MAJOR VIRTUAL PROJECT RISK FACTORS

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ABSTRACT

Research on the major risk factors for traditional projects is abundant; however, despite research citing increased communication and trust issues in virtual environments, research on the major risks for projects conducted in virtual environments is scarce. This paper addresses that void by reporting on a research study of virtual project risk that culminated in a survey of 107 virtual project management practitioners from throughout the United States. Prior literature, in-person interviews, and a focus group were used to develop a comprehensive list of fifty-five potential risk factors. Survey participants were asked to rate each of these potential risks, by considering the degree of impact it had on the successful completion of a recent virtual project in which they participated. Similar to past surveys focused on traditional software development projects, the goal of this research was to identify a set of major virtual project risks, those risks most likely to have the greatest impact on the successful completion of a virtual software development project. The study identified a set of three major risks that can be considered critical for virtual projects: 1) lack of or inadequate communication, 2) project critical to the organization and 3) integration of project components is complex. Surprisingly, these risks are different from those previously identified in the literature as top risks for traditional projects. One risk identified here did not even appear in prior studies of traditional project risk. The other two appeared but were never noted as among the most critical risks. Included in this paper is a detailed discussion of each of the three major risk factors, as well as potential areas for future research into virtual project risk. The results of this study will benefit project management practitioners in managing risk in a virtual project environment.

Keywords: virtual project risk, risk, project risk, virtual projects, virtual teams, project management, communication, complexity, complex projects, complex components, critical projects, software development, risk management

INTRODUCTION

Projects are temporary work efforts, each with a specific goal or objective to be completed within a specified time frame [1]. Virtual projects have been defined as projects where team members are distributed across work locations in different cities, states, countries and/or time zones, making face-to-face communication difficult or impossible. Such teams are referred to as virtual teams. Since team members work from distributed locations, a need is created for project team members to rely heavily on technology for communication, i.e. collaboration tools, often referred to as information and communication technologies or ICTs. Powell, et al. [16] identified a sometimes “exclusive reliance” on ICTs as a distinctive feature of virtual teams.
Risk factors on projects have often led to challenged projects as well as project disasters [5, 19]. The importance of researching project risk has been acknowledged widely in the literature. Zmud [23], in his research found a “major source of the software problem” to be the failure to assess the project risk, as well as failure to adapt management methods based on the assessed risk. Boehm [4] developed a method to formalize risk assessment through risk identification, analysis and prioritization as a means of achieving project success. Finally, Wallace et al. [21] established that project risk factors can adversely affect a project if the project manager does not address them with appropriate countermeasures. Although project risk on traditional software development projects has been researched at length, traditional software projects no longer dominate software development. Rather, virtual teamwork has emerged as a growing means of conducting projects [15, 18]. Several driving forces have catapulted the use of virtual teams into the forefront, including the growth of global organizations, the continuing rise in business travel costs, widespread budgetary concerns, and an increase in outsourcing and offshoring [7, 12].

While the use of virtual teams has become quite commonplace, the initiation and rapid growth of virtual project work was not accompanied by customized processes and procedures, standards, methodologies or guidelines developed specifically for the virtual environment. Most project management practitioners instead rely upon existing traditional project risk assessment and handling methods, originally designed for co-located project teams. However, unique issues have been documented in virtual environments, including communication issues [9], trust issues [11, 14, 16] and issues with invisible team members, sometimes referred to as “deadbeats” or “free-riders” [6]. Although such issues could occur on traditional projects, the literature cited above suggests these problems may occur more frequently or with greater intensity when the environment is virtual. Supporting this position, Majchrzak, et al. [11] in their research found a number of risks, which they labeled “hazards” that can be more dangerous on virtual software projects than on traditional projects. The researchers specifically cited the following risks in the “hazard” category: mistrust, cliques, uninformed managers and the allure of other interesting but unrelated work. Thus, prior research suggests that virtual project risks may differ from traditional project risks. Since prior research addressed traditional project risk, our objective in this research was to identify a set of top risks that are likely to have the greatest impact on the successful completion of a virtual software development project.

The benefit of a top or critical risk factor list was validated by Boehm [4], who in his research on traditional software project risk, emphasized the need to specifically address top risks rather than create a lengthy list of all potential risk factors, including those with a low or miniscule impact. Adhering to the top risks approach can aid project management practitioners in using their time more effectively, since it would be nearly impossible to monitor and address every potential risk factor. When project management practitioners implement risk management plans, knowing the most critical threats to virtual projects can help these managers do a more complete and targeted risk analysis. Further, knowing what the most critical risks are on virtual projects is part of keeping pace with technology. More than a dozen years ago, Keil et al. [8], investigating top traditional project risks, justified the need for a new risk factor list based on organizational and technology changes. Since virtual project teamwork clearly has emerged as a new organizational form, it is reasonable to expect similar adjustments in risk factor lists for virtual software projects. Yet, as the Background section below will show, the seminal research into major project risk was conducted years ago using traditional projects.

The next section of this paper presents background information on prior research that involved the formation of both comprehensive risk factor lists and top risk factor lists for traditional, non-virtual projects. Each study is explained through a description of its stated goals, research methods, research participants and the resulting top risks identified by each group of researchers. This review is followed by a methodology section which will detail how the current research study was conducted. Results and Discussion sections will share the outcome of this study by identifying the critical risks for virtual projects and noting the relationships among the critical factors. The paper will conclude by first looking to the past and comparing the three factors identified here as critical on virtual projects with prior lists of top risks for traditional projects and then looking to the future of virtual project risk research. Please note that the research reported upon here is but one portion of a much larger study of project risk. Our goal here is to focus on identifying major risk factors in virtual project environments and to compare these with similar factors already identified by other researchers in traditional development environments involving co-located team members.

**BACKGROUND: TRADITIONAL PROJECT RISK**

Several researchers have studied and identified the threats and/or sources of threats to the outcome of traditional software development projects.
searchers identified specific detailed issues such as “nonexistent or unwilling users” [2], and labeled them risk factors [2, 4, 8] or uncertainty factors [3, 23]. Other researchers identified broad general areas of risk potential such as “users” and labeled them categories or dimensions [13, 22]. Barki, et al. [3], in their research, pointed out the “high degree of resemblance” between “risk factor” and “uncertainty factor” labels in prior literature. Therefore, risk factor and uncertainty factor will be treated as equivalent in this paper and referred to simply as risk factors.

The body of research on traditional, non-virtual software development project risk was published primarily between 1979 and 2004. We summarize this research here in the order in which it occurred so that the reader may gain a sense of the evolution of both thought and study methods. Alter [2] identified eight key risk factors that threatened the success of software development: 1) nonexistent or unwilling users, 2) inability to cushion impact on others, 3) multiple users or implementers, 4) loss or lack of support, 5) turnover among all parties, 6) lack of experience, 7) inability to specify purpose or usage, and 8) technical or cost-effectiveness problems. Alter’s research was conducted by reviewing implementation case histories from fifty-six decision support systems. Face-to-face interviews were conducted with the participants, who were system implementers or users of these systems. The purpose of the research was to answer three questions: 1) what situational factors favored or opposed successful implementation, 2) what actions were taken in response to these factors, and 3) what determined whether these actions were successful.

Zmud [23] identified four uncertainty factors considered critical in terms of influencing the outcome of a software development project. The first uncertainty factor was technological complexity, which he described as selection of an appropriate hardware/software design, estimating of resources and design of the operation of the final product. Zmud’s second factor, the degree of novelty or structure of the application, was defined as the development of clear, concise and complete requirements. The third factor, technological change, covered the influence of change on all aspects of the project. Finally, the fourth factor, project size, referred to all issues related to large projects. For instance, in a large project, team members are more likely to have interdependent tasks which can increase the chance of team members who don’t collaborate well to need to work together. Zmud’s research was conducted by synthesizing existing ideas of practitioners on methods of staffing, planning, and controlling used in successful software development projects. His objective was to achieve a “managerial exploitation of modern software practices” that would lead to project success. In particular, these methods were related to evolutionary development and the evolutionary life cycle, which promoted the segmentation of development projects into manageable pieces.

McFarlan [13] indicated risk was inherent to projects and identified three critical risk dimensions that influenced the risk in a project. Project size, the first risk dimension, refers to the increased risk that accompanies increases in project budget, project team size, project duration and the number of departments involved. The second dimension, experience with technology, refers to the higher level of risk associated with projects where the project team is not familiar or comfortable with the project hardware, operating systems, database or programming language. The last dimension, project structure, can fall into one of several categories: high structure/low technology, high structure/high technology, low structure/high technology or low structure/low technology. Conclusions were based on McFarlan’s analysis of specific corporate projects, i.e. case studies and first-hand acquaintance with a number of Information Systems (IS) projects over a ten year span around the 1970’s. The purpose of this research was to focus on the three deficiencies mentioned above in actual practice and to suggest ways of redressing them.

Boehm’s research [4] identified the following list of “top ten” risk factors on software development projects: 1) personnel shortfalls, 2) unrealistic schedules and budgets, 3) developing the wrong functions and properties, 4) developing the wrong user interface, 5) gold-plating, 6) continuing stream of requirements changes, 7) shortfalls in externally furnished components, 8) shortfalls in externally performed tasks, 9) real-time performance shortfalls, and 10) straining computer-science capabilities. His research was conducted with the purpose of identifying a checklist of the ten primary sources of risk on traditional software projects, which could be used by practitioners, managers and systems engineers. The list was created from observations by Boehm of project managers in one industry.

Barki, et al. [3] identified a much more comprehensive list of risks. As shown in Table 1, five crucial risk dimensions were identified and validated, with 24 total uncertainty/risk factors assigned within the five dimensions. The purpose of this research was to develop a construct with which to measure software development risk and to develop a conceptual definition of software development risk. Unlike prior studies, a survey questionnaire and face-to-face interviews were employed to conduct the research. Participants were project leaders and users from 100 of the largest companies in Quebec working on an ongoing traditional project at the time of the research.
Keil, et al. [8] identified the following top eleven risk factors: 1) lack of top management commitment to the project, 2) failure to gain user commitment, 3) misunderstanding the requirements, 4) lack of adequate user involvement, 5) failure to manage user expectations, 6) changing scope/objectives, 7) lack of required knowledge/skills in the project personnel, 8) lack of frozen requirements, 9) introduction of new technology, 10) insufficient/inappropriate staffing, and 11) conflict between user departments. The purpose of this research was to identify a set of risks which were the most important on traditional software projects, similar to the purpose of the research by Boehm [4]. Unlike prior studies, Keil's research was conducted through a Delphi study with 41 experienced project managers in three countries. Risks were rated on a 10-point scale where 7 or higher (top 30%) were classified as “high importance” and ratings of 7 to 5 were classified as “moderate”. The average perceived importance scores were used in calculating overall ratings. The resulting list was thought to be somewhat universal since each group, located in different countries, identified this same core set of risks, thus suggesting a “global relevance.”

Wallace, et al. [21], identified the largest set of risks with fifty-three risk factors which they mapped into the following four quadrants representing categories: Q1 Customer Mandate, Q2 Scope and Requirements, Q3 Environment and Q4 Execution. Some of these quadrants are similar to segments identified by other research like the Barki, et al. [3] study, whose "organizational environment" parallels Wallace's Q3. Instead of using the previous method of prioritizing the risks themselves, these researchers focused on an organizing method which was developed as a risk categorization framework to group risks. Groupings were based on two major concepts: 1) the level of perceived relative importance of the risk and 2) the project manager’s degree of perceived level of control over the risk. The main purpose of the groupings was to improve the ability of project managers to incorporate these risks into risk management strategies. The research also explored each of the four risk categories (labeled as quadrants) and their relationship to project outcome. Similar to the research by Barki, et al. [3], a survey questionnaire was used to obtain information from the participants. Participants were 500 project managers who were members of the Project Management Institute (PMI) Information Systems Special Interest Group (IS SIG) [21, 22].

As a group, each of these research studies had at least one aspect in common: identifying causes of project threats at varying levels of detail, either broad categories or detailed risk factors or both. Some general areas of risks, including technical complexity, turnover, and team member expertise, appeared in multiple studies, resurfacing over time. Conversely, some areas of risks, including project structure and project size, were only identified in one or two of the studies. This situation may be a result of an ever-changing technological environment, the increasing span and sophistication of the research methods used, or variation in the goals and methods of the research. In any case, all of the research studies focused on the relationship between risks and the success of the pro-
ject in some manner. However, none focused on virtual projects.

**METHODOLOGY**

This research study employed a multi-step methodology, designed to culminate in a survey. The survey method was chosen because seminal literature indicated several prior research studies on traditional projects made use of this method [3, 22]. The purpose of the first few steps in the process was to develop a comprehensive set of potential risk factors upon which to base the ultimate survey. The objective of the survey in the second segment was to determine which of these risk factors posed the greatest threat to virtual projects.

After an in-depth literature review identifying previously identified risk factors, an open-ended questionnaire was and piloted using face-to-face interviews with IS project management practitioners. This approach used open-ended questions to elicit risk factors from the project managers as they discussed their specific projects. Next, a focus group was conducted using an electronic collaboration tool. Participants in this focus group were part-time Information Technology (IT) graduate students who worked fulltime as IT professionals. The resulting list of project risk factors from the focus group, the face-to-face interviews and literature review were combined then sorted and grouped in an iterative process to create a list of fifty-five specific risk factors for inclusion in the survey, as detailed in Table 2. Once the survey was revised from the open-ended questionnaire used in the face-to-face interviews, it was converted into an electronic format which included the fifty-five risk factors and piloted again. Finally, the survey was mass distributed to IS/IT project management practitioners through the use of a purchased distribution list from a project management support website, and through posting the survey on the Project Management Institute website under the survey webpage. The following section will discuss the results from the analysis of the survey data and elaborate on details of the survey questionnaire.
Table 2: List of Fifty-five Potential Risk Factors

<table>
<thead>
<tr>
<th>Team members are not accountable for bad or poor decisions</th>
<th>Project scope too limited or vague</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of commitment from management</td>
<td>Project scope was scaled back from original scope</td>
</tr>
<tr>
<td>Lack of or inadequate communication</td>
<td>Forced to work within dictated constraints</td>
</tr>
<tr>
<td>Technical connectivity issues hinder communication</td>
<td>Idle people resources, for example due to early staffing or project windup</td>
</tr>
<tr>
<td>Too many meetings</td>
<td>Lack of appropriately skilled resources</td>
</tr>
<tr>
<td>Conflict among team members</td>
<td>Insufficient knowledge transfer</td>
</tr>
<tr>
<td>Project team members resist change</td>
<td>Loss of key resource(s) that impact the project</td>
</tr>
<tr>
<td>No contingency planning</td>
<td>Resource inexperience with company and its’ processes</td>
</tr>
<tr>
<td>Cost overruns</td>
<td>Personnel turnover</td>
</tr>
<tr>
<td>Excessive wait for funding approval, no funding or loss of funding</td>
<td>Loading up project with excess resources to resolve issues</td>
</tr>
<tr>
<td>Unrealistic Estimate/Budget expectations</td>
<td>No sponsors or wrong sponsors</td>
</tr>
<tr>
<td>Project critical to the organization</td>
<td>Misidentification of stakeholders</td>
</tr>
<tr>
<td>Cultural or language differences</td>
<td>Lack of stakeholder or end-user involvement in project</td>
</tr>
<tr>
<td>Poor decision making process</td>
<td>Lack of project team cohesion</td>
</tr>
<tr>
<td>Lack of balance or diversity on the project team</td>
<td>Inadequate technical resources, i.e. hardware, processing availability</td>
</tr>
<tr>
<td>Integration of project components is complex</td>
<td>Technology hardware new to the organization</td>
</tr>
<tr>
<td>Lack of knowledge needed for successful integration of project components</td>
<td>Technology software new to the organization</td>
</tr>
<tr>
<td>Catering to desires and wants of a few stakeholders</td>
<td>Unidentified technical constraints</td>
</tr>
<tr>
<td>Company politics and/or lack of integrity</td>
<td>Creation of meaningless intermediate deliverables to give the impression deadlines are being met</td>
</tr>
<tr>
<td>Geopolitical issues</td>
<td>Unrealistic time estimate</td>
</tr>
<tr>
<td>Hidden agendas impact the project</td>
<td>Lack of needed training</td>
</tr>
<tr>
<td>Project manager replaced during project</td>
<td>Developed application or product unacceptable to end-user</td>
</tr>
<tr>
<td>Inadequate project management and/or inexperienced project manager</td>
<td>Inexperienced end users</td>
</tr>
<tr>
<td>Unclear project objectives</td>
<td>Lack of end user buy-in</td>
</tr>
<tr>
<td>Poor quality deliverables</td>
<td>Poor vendor performance</td>
</tr>
<tr>
<td>Poorly written, unclear or vague project requirements</td>
<td>Poor vendor relationship</td>
</tr>
<tr>
<td>Developed application or product doesn’t satisfy require-ments</td>
<td>Lack of coordination among vendors</td>
</tr>
<tr>
<td>Too many scope changes/scope creep</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

Demographics

The 107 survey participants self-identified as IS/IT project leaders/managers and systems analysts playing a leading role in a virtual project. This self-selection and self-identification of participants is a limitation of this study and may have produced some self-reporting bias. The majority of the survey participants managed their project as either the project manager or project leader (65%). 19% served as team leads on the project, while 5% of respondents were team members and 11% were in roles such as executive positions overseeing multiple IS/IT projects.

The size of the projects reported upon varied widely, and was measured by three factors, the cost, duration, and project team size, as shown in Table 3. The majority of the project costs were in the $100,000 to $1 million range, with a large number of projects falling in the over $1 million range. Half of the projects were less than one year in duration. The project team size was distributed among three potential size groups.
Critical Risks

The primary objective of this research study was to identify the most critical risk factors on software development projects operating in a virtual environment. Critical was defined as having a high negative impact on the successful completion of a project, i.e. notably over-budget, behind schedule and/or with a lower level of functionality or quality than was requested or expected. The degree to which any or all of these three targets were not met is indicative of a project failure or in extreme cases, a project disaster. The survey data from this research was analyzed by considering the perceived impact of each potential risk factor, as indicated by the project management practitioners who participated in the survey. This is consistent with the approach taken in earlier studies, including that of Keil et al. [8]. Participants from various companies, locations, etc. were asked to answer the survey questions based on a recent project where they either managed or served in a lead role. This too is consistent with the approach used in recent research on requirements volatility risk. Participants were asked to refer to a recent project when answering the survey questions to improve the reliability of the survey results and to discourage survey participants from merely stating their generalized opinions [20]. The survey contained the fifty-five project risk factors and participants were asked to rate each risk factor on a three-point Likert scale with the following meanings: “1” = the risk had no impact on the successful completion of the project or did not occur on the project; “2” = the risk had a moderate impact on the successful completion of the project; “3” = the risk had a high impact on the successful completion of the project.

Chi-square tests were used to determine significance between observed and expected frequencies. As shown in Table 4, of the fifty-five risk factors tested, three risks emerged as major. Figure 1 shows the corresponding percentages of survey participants reporting various levels of these three risks.

The three risk factors identified here had both the lowest p-values and the highest percentages of impact of any type among all of the fifty-five potential risks studied. Interestingly, as shown in Figure 1, for the Integration of project components is complex risk factor, the “moderate” impact level was two percentage points higher than the “high” impact level. Together 82% of respondents felt there was an impact and the percentage of respondents who felt there was “no impact” or did not have this risk occur on their project was very low at 18%. The “moderate” impact level percentages of the other two risk factors were lower than the “high” impact level percentages.

Table 4: Respondents reporting risk impact (n=107)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>No Impact</th>
<th>Moderate Impact</th>
<th>Major Impact</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of or inadequate communication</td>
<td>22</td>
<td>41</td>
<td>44</td>
<td>0.018</td>
</tr>
<tr>
<td>Project critical to the organization</td>
<td>24</td>
<td>35</td>
<td>48</td>
<td>0.017</td>
</tr>
<tr>
<td>Integration of components is complex</td>
<td>19</td>
<td>45</td>
<td>43</td>
<td>0.003</td>
</tr>
</tbody>
</table>
DISCUSSION

We now discuss each of the three major risk factors in detail. Following this, we consider how these critical virtual project risk factors ranked in prior studies of traditional co-located software projects, as well as how these three factors relate to one another.

Lack of or Inadequate Communication

The lack of or inadequate communication risk factor refers to communication problems on a project that impact project success. This includes missing communication, where project team members are not adequately informed about important aspects of the project work, resulting in confusion. Inadequate communication can also occur when there is so little communication that problems result because team members don’t know what to do or what is expected of them. A majority of the participants (41.12%) indicated this risk factor had a “high” impact. Additionally, 38.32% perceived the impact was moderate while only 17.76% perceived there was no impact or did not experience this type of communication risk on their project. The very low percentage of the “no impact/did not occur” responses indicates a majority of virtual software projects (approximately 79%) have their project outcome negatively impacted by this risk in some way.

There are several reasons we would expect communication risk to be higher on virtual projects. First, since virtual projects have little or no face-to-face communication, team members must rely on ICTs such as video conferencing, e-mails, wikis and blogs, collaboration tools and instant messaging. Over a decade ago, Lipnack and Stamps [10] indicated these technologies would dramatically improve virtual teams, and enhance the ability of teams to “work together at a distance”. Since that time, ICTs have improved in variety, quality, features and affordability. Yet, it appears relying on these tools to ensure adequate communication is insufficient. Some team members may be unfamiliar with the tools, i.e. not adept at posting information they are responsible for providing or not adept at finding the information they are responsible for reading. For instance, if a SharePoint site is used as a project communication tool, but is not well organized, it may be difficult to find the many documents used by project managers to keep a project on track including, change control logs, issues lists, status reports, and volumes of documentation on requirements. One recommendation for project management practitioners is to use one set of communication tools, organized in one consistent manner, and then train all personnel on the tools’ standard organization and usage. Beyond this, there is always the possibility that some people will still be uncomfortable with e-communication and use it only as a last resort, and no amount of standardization within an organization will ensure across-the-board familiarity with communication tools when some team members are brought in as outside contractors. There are many more potential reasons to expect elevated communication risk on virtual projects. For example, on virtual projects, in
many cases, team members are working together for the first time and therefore, are likely to have no prior established relationships with each other. Furthermore, it is possible they will never work together again. This potentiality may affect team members' effort in building a high-quality working relationship. Sakthivel and Chang [17] also found relationship conflicts to be common in virtual work.

Future research needs to delve much more deeply into lack of or inadequate communication on virtual projects. Are some team members uncomfortable with electronic communication? Are some team members unfamiliar with the specific communication tools being used? Are the communication tools unable to convey messages with the necessary levels of richness? Is the organization of the formal communication repositories obscure? Are communication issues more likely to relate to one-time information passing or to reference sources? Is there a problem communicating major concepts, small details, or both? Are certain media types preferable for transmitting certain types of messages? Do communication issues differ with project phases, i.e., initiation, planning, design, implementation? While some research is ongoing with respect to virtual project communication, there is still a substantial communication-related agenda awaiting researchers.

Project critical to the organization

The project critical to the organization risk factor refers to the level of importance the project has when compared with other projects in the organization's project portfolio. This risk factor had the greatest number of “high” impact participant responses of all fifty-five risk factors in the survey. A majority of the respondents (44.86%) indicated this risk factor had a “high” impact, while 32.71% perceived the impact as moderate. There is no way to determine how many projects are critical to an organization in any given year. For example, in a small company with a stable market, there may only be one or two critical projects in a given year, but for a large company in a very competitive environment there might be ten or twenty projects. Being one of twenty critical projects may be less stressful than being one of two. Responses indicate a majority of virtual software project respondents (approximately 78%) believe their project outcome was negatively impacted by the fact that their project was critical to the organization.

Projects that are high profile or necessary to the success or continued existence of the company as a whole bring with them increased anxiety for project team members and particularly for the project manager. Project managers on high profile projects often find their careers either skyrocket or plummet, depending largely on the project's success. Further, working on such a project can be similar to living in a fishbowl; everyone appears to be watching and many have an opinion about how well the team is doing and how they could do a better job. With heavy involvement of multiple levels of management, high profile projects run the risk of having too much active management, as in the old adage that "too many cooks spoil the broth." This risk factor may have a higher impact on virtual projects for a variety of other reasons, as well. Distributed teams cannot easily observe and respond appropriately to the reactions of users or management. In a face-to-face traditional environment, subtle cues, including body language and tone of voice, can be observed and interpreted. In a virtual environment, body language is typically hidden during conference calls and written communication, including email, wikis, electronic work groups, and the like. Alternatively, the virtual nature of these projects may draw increased management attention and cause them to be treated as more critical than other similar projects developed using traditional colocated teams. Without further research into this risk factor, it is impossible to declare definitively how project managers should best address this risk. However, certainly an increased emphasis on communication, particularly communication involving management, would be beneficial. Proactively anticipating communication needs may increase the comfort level of managers at all levels, and thus lessen any potential micromanagement or conflicting directions.

Integration of project components is complex

The integration of project components is complex risk factor alludes to the number, but more primarily the complexity of interfaces required by the project. Even the factors that determine the level of complexity are themselves complex. For instance, interfaces between applications running on different computer platforms or written in different programming languages require more expertise than simpler technical interfaces. Also, some applications fit together well, like two pieces of the same puzzle, while others fit like pieces from two different puzzles that must be twisted in order to be joined, and may never work as if they were made to fit together. Other factors can make integration complex, such as lack of or misleading documentation, resistant users, and lack of knowledge, skills or expertise. In virtual projects, this risk may occur in part because of the difficulties inherent in exchanging complex information. Complex documentation and diagrams may be difficult or impossible to understand correctly without face-to-face communication.
Further, casual “water cooler” or “over the cubicle wall” comments that may facilitate the understanding of complexity in a traditional co-located project environment are not available in the virtual environment.

A majority of the respondents (40.19%) indicated this risk factor had a high impact, while a slightly higher number (42.71%) perceived the impact was moderate. The total percentage of impact was 82% when moderate and high impact were combined. In addition, the low percentage of “no impact/did not occur” (17.76%) also emerged as a solid indicator of critical risk. These results reflect the need for virtual project management practitioners to always evaluate this risk on their projects as well as develop a plan to manage this risk so it occurs to prevent it from becoming a risk.

One method to attack complexity risk is through diligent requirements definition, ensuring all necessary interfaces are identified and thoroughly analyzed and designed. On a virtual project, extra efforts may be needed to ensure all necessary users and experts are included in these discussions. The use of the appropriate ICTs may be required so that written documents, drawings, and meeting notes can be stored in a well organized, easy to retrieve manner and in a format that is easy to interpret. In projects with high levels of complexity but without face-to-face communication, extra expense may be needed to acquire high-quality tools such as groupware, collaboration tools, and videoconferencing equipment and to then train the project team, consultants, experts and users to utilize the tools effectively. Constant monitoring may be necessary to ensure the tools are being used and the documentation is accurate. Most importantly, team members must feel engaged and comfortable with the use of the tools. Finally, in the case of the other two major risk factors identified by this research, much further research must be done into the nature of the risk and how it can best be managed and mitigated on virtual projects.

Relating study results to prior research

Before this study, it was tempting to assume the major virtual software project risk factors might also be found on the top traditional project risk lists. Surprisingly, this was not the case. Consider the first critical virtual project risk, lack of or inadequate communication. Of all of the prior literature cited in the background section, only Wallace [21] mentioned any aspect of communication as a risk factor, “Ineffective communication” and “team communication issues”. Wallace focused on grouping risks into categories, but did not note either of these communication related risks as particularly significant. Thus, while communication issues have been identified in the past as potentially problematic, communication was never identified as critical in the seminal literature on traditional project risk. However, problems communicating among virtual team members, users and developers did emerge as an important risk in our face-to-face interviews, and that importance was substantiated by our survey. For the next virtual project risk factor, project critical to the organization, none of the prior literature cited criticality to the organization as an increased risk, and only Wallace [21] mentioned any aspect of project importance to the organization. This, however, was in the context of discussing project priorities. Again, this risk factor emerged in our face-to-face interviews, and was strongly supported by our survey results. Finally, consider the last critical virtual project risk factor identified here, integration of project components is complex. Boehm [4] touched on the integration concept when he spoke more narrowly of the number of system interdependencies, although this factor did not make his top ten risk list. While Barki [3] and Wallace [22] each identified two risks related to integration of components, all four of these factors focused narrowly on the number of links rather than the broader concept of the inherent difficulty of integrating components. Finally, Keil, et al. [8] in their Delphi study did not list any aspect of integration in its list of eleven major risk factors. On the other hand, our face-to-face interviews identified complexity of integration as a potentially serious risk factor, and this was supported by our survey.

Relationships among critical risks

Three risks have been identified by this research as most critical on virtual software development projects. As demonstrated by the previous discussion and shown in Figure 2, these risks are related. Integrating complex components undoubtedly places added communication burdens on any project. Similarly, the more critical a project is to an organization, the more involved personnel at all levels, are likely to be in project communications. Fortunately, of the three critical risks identified here, the most central, communication, is currently the subject of much research. For virtual project managers, communication research that directly addressed the two other risks identified here would be of great value. Future research should address two specific questions generated by this current research: What are the best practices for communicating complexity in a virtual environment? What are the best practices for maintaining open communications on high-visibility projects? Just as each of the three risks identified here demands further research; there is also a need for further research into the relationships among the three, and particularly between communication-related risk and each of the other two.

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CONCLUSION

As detailed in the Background section of this work, numerous researchers have studied risk in traditional projects. We reported here on just one portion of a much larger study of virtual project risk. While this study does provide substantive evidence that major project risk is different in a virtual environment, much more research needs to be undertaken in order to build our understanding of virtual project risks. In addition, while much research currently is being conducted into communication on virtual projects, more of this project communication research needs to be specifically focused on risk. Looking beyond communication, the other two major risks factors identified here need substantially more study, as well. How a project manager can best anticipate, manage, and mitigate the risks of integrating complex components needs to be explored in detail. Perhaps most importantly, the newly identified risk factor of project criticality to the organization needs to be explored in depth. We need to understand what factors make a project critical to an organization, as well as how that criticality generates risk and how that risk can best be managed in a virtual environment. Finally, we need to develop in-depth understanding of how the three critical risks identified here interact with one another.

This research has demonstrated that the virtual environment does indeed spawn different major project risk factors than those previously identified on traditional projects involving co-located project team members. Given that virtual projects have emerged as a permanent part of the Information Technology landscape, we now need to openly recognize that virtual project risk is not identical to traditional project risk. Only then will virtual project risk receive the research attention it requires.

REFERENCES


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