each empirical interaction from the overview in Table 1 will be elaborated upon below, with specific references to the three studies conducted in the case organization.

Interaction 1 - *The barriers to technology acceptance*

The complex user interface; inadequate system competency of provider, administrators, and management; and insufficient user training and system knowledge resulted in low technology acceptance (the system is perceived as a reporting obstacle/barrier).

Participants in Study 1 described the user interface of the new reporting system as complicated and time consuming. Participants in Study 2 supported this picture and voiced concern with the low familiarity of the system terminology, while participants in Study 3 believed that the inclusion of risk assessment complicates the reporting process. Based on these descriptions, the work of removing inconsistencies in the system dialog boxes and clarifying ambiguities in system terminology seems to have failed, suggesting a lack of competency among the system provider, system administrators, and managers concerning design choices. This conclusion is supported by the limited focus on the implications of transferring a system from one unique sector to another. Finally, participants in Study 1 and 3 perceived the lack of training in the use of the system and the missing continuity in this training, respectively, as reporting barriers.

Interaction 2 – *The dependency between user involvement and system improvements*

A low degree of feedback and user participation resulted in few improvements/changes in system design.

Several concerns were raised in Study 1 regarding a lack of personal feedback on errors reported; participants attributed this weakness to a dysfunctional system and the absence of system improvements/changes. The impression of low feedback from responsible personnel was supported by participants in Study 2 as well as a manager in Study 3. Furthermore, in Study 2, perceptions of little follow-up and few changes occurring as a result of reported errors indicated insufficient communication and/or feedback on how reported errors are being used as well as how the system contributes to the state of the current reporting practices (motivational aspects that influence perceptions). Finally, one manager in Study 3 characterized the involvement of the entire organization throughout the implementation process as weak.

Interaction 3 – *The connection between system expectations and system impressions*

Early raised and later unfulfilled system expectations resulted in initial positive impressions and subsequent negative system perceptions respectively.

Several participants in Study 3 spoke positively of about the project groups' early interest in using the new reporting system to improve the quality of current safety practices and the philosophy of making the system an example of a leading safety practice. Participants in Study 3 described how these expectations created an initial excitement around the new system, fueled by an interest in using the system to transform current reporting practices into a leading "best practice." According to the managers in Study 3, these expectations were also present during the pilot phase, motivating efforts and the belief in the new system. However, further into the implementation process, these impressions seem to have changed character, judging by the low feedback, insufficient training/resources, and complexity of the user interface criticized by participants in all three studies. The unfulfilled early expectations could explain this change in attitude and perception.

Interaction 4 – *Management's negative influences on system perceptions*

Several management aspects, including the choice of resources/project group size, the focus on efficiency and minimum staffing, and the inadequate system competency of administrators and managers, resulted in negative perceptions of the implementation process.

According to many participants in Study 3, a number of management aspects added to the unfavorable system perception described in the third interaction, including the small project group and the limited resources made available to the group, the responsible managers' lack of necessary system understanding, the reliance on super users due to insufficient system staff and resources available for training programs, the uneven influence of the project group members, and the focus on economical priorities by managers locally. The insufficiency of resources used to train personnel was also described in Study 1, while a lack of system knowledge among administrators and managers can be seen in the reporting standstill that occurred as a result of the procedural change described in Study 3. In addition, the focus on increased efficiency and minimum staffing relates both to the available time used in error reporting and to the priority given to reporting (frequency/amount) according to

participants in Study 2. Finally, a manager in Study 3 suggested that the lack of staffing and resources can be attributed to weaknesses in the overall implementation strategy. The impression of strategy weaknesses was supported by Study 3, explaining how the process in which responsibility changed hands from provider to enterprise was closely followed by several key individuals leaving the project group and by the decision that only one part-time position should be kept open to manage the system.

Interaction 5 – Management’s positive influences on system perceptions

The considerations involved in choosing the system and the early efforts by management and administrators resulted in initial positive system perceptions.

Based on the descriptions provided in Study 3, initial efforts to choose the system, appoint a project group, and conduct a pilot project to test the system suggest that the preliminary and early implementation phase was executed satisfactorily. The successful execution of the system acquirement and testing phase can explain the organization’s early positive system expectations as well as the system staff/project group’s motivation and efforts.

Interaction 6 – The implications of weaknesses in management and response system

A dysfunctional response system and weak management commitment resulted in low feedback, weak communication, and unfavorable system perceptions.

The users’ perceptions of reporting barriers due to weaknesses related to feedback and communication (interaction 2) indicated an insufficient response system characterized by few resources spent on running the system (small project/support group) and a focus on economical priorities (interaction 4). In addition, Study 3 explained how one person was allowed to overshadow input and contributions from the rest of the project group, implying that the priorities of one person rather than a balanced project group dictated the work on the reporting system, thereby adding to the explanation of missing feedback.

Interaction 7 – The implications of a dysfunctional reporting culture

A dysfunctional reporting culture resulted in unclear reporting guidelines (lack of training), an absent reporting responsibility, and little feedback.

The results from the three studies—describing a lack of resources, time, training, and feedback during the implementation process—suggest that managers’ limited efforts went into prioritizing the reporting system and making explicit the individual responsibility of each health care worker in the organization. Instead, participants in Study 1 and 2 spoke of how efficiency dictated the everyday responsibility of health care workers during the earlier as well as later phases of the implementation process. The combination of these factors, spanning from the availability of time and resources to the low feedback and strong focus on efficiency, explain why participants described their reporting culture as characterized by a lack of reporting (Study 1), few reporting initiatives (Study 2), and reporting standstill (Study 3).

Interaction 8 – The effect of resources and time on reporting practices

Insufficient time and staffing resulted in low frequency of error reporting.

The lack of available time and resources was a concern expressed by participants in all the three studies, but most strongly observed in Study 1, where time combined with system complexity was said to affect the priority of reporting. Similarly, participants in Study 2 described how time affects when and how often errors are reported; according to them, time used on reporting also relates to constraints imposed by increased efficiency and minimum staffing. Finally, a system manager in Study 3 described how the managers in the organization found the process of electronic reporting difficult and time consuming, implying that the system counteracted reporting initiatives.

CONCLUSION

Two research objectives guided this paper: understanding which particular combinations of interactions influenced the implementation process in the case organization (research objective A) and how these interactions could help explain the outcome of the implementation process (research objective B). Based on a set of theoretical interactions, this article has been able to identify and describe the nature and influence of eight particular interactions of the implementation process and outcome (satisfying objective A). Of these eight empirical interactions, six had a negative influencing character that affected the implementation process unfavorably,

compared to only one positive (interaction 5) and one partly positive interaction (interaction 3), as illustrated in Table 1. This imbalance in influences contributed to an overall negative outcome of the implementation process (satisfying objective B).

The intention in writing this paper has been to strengthen the awareness of how different combinations of human, technological, and organizational aspects and interactions can affect the direction and outcome of an implementation process. Such awareness needs to be accounted for by system providers, administrators, managers, and health care personnel during all phases of the implementation process. Specifically, in this case organization, a combination of several negative interactions led to an overall unfavorable outcome; this particular outcome suggests the general importance of targeting and intervening in one or more of the interaction aspects—preferably early in the implementation process—to break possible chains of negative influence as well as assist in strengthening the positive chains and influences.

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