Prioritizing Clinical Information System Project Risk Factors: A Delphi Study

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Abstract

Identifying the risks associated with the implementation of clinical information systems (CIS) in health care organizations can be a major challenge for managers, clinicians, and IT specialists, as there are numerous ways in which they can be described and categorized. Risks vary in nature, severity, and consequence, so it is important that those considered to be high-level risks be identified, understood, and managed. This study addresses this issue by first reviewing the extant literature on IT/CIS project risks, and second conducting a Delphi survey among 21 experts highly involved in CIS projects in Canada. In addition to providing a comprehensive list of risk factors and their relative importance, this study is helpful in unifying the literature on IT implementation and health informatics. Our risk factor-oriented research actually confirmed many of the factors found to be important in both these streams.

1. Introduction

Most industrialized countries have undertaken major reforms of their health care systems during the last few years. These reforms have attempted to strengthen the primary health care sector and favour the emergence of integrated health care networks as a new model of care organization [1, 2]. In this new environment, the deployment of clinical information systems (CIS) such as electronic patient record (EPR) systems, picture archiving and communication systems (PACS), telemedicine applications, and computerized physician order entry (CPOE) systems has become one of the critical benchmarks for achieving several health care reform priorities. The goals of CIS include raising productivity levels among clinicians, integrating the care process, and improving the quality of services provided to patients by transferring routine, manual tasks currently performed by health professionals to software solutions. Achieving these benefits has, however, been difficult in practice, and it is not surprising that many initiatives in this area still fail [2-4]. For instance, a study by Kaplan [5] reported a failure rate of about 50% among CIS implementations in health care organizations in the United States. This appears to be a widespread trend affecting many industrialized countries [6-7].

Many experts attribute these problems to a variety of factors such as the quality of project management, rather than the technology itself. In fact, currently available technologies have functionalities that provide excellent solutions, but the health care industry appears to have difficulty finding satisfactory solutions in today's environment of health care production [2].

Though the IT implementation literature provides several checklists of risk factors, we still have a poor understanding of typical CIS risk factors. As described in the following section, we found only three empirical studies in the specialized literature on medical informatics that examined this issue. Given the importance of identifying the individual risk factors associated with CIS projects, and in order to improve success rates in this type of project, it is first necessary to create a foundation for theory-building on CIS project risk management. This article addresses this issue by first reviewing the existing literature on risks involved in IT projects, and second conducting a Delphi survey among 21 experts highly involved in CIS projects in Quebec, Canada. The Delphi study aims at answering the following two research questions that are essential for developing a more comprehensive and controlled approach to CIS project risk management: 1) What are the typical risk factors faced by CIS project managers? 2) What is the relative importance of these risk factors according to experienced and knowledgeable CIS project managers?

2. Literature Review

Identifying the risks associated with a CIS implementation can be a major challenge for managers, clinicians and IT specialists, as there are numerous ways in which these risks can be described and categorized [2]. Risks vary in nature, severity and consequence. What's more, it is important to identify, understand and manage high-level risks. Unfortunately, the extant literature on the subject has little to offer in the way of models that would structure the risk factors in an integrated whole and provide a theory of managerial action. We believe that the managers and clinicians involved in this type of project would be better supported if they had a comprehensive list of risk factors, which they could monitor over time and mitigate accordingly.

In order to arrive at such a unifying framework, we examined and integrated risk factors identified in four recent studies that addressed this issue: one in the area of IT implementation and three in the broader field of health informatics. Table 1 presents a taxonomy encompassing the vast number of risk factors that have been identified in these studies, and classifies them under different dimensions so as to organize them in a meaningful way.

Before presenting our initial taxonomy, we should first clarify what we mean by "risk factor." We define risk factors as *contextual issues* that can influence the probability that an undesirable result will occur. Examples of undesirable results include not meeting deadlines, a system not being adopted by its targeted users, or not achieving the expected benefits. It is also important that risk factors not be confused with what might be termed mismanagement. According to our definition, risk factors should first and foremost be considered those contextual issues upon which managers can act or intervene, to varying degrees, by applying a series of tactics (e.g., by having future users help identify information requirements and by managing relationships with external partners). Not being able to use these tactics or not applying them in an optimal manner does not in itself represent a risk factor (e.g., not managing change well, underestimating user acceptance, or failing to secure user commitment). Nevertheless, we freely acknowledge that these phenomena may indicate *poor risk management* in any given project.

The first study on which we based our initial taxonomy comes from the field of information systems. Schmidt et al. [8] used a systematic and rigorous procedure to identify the risks involved in software projects. They developed an authoritative list of risk factors to serve as the basis for further study and theory development. Their list of factors, which is one of the most exhaustive and rigorous published in this area, was derived from the input of a multicultural group of 41 experienced IT project managers.

The other studies used to develop our taxonomy are those that attempted to apply knowledge acquired specifically in the area of information systems for medical informatics. First, Chiang and Starren [9] proposed a conceptual framework for understanding the risk factors associated with small electronic medical record (EMR) projects. Based on their assessment of a delayed EMR project in a small specialty practice, they found that outcomes were mainly determined by the lack of a project champion, changes to membership on project teams, and failure to understand project requirements. Second, Brender et al. [10] conducted a Delphi study with 19 participants at the European Federation for Medical Informatics (EFMI) 2004 Conference in order to identify success and failure criteria for CIS projects. A total of 27 *failure criteria* were identified by the panel of academics, out of which the most significant were poor response time, misalignment of the system and the organization, and project structure and/or work procedures. Finally, Sicotte et al. [2] proposed a risk framework to examine obstacles to successful implementation of interorganizational CIS. To test the applicability of the model, they conducted a longitudinal multiple-case study of two large-scale projects. Variations in risk factor measures assessed throughout both projects were analyzed in order to determine their impact on project success. Their analysis showed that the proposed framework was very robust, and suitable for conducting a thorough risk analysis of this particular type of system.

3. Conceptual Framework

The primary objective behind this initial classification, which represents an extension of the taxonomy developed by Sicotte et al. [2], was to structure the reader's thoughts on the subject. Overall, seven risk dimensions have been identified in relation to IT projects: technological risk, human risk, usability risk, project team risk, project risk, organizational risk, and strategic/political risk. According to the initial taxonomy presented in Table 1, the success of a CIS project lies in the ability to identify the risk factors that a given CIS project faces at various points in time, in order to develop the appropriate palliative strategies that could reduce them, and ultimately improve chances of success. In the following sections, we will briefly present each of these risk dimensions.

Technological Risk: Hardware and software complexity has long been considered a critical IT project risk factor [11-12]. In the health care sector, the recent availability of computer-based patient record software has exacerbated this risk factor [13]. Software complexity also refers to the interdependence of the new application with the organization's existing information systems. This risk factor is further increased when a network infrastructure is required, representing an additional layer of technological risk. Indeed, in the context of regional health information networks, the presence of varied and more or less compatible hardware and software systems specific to the participating organizations introduces additional problems of systems integration and adequate processing speed and security [14-15]. Overall, technological complexity makes it more difficult to estimate the resources required, exposing the project to feasibility, budget, and scheduling risks.

Table 1. Initial Taxonomy of CIS Project Risks

Risk Dimensions	Risk Factors	[8]	[9]	[10]	[2]
Technological	Introduction of a new technology	√			
	Complex/unreliable technical infrastructure or network Complex software solution	√	√	 √	√ √
	Complex/incompatible hardware				√
	Poor software performance			√	
Human	Unrealistic expectations	√	√	√	√
	Overall resistance to change	√		√	√
	Lack of cooperation/commitment from users	√	√	√	
	Lack of computer skills and knowledge among users	√			√
	Prior negative experiences with CIS projects				√
Usability	Poor perceived system ease of use				√
	Poor perceived system usefulness			√	√
	Misalignment of CIS with local practices and processes			√	√
Project team	Changes to membership on the project team	√	√		
	Lack of project leadership	√			
	Lack of required knowledge or skills	√	√	√	√
	Lack of clear role definitions	√			
Project	Large and complex project	√			
	Scope creep	√		√	
	Changes to requirements	√			
	Insufficient resources	√		√	√
	Lack of a project champion		√		
	Lack of a formal project management methodology	√		√	
Organizational	Lack of support from upper management	√			√
	Organizational instability	√		√	
	Lack of local personnel knowledgeable in IT				√
Strategic / political	Misalignment of partners' objectives and stakes		√		√
	Political games/conflicts	√	√		√
	Unreliable external partners	√		√	√

Human Risk: Resistance to change is a phenomenon that is so pervasive and widely recognized that it scarcely requires documentation [16]. Previous research has revealed that major concerns include users' openness to change, their attitudes toward the new system and their expectations [e.g., 17-18]. From this perspective, organizational history or memory of previous technological initiatives may affect the way a new technology is framed and hence have an influence on the success of an implementation. Also, previous IT research has underscored the importance of users' computer skills and knowledge [8]. Physicians have long been accused of reluctance to use computer-based information systems, and several studies have produced evidence of computer resistance among physicians [e.g., 19-20]. Therefore, it should be recognized that physicians and other health professionals strongly influence CIS implementation risks, particularly when one takes into account the high level of responsibility and autonomy enjoyed by these professionals in their practices.

Usability Risk: Perceived system usefulness represents one of the most studied constructs in the IT literature. This risk factor is particularly important in the case of critical organizational activities such as clinical care. In this context, the validity and pertinence of information should be paramount, as well as factors such as system downtime and display speed [21-22]. Similarly, another important factor identified in the literature is the extent to which the new system is perceived to be user-friendly. The complexity of interface development remains a barrier to widespread dissemination of computer-based patient records [23]. Furthermore, substantial investments in IT have delivered disappointing results, largely because organizations tend to use technology to just mechanize old ways of conducting their business [24]. Simply laying technology on top of existing work processes trivializes its potential. To ensure that the technology is used effectively, system deployment must become synonymous with organizational redesign. The implementation of a CIS carries certain risks in this area, especially if it interferes with traditional practice routines [2, 25].

Project Team Risk: Staff volatility represents a major risk factor associated with the project team [2, 11]. At some point in a CIS project, losing the project champion, the project leader or any other key actor may impede project success [e.g., 2]. CIS projects might also fail when project teams are formed but the project manager does not have the skills or the power needed to succeed. The lack of required skills and poor role definitions for project personnel also represent major barriers to CIS project success [11, 25].

Project Risk: The IT literature has long recognized project size as a major risk factor. Project size refers to the number of people affected by the introduction of a new technology and the number of departments or organizations concerned by the new system. Greater project complexity exacerbates coordination challenges and exposes the development process to unpredictable coordination failure. Regardless of project size, in an ideal situation, all of the necessary resources should be available as required. These resources include not only financing but also people and equipment. Scope creep refers to situations where the scope of the new CIS is not thoroughly defined before the project's start, and where the real work effort, skill set and technology required to complete the project are not clearly understood [8]. Changing requirements can also raise the risk of exceeding budget and schedule constraints. The presence of a local champion with enough credibility and power to lead the change effort and encourage the group to work together as a team is an important factor that strongly influences project outcomes, especially in complex organizations such as health care organizations. Finally, a "one-methodology-fits-all" mentality can lead to uninformed choices that can raise project risk level. It is not the chosen development methodology *per se* that drives project risk, but how well the selected methodology fits a given project [27].

Organizational Risk: From an organizational perspective, support from upper management represents a meaningful factor that can also mitigate CIS project risk [28]. In fact, few nostrums have been prescribed so religiously for the development and implementation of IT as support from upper management. Sustained involvement by executive managers is critical for the change to take on a life of its own and in order to maintain high project visibility throughout the organization and across the entire implementation phase [29]. Another issue concerns organizational instability. In contrast to the previous factor, this issue represents a largely unexplored area in the IT/health informatics domains. Associated with this factor are changes in senior management that may lead to a mismatch between organizational needs and project objectives. Lastly, these projects may also be hampered by a lack of local IT personnel to support end users after a "go live."

Strategic/Political Risk: The implementation of a CIS may pose numerous strategic difficulties. The collaboration of several groups of professionals and organizations is essential in a context of extensive organizational change and where the demands on human and financial resources are great. Political factors arising from conflicting individual/organizational interests and objectives will tend to impede the implementation process [16]. In this context, the degree of participation and the adherence of each participating actor or partner are influenced by the value they associate with the collective project due to their own objectives. A strategic stance is needed if the project is to pursue common objectives [2]. This is particularly true when antagonism or conflicts easily arise between parties as a result of misunderstandings, unanticipated changes in the scope of the project, missed or delayed delivery dates, or other disputes that may polarize partners into opposing camps [12]. Finally, the selection of external partners represents an important strategic decision. This selection must be made with due consideration of several criteria, including financial strength, relevant experience, prior successful implementations, the quality of service that can be provided after implementation, and the general reputation of each potential partner.

In conclusion, Table 1 presents risk factors that have been proposed in the literature, and which are most often linked to the "worst" CIS implementation scenarios. It is important to note that this preliminary list only represents an illustration of the risk factors that have been identified in the literature in relation to IT/CIS projects. This list however will not be part of the theory building process adopted in this study through the Delphi survey. It will only be used as a framework when comparing the findings of the survey with the existing literature on this topic in the IS and health informatics fields.

4. Methodology

The overall objective of this study is to build an authoritative list of CIS implementation risk factors and determine the relative importance of these risk factors. To ensure a reliable and validated data collection process, we opened our inquiry to divergent opinions and sought feedback-based convergence and closure on the factors that truly count in CIS implementation projects. We therefore chose a ranking-type Delphi survey [30] as the research method for this study, in which the opinions of a panel of experts are elicited through iterative, controlled feedback.

We first recruited the members of the panel from experienced CIS project managers in Québec, Canada. Over the last seven years, the Canadian and Quebec governments have invested heavily in health care technology projects. More specifically, investments in the order of CAN$1.5 billion have been made to achieve three main types of contributions: 1) the computerization of intra-institutional clinical processes (e.g., pharmacy, laboratories, radiology, and electronic patient records); 2) the deployment of telehealth projects; and 3) the establishment of integrated care networks or continuums. Despite these major investments, the benefits associated with IT deployment have not been easy to attain in Québec health institutions. Indeed, many CIS project failures in Québec have been discussed in the scientific press in the past 10 years [e.g., 2, 20, 31-32]. Over the years, however, an understanding has developed in the Québec health network that quality of project management plays a critical role in a successful implementation. Table 2 presents the demographic profile of the 21 participants, which reveals a diverse and rich background in the area of CIS project management.

Table 2. Profile of the Delphi Participants (n=21)

		n	%
Gender	Male	14	67%
	Female	7	33%
Age	30-39	5	24%
	40-49	7	33%
	50-59	9	43%
Highest education degree	Bachelors	3	14%
	Post-graduate diploma	3	14%
	M.S. / M.B.A.	9	43%
	Ph.D. or equivalent	6	29%
Background	Administration	7	33%
	Clinical	8	38%
	Information technology	6	29%
		Average	**Median**
Number of years of experience in the health care industry		23	15
Number of major CIS projects the panellist has managed		12	6

Following Schmidt et al. [8], our Delphi survey process was divided into three phases. In the first phase, a brainstorming round was conducted to elicit as many risk factors as possible from the panel of experts. Each panellist was asked to provide short descriptions of the factors in order to aid the researchers in the data analysis. Two of the authors worked independently, collating the responses; then the two independently constructed lists were compared and reconciled by all four authors working together. As explained in the following section, it was possible to associate almost all the factors identified in this stage with those of our initial taxonomy in Table 1.

In the second phase, the combined list was circulated to all panellists for corrections, additions, and, eventually, validation. We provided them with a list of definitions for each risk factor that would guide their response. We also sought to narrow the initial list of factors so that they could be meaningfully ranked by each expert. To this end, the panellists were asked to rate the factors according to their relative importance to the successful completion of a CIS project. We used a 7-point Likert scale (1 = relatively insignificant factor, 7 = a very significant factor). Only factors with a mean of over 3.5 were selected for the following phase. All 21 experts participated in the second phase.

In the third and final phase, our experts ranked the selected risk factors in order of priority – that is, the top-ranked factor would be the factor most deserving of a project manager's attention. Following Schmidt [30], we measured the degree of consensus among the panellists using the Kendall rank correlation coefficient (W). The rounds of ranking stopped when the correlation coefficient indicated a strong consensus. Two ranking rounds were conducted before the panel reached an acceptable level of agreement. To facilitate the ranking process, in the second round the factors were listed in order of average ranks received. Twenty participants ranked the risk factors in the first round, and 19 experts completed the second round. Given that the study's three phases were conducted over an approximate three-month period, the response rate obtained was very good.

5. Results

5.1 Initial List of CIS Risk Factors

In the first stage, the experts provided a list of 20 responses (on average). The number of factors presented by each respondent ranged between 5 and 55, out of which many overlapped or referred to the same risk. The responses that were obtained were a mix of risk *items* and risk *factors*. We believe that it is important to separate these two concepts, since a single risk factor may comprise several items. For instance, the items "use of a technology that has not been used in prior projects," "bleeding edge technology in the market" and "deployment of an immature software," proposed by our group of experts, were grouped under a single risk factor called "Introduction of a new technology."

A second observation was that approximately 15% of the responses represented mismanagement rather than risk factors *per se*. Examples of mismanagement include: "underestimating the complexity of the required technological infrastructure," "failure to involve targeted users in the process," and "no formal reengineering efforts." As a result, we did not retain these responses, since they do not satisfy the definition of a risk factor presented above.

Once duplicates were eliminated, similar items were grouped under a single factor, and issues related to mismanagement were removed, we were able to derive an initial list of CIS risk factors produced through the Delphi survey. For consistency and clarity, we organized this list according to the seven dimensions that were presented in the initial risk taxonomy (see Table 3). Participants noted that this first consolidated list was a good representation of their ideas. Compared to the taxonomy derived from the literature (Table 1), the expert panel provided two additional risk factors. The first was related to the attitude of team members (i.e., when a team is not very committed to the project and not motivated to meet the project's objectives). The respondents underscored the fact that a project can be compromised not only by the users' attitudes but also by attitudes in the development team. The second factor concerned changes in the environment. Since Canada has a public health system, system development must take legal and ethical constraints into consideration, including limits on the sharing of clinical data between institutions and patient consent requirements, so a change in regulations can affect CIS projects.

It is important to note that 8 out of the 29 factors in the initial list (based on the literature) were not identified by the expert panel as relevant risk factors in the case of CIS projects (see Table 3). Three of these factors involve the human dimension (overall resistance to change, lack of cooperation/commitment from users, and prior negative experiences with CIS projects), two are related to the project team (poor project leadership and lack of clear role definitions), two are associated with the project dimension (changes to requirements and lack of a formal project management methodology), and one factor concerns the strategic/political dimension (misalignment of actors' and partners' objectives and stakes). Future qualitative research could explore *why* these factors do not seem to influence CIS success.

Table 3. Revised Taxonomy of CIS Project Risks Based on Delphi

Risk Dimensions	Risk Factors	Literature Review	Current Delphi
Technological	Introduction of a new technology	√	√
	Complex/unreliable technical infrastructure or network	√	√
	Complex software solution	√	√
	Complex/incompatible hardware	√	√
	Poor software performance	√	√
Human/User	Unrealistic expectations	√	√
	Overall resistance to change	√	
	Lack of cooperation/commitment from users	√	
	Poor computer skills	√	√
	Prior negative experiences with CIS projects	√	
Usability	Poor perceived system ease of use	√	√
	Poor perceived system usefulness	√	√
	Misalignment of system with local practices and processes	√	√
Project team	Changes to membership on the project team	√	√
	Poor project leadership	√	
	Lack of required knowledge or skills	√	√
	Lack of clear role definitions	√	
	Negative attitude of project team members		√
Project	Large and complex project	√	√
	Project ambiguity	√	√
	Changes to requirements	√	
	Insufficient resources	√	√
	Lack of a project champion	√	√
	Lack of a formal project management methodology	√	
Organizational	Lack of commitment from upper management	√	√
	Organizational instability	√	√
	Lack of local personnel knowledgeable in IT	√	√
	Environmental changes		√
Strategic/ political	Misalignment of actors' and partners' objectives and stakes	√	
	Political games/conflicts	√	√
	Unreliable external partners	√	√

Underline = change in label based on the Delphi survey results; *Italic* = new risk factor

As part of the study's second phase, the list of 23 factors was returned to the 21 experts for validation. It is important to point out that each factor was accompanied by a brief description in order to avoid any ambiguity. Several respondents offered suggestions on how to formulate the names and descriptions given to the risk factors. Some of their suggestions were considered appropriate and integrated into our taxonomy. The changes in wording of the risk factors are underlined in Table 3. For instance, many experts suggested that we replace "*support* from upper management" by "*commitment* from upper management" in order to emphasize the key role this factor plays in CIS projects. Others suggested that "project ambiguity" was more encompassing than "scope creep." In this stage, we also asked the group of experts to assess the relative importance of each of the 23 risk factors. All the factors, without exception, had a mean greater than 3.5/7, so they all found their way into the final list.

5.2 Ranking of Risk Factors

As indicated above, the first attempt to arrange risk factors in order of priority provided inconclusive results, with a relatively low Kendall rank correlation coefficient (W=.36). However, we concluded the third phase when the second round produced a correlation coefficient of .65 [30]. Table 4 presents the final rankings for the 23 risk factors.

Table 4. Final Rankings of Risk Factors

Ranks	Risk Factors	Risk Dimensions
1	Lack of a project champion	Project
2	Lack of commitment from upper management	Organizational
3	Poor perceived system usefulness	Usability
4	Project ambiguity	Project
5	Misalignment of system with local practices and processes	Usability
6	Political games/conflicts	Strategic/political
7	Lack of required knowledge or skills	Project team
8	Changes to membership on the project team	Project team
9	Organizational instability	Organizational
10	Insufficient resources	Project
11	Poor software performance	Technological
12	Negative attitudes on the part of project team members	Project team
13	Unrealistic expectations	Human
14	Poor perceived system ease of use	Usability
15	Unreliable external partners	Strategic/political
16	Large and complex project	Project
17	Environmental changes	Organizational
18	Complex software solution	Technological
19	Lack of local personnel knowledgeable in IT	Organizational
20	Complex/unreliable technical infrastructure or network	Technological
21	Complex/incompatible hardware	Technological
22	Introduction of a new technology	Technological
23	Poor computer skills	Human

Overall, the exercise reveals that the lack of a project champion is the factor that CIS project managers felt most deserves their attention. Although this is not a novel finding, it is an issue that has been ignored in many authoritative lists [e.g., 2, 8]. In fact, in the health informatics literature, only Chiang and Starren [9] have included this factor in their list. The importance of a project champion is a recurring theme in the IT literature. The professional bureaucracy, a structure very typical of hospitals and other health care organizations, can explain why this factor was ranked first. Indeed, since professional bureaucracies confer greater decision-making power to the professionals working in an operational center, not only over the nature of their own work but also over administrative decisions that could affect them, having a physician who actively and vigorously promotes his personal vision with regard to information technology use is likely to help push the project over or around approval and implementation hurdles.

Four other risk factors stood out due to the high ratings they received from all the experts (see Table 4). First, lack of commitment from upper management was ranked #2, while it ranked #1 in Schmidt et al.'s [8] Delphi survey. As mentioned above, great emphasis was placed on this factor, to the extent that experts chose the term "commitment" rather than "support" to indicate the strong, active role that upper management must play in CIS projects. We concur with Schmidt et al. [8] that, given the importance ascribed to this factor, further research is needed to determine the means by which CIS project managers can ensure that they have the appropriate type and level of commitment from senior management.

Our panel of experts also confirmed the importance of a variable that has been extensively studied in information systems: the perceived usefulness associated with use of a CIS. Perceived system usefulness is defined by Davis [33] as the prospective user's subjective determination of the probability that using a specific application system would improve his or her job performance. This factor appears particularly important in health informatics projects, since health care professionals are quick to rebel against anything that they perceive will erode either the quality of patient care or their profession's status or discretionary powers [34]. Early, pre-implementation attitudes toward a CIS are often the "starting point" for shaping behaviours (e.g., spreading negative rumours, involvement in early planning and design phases, resistance to informational attempts). As a result, it is imperative to establish and demonstrate early on that the new system will have a positive impact on users' tasks and overall performance.

Next, project ambiguity was ranked #4 by our respondents. It is important to communicate a clear and consistent vision of what the future will look like [35, 36]. Failure to do this will mean a missed opportunity for enhancing changes in users' cognitive interpretations of the organization's character and undermine individual readiness. In some situations, CIS project managers might be concerned about their chances of being able to articulate a clear vision when they may only possess a general idea of the end state of the proposed change. According to Kanter [35], a general idea can be sufficient, because a change in mindset does not require an explicit and complete detailing of every aspect of the proposed change. It may be enough to provide a description of what the new principles are and their effects on the organization's activities, and explain how utilizing these modified processes will enhance attainment of organizational goals [36].

Finally, the fifth-ranked risk is the result of the quality of alignment between the CIS's characteristics and the organization of clinical work. This risk expands the notion of a user-technology interface by incorporating the fact that professional work in clinical settings is basically a collective effort. Analysis of this factor makes it possible to capture the fact that clinicians, including physicians and nurses, depend on each other in order to manage the clinical information of patients. CISs must therefore be designed as a function of work that is organized around this group contribution. This approach to organizing work implies requirements in terms of the individual and group management of clinical data, as well as the sharing of data between teams and a trend toward data sharing among a variety of organizations [22, 37, 38].

An examination of all the data presented in Table 4 reveals that the great majority of the factors associated with the technological dimension are considered less important. Technological risk factors are ranked #11, #18, #20, #21 and #22 in the final list. Without minimizing the importance of the technological challenges associated with implementing CIS, this finding supports the idea that these factors rarely figure among the main reasons for a project failure [34]. This result might also be related to some contextual factors. For instance, the great majority of CIS are rarely designed and programmed internally, and the risk associated with software development is often transferred to the supplier, who is responsible and held accountable for them.

6. Conclusion

Over the past 10 years, CIS projects have undergone an astounding series of changes. Health care is going through a period of radical transformations. CIS deployments have become critical benchmarks for achieving health care organizational reform priorities, including home care, primary care and care networks. However, several studies have shown that the expected benefits often remain, in practice, out of reach, and the failure rate remains unreasonably high.

In this paper, we posit that in order to reduce the chances of failure in health informatics projects, CIS managers should assess risks early and consistently throughout the software development process. However, proper risk management and the development of strategies to alleviate these risks require an understanding of: (1) what the typical risks are, and (2) which of these risks are perceived by project managers as more deserving of their attention. In this paper, we have made progress in addressing these two issues. First, we used a systematic and rigorous procedure to identify typical CIS project risks, developing an authoritative list of factors upon which further study and theory development can be based. Since the list was based on the input of 21 experienced CIS project managers, we are confident that it has a strong foundation. Second, we have identified risk factors that the panellists ranked as being most deserving of their attention. The resulting checklist lays a solid theoretical basis for further research that might help us identify the most effective countermeasures for mitigating CIS risk.

In addition to providing a comprehensive list of the risk factors faced in CISs projects and their relative importance, this study assisted in unifying the literature on IT implementation and health informatics. Our risk factor-oriented research actually confirmed many of the factors found to be important in both these streams. In this study, we have shown that both fields can profit from a cross-fertilization of results in order to provide a broader understanding of CIS risk factors. Overall, we hope this study will provide a solid baseline from which to proceed with the study of CIS risk management.

To conclude, we must acknowledge the main limitations of our findings. As with any Delphi study, our results are based on a limited number of subjects. While participants were chosen for their vast experience as CIS project leaders, we can make no claim about the representativeness of our sample. Our panellists were not chosen randomly, and they all came from the same region. Clearly, additional Delphi studies must be conducted with CIS project leaders from other parts of the world to allow more generalizability of the findings.

References

[1] Payton FC & Ginzberg MJ "Inter-organisational Health Care Systems Implementations: An Exploratory Study of Early Electronic Commerce Initiatives," *Health Care Management Review*, 26(2), 2001, 20-32.

[2] Sicotte C, Paré G, Moreault MP & Paccioni A "A Risk Assessment of Two Interorganizational Clinical Information Systems," *Journal of the American Medical Informatics Association*, 13(5), 2006, 577-566.

[3] O'Connell RT, Cho C, Shah N, Brown K & Shiffman RN "Take Note(s): Differential HER Satisfaction with Two Implementations under One Roof," *Journal of the American Medical Informatics Association*, 11(1), 2004, 43-49.

[4] Kleinke JD "Dot-Gov: Market Failure and the Creation of a National Health Information Technology System," *Health Affairs*, 24(5), 2005, 1246-1263.

[5] Kaplan B. "Culture Counts: How Institutional Values Affect Computer Use," *M.D. Computing*, 17(1), 2000, 23-26.

[6] Sia SK, Tang K, Soh C & Boh WF "Enterprise Resource Planning Systems as a Technology of Power: Empowerment or Panoptic Control?" *The Data Base for Advances in Information Systems*, 33(1), 2002, 23-37.

[7] Gartner Group. *Predicts 2005: Healthcare Providers are Automating*, www.gartner/research /122800/122843.html, 2005, site visited on Feb 9, 2006.

[8] Schmidt R, Lyytinen K, Keil M & Cule P "Identifying Software Project Risks: An International Delphi Study," *Journal of MIS*, 17(4), (2001), 5-36.

[9] Chiang MF & Starren JB "Software Engineering Risk Factors in the Implementation of a Small Electronic Medical Record System: The Problem of Scalability," *Proceedings of the AMIA 2002 Annual Symposium*, 145-149.

[10] Brender J, Ammenwerth E, Nykanen P & Talmon J "Factors Influencing Success and Failure of Health Informatics Systems," *Methods of Information in Medicine*, 45(1), 2006, 125-136.

[11] Barki H, Rivard S & Talbot J "Toward an Assessment of Software Development Risk," *Journal of MIS*, 10(2), 1993, 203-225.

[12] Sherer SA & Alter S "Information System Risks and Risk Factors: Are they Mostly about Information Systems?" *Communications of the AIS*, 14, 2004, 29-64.

[13] Doolan DF, Bates DW & James BC "The Use of Computers for Clinical Care: A Case of Series of Advanced U.S. Sites," *Journal of the American Medical Informatics Association*, 10(1), 2003, 94-107.

[14] Starr P "Smart Technology, Stunted Policy: Developing Health Information Networks," *Health Affairs*, 16(3), 1997, 91-105.

[15] Overhage JM, Evans L & Marchibroda J "Communities' Readiness for Health Information Exchange: The National Landscape in 2004," *Journal of the American Medical Informatics Association*, 12(2), 2005, 107-112.

[16] Markus ML "Power, Politics, and MIS Implementation," *Communications of the ACM*, 26(6), 1983, 430-444.

[17] Lyytinen K & Hirschheim R "Information Systems Failures, A Survey and Classification of the Empirical Literature," *Oxford Surveys in Information Technology*, 4, 1987, 257-309.

[18] Battacherjee A "Understanding Information Systems Continuance: An Expectation-Confirmation Model," *MIS Quarterly*, 25(3), 2001, 351-370.

[19] Miller RH & Sim I "Physicians' Use of Electronic Medical Records: Barriers and Solutions," *Health Affairs*, 23(2), 2004, 116-126.

[20] Lapointe L & Rivard S "Getting Physicians to Accept New Information Technology: Insights from Case Studies," *Canadian Medical Association Journal,* 174(11), 2006, 1573-1578.

[21] Lee F, Teich JM, Spurr CD & Bates DW "Implementation of Physician Order Entry: User Satisfaction and Self-reported Usage Patterns," *Journal of the American Medical Informatics Association*, 3, 1996, 42-55.

[22] Ahmad A, Teater P, Bentley TD, Kuehn L, Kumar RR, Thomas A & Mekhjian HS "Key Attributes of a Successful Physician Order Entry System Implementation in a Multi-hospital Environment," *Journal of the American Medical Informatics Association*, 9, 2002, 16-24.

[23] Van Der Meijden MJ, Tange HJ, Troost J & Hasman A "Determinants of Success of Inpatient Clinical Information Systems: A Literature Review," *Journal of the American Medical Informatics Association*, 10(3), 2003, 235-243.

[24] Siau K “Inter-organizational Systems and Competitive Advantages – Lessons from History,” *Journal of Computer Information Systems*, 44(1), 2003, 33-39.

[25] Anderson JG & Aydin CE “Evaluating the Impact of Health Care Information Systems,” *International Journal of Technology Assessment in Health Care*, 13(2), 1997, 380-393.

[26] Hunsucker JL & Loos D "Transition Management, an Analysis of Strategic Considerations for Effective Implementation," *Engineering Management International*, 5, 1989, 167-178.

[27] Tiwana A & Keil M “The One-Minute Risk Assessment Tool,” *Communications of the ACM*, 47(11), 2004, 73-77.

[28] Jarvenpaa SL & Ives B "Executive Involvement and Participation in the Management of Information Technology," *MIS Quarterly*, 15(2), 1991, 205-227.

[29] Hazeltine FW "The Key to Successful Implementations," *Production and Inventory Management Review with APICS NEWS*, 10(11), 1990, 41-42 and 45.

[30] Schmidt R “Managing Delphi Surveys Using Nonparametric Statistical Techniques,” *Decision Sciences*, 28(3), 1997, 763-774.

[31] Sicotte C, Denis JL & Lehoux P “The Computer Based Patient Record: A Strategic Issue in Process Innovation,” *Journal of Medical Systems*, 22(6), 1998, 431-443.

[32] Paré G & Trudel MC "Knowledge Barriers to PACS Adoption and Implementation in Hospitals", *International Journal of Medical Informatics*, 76(1), 2007, 22-33.

[33] Davis FD "Perceived Usefulness, Perceived Ease of Use, and Acceptance of Information Technology," *MIS Quarterly*, 13(3), 1989, 319-340.

[34] Lorenzi NM & Riley RT *Organizational Aspects of Health Informatics: Managing Technological Change*, New-York, NY: Springer Verlag, 1995.

[35] Kanter RM “The Enduring Skills of Change Leaders,” *Ivey Business Journal*, 2000, 31-36.

[36] Kotter JP *Leading Change*, Boston: Harvard University Press, 1996.

[37] Shu K, Boyle D, Spurr C, Horsky J, Heiman H, O’Connor P, Lepore J & Bates DW “Comparison of Time Spent Writing Orders on Paper with Computerized Physician Order Entry,” In Patel et al. (Eds), *Proceedings of Medinfo 2001* Amsterdam: IOS Press.

[38] Weiner M, Gress T, Thiemann DR, Jenckes M, Reel Sl, Mandell SF & Bass EB “Contrasting Views of Physicians and Nurses about an Inpatient Computer-based Provider Order-entry System,” *Journal of the American Medical Informatics Association*, 6(3), 1999, 234-244.