An Interpretive Study of Software Risk Management Perspectives

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This research proposes a framework for a field investigation of risk management in the context of a particular software development organization. It was experimentally tested within several companies. This framework was designed to provide an understanding of software development risk phenomena from a project manager's perspective and to give an indication of how this perspective affects their perception . This study can be used as a precursor to improving research into the creation of new software risk management frameworks.

Categories and Subject Descriptors: K.6.1 [**Management of Computing and Information Systems**]: Project and People Management - *Management Techniques*; K.6.3. [**Management of Computing and Information Systems**]: Software Management

General Terms: Management, Human Factors

Additional Key Words and Phrases: Interpretive research, phenomenological research, software risk management, software risks

1. INTRODUCTION

The increasing reliance on software systems and the increasing amount of software in systems constitutes an indication that overcoming the chronic problems of software development, such as cost overruns, project delays and unmet user requirements [Ropponen and Lyytinen 1997], is not only highly desirable but a priority for the economy. According to Klein and Jiang [2001], studies continue to indicate that about 85% of all projects end in failure. Furthermore, it is estimated that 31.1% of projects will be cancelled before they are ever completed [Boehm 2000]. Software development, given its diverse and abstract nature, offers unique challenges and risks [Moynihan 1997]. A formal risk management programme is a structured way of evaluating risks to the software development process. A typical risk management framework involves identifying and analysing the risks to a project and then implementing and monitoring measures to reduce them.

The first step in a typical risk management programme is the identification of risk, usually involving checklists, questionnaires or brainstorming sessions. The next step is the *analysis* of the risks identified in such a way that they can be ranked in a meaningful manner. This is followed by the development of contingency measures to decrease the impact of each risk or avoid it altogether [Lyytinen et al. 1998]. The final step is risk monitoring, which ensures that the risk-reducing methods are implemented effectively and also determines whether or not the risk-reducing tactics are in fact reducing risks [Bandyopadhyay et al. 1999]. A risk is any variable within a project that may result in project failure. Generic risk concerns include schedule risk, requirements risks, budget risks and personnel risks. According to Pressman [1997] there has been considerable debate regarding the proper definition of software risk, but the general consensus is that risk always involves two characteristics:

1. Uncertainty – the event that characterizes the risk may or may not happen, i.e. there are no 100% probable risks.
2. Loss – if risk becomes a reality, unwanted consequences or losses will occur.

The aim of this paper is to propose a framework for a field investigation in the context of a particular software development organisation. The desired outcome of this study was firstly to determine what contextual factors contribute to successful risk management practices and the converse, i.e. the factors that hinder successful risk management. Secondly, it was necessary to establish which factors result in 'risk-aversive attitudes', i.e. the factors that result in managers negating the use of risk management. Thirdly an attempt was made to determine the factors that foster risk-aware attitudes. The final aim was to posit the framework's potential as a tool for managers to enhance their software development risk management practices.

The crucial step in any risk management process is the analysis of identified risks in order to determine the degree of attention each risk need be given, since this will ultimately affect the success of a project. This paper begins with an evaluation of risk analysis, which was the precursor to adopting a non-positivist research paradigm in this research. This is followed by a justification of the epistemological stance adopted, then the derivation of the interpretivist framework, based on prior research, then the methods used, next the analysis of the data and, finally, the conclusions.

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2. RISK ANALYSIS

2.1 Estimating the Risk Exposure

As risk implies a potential loss, there are two elements at issue here: firstly the probability of an unsatisfactory outcome and secondly the consequences of such an outcome [Fairley 1994]. These two measurements are estimated using risk analysis techniques, the multiplicity of which forms the risk exposure metric that is defined by the formula below:

$$Risk = Prob(UO) \times Loss(UO) \quad (1)$$

where

Prob (UO) is the probability of an unsatisfactory outcome.

Loss (UO) is the loss to the parties affected if the outcome is unsatisfactory.

The risk exposure can be used to determine the degree of attention each risk need be given. Risk exposure has several magnitudes, as risk can impact on the cost, schedule, performance and quality [Chittister and Haimes 1993]. For example, personnel risks can be measured in man-months, while schedule risks can be measured in weeks or months. Risk exposure can be used in managing the risk, which involves the use of two strategies that reduce risk exposure either by reducing the probability or by reducing the associated loss [Gemmer 1997].

2.2 Comparisons of Risk Analysis TechniquesiIn Calculating Risk Exposure

Quantitative risk analysis techniques (such as cost risk analysis, decision analysis and network analysis) are historically favoured over qualitative risk analysis techniques (such as scenario analysis and the Delphi technique). The quantitative methods are seen as being more objective and are based on models and metrics, whilst qualitative methods are more subjective. However, quantitative models such as the cost-risk analysis models are usually automated, delivering a final amount. This final amount seduces analysts into overlooking dependency between individual sources of risk [Chapman and Ward 1997]. The validity of the risk exposure metric, whether quantitatively or qualitatively attained, is compromised by two types of uncertainty: Firstly uncertainty in perceiving impact and secondly, uncertainty in perceiving probability [Gemmer 1997]. Quantitatively estimated values for the probability and impact are 'manipulated with very positivistic formal and logical mathematical operations' and if the original values are incorrect, then the 'probability arithmetic that follows is complete nonsense' [Baskerville and Stage 1996]. The accuracy of quantitative methods is compromised by a further consequence. Quantitative methods ignore the intuitive issues and this tends to create an illusion of accuracy [Steen 1997] that does not in fact exist. At least qualitative estimates improve the quality of decisions, since decisions based on intuitive estimates may be worse than making decisions without qualitative estimates [Gemmer, 1997].

In terms of the normal scientific paradigm, a software development project is sufficiently well defined, such that, not only is there adequate information, but that information is accurate enough to permit the prediction of future events [Charette, 1996]. Paradoxically, the existence of risk management is an acknowledgement that the 'normal science paradigm' does not work. However, quantitative risk analysis is itself positivistic in nature. Therefore risk analysis principles based on normal scientific principles can lead to problems, as indeed happens in software project management. For example, software project management assumes that schedules and budget can be accurately predicted. Analogously, the existence of the risk exposure metric promotes the same belief that risks can be accurately predicted. Kitchenham and Linkman [1997] assert that effort estimation with work function points is problematic since it is assumed that this estimation model can include all the factors that affect the effort required to produce a product. The same logic can be applied to the risk exposure metric because it cannot include all the factors that contribute to risk affecting the outcome of a project since, like other estimation models, it is merely an abstraction of reality [Kitchenham and Linkman 1997]. Most risks involve some combination of political, social, economic, environmental and technical factors, and therefore it is difficult to place a 'hard' number on something when there are so many factors coupled with the obscure nature of personal perceptions [Gemmer 1997]. Absolute risk does not exist, and it depends to a great extent on the individual's perspective [Barki et al. 1993].

The issues surrounding quantitative as opposed to qualitative techniques reflect the diversity of problems in risk analysis in specific software development environments. This underlines the need for a better understanding of how risk management is conducted in organizations in order to gain an insight into the way it affects them.

The software development process is complex and the best way to comprehend it is to draw information from the point of view of those who experience it. With the exception of Moynihan [1997], no systematic attempts have been made to gauge the opinions of those who actually have experience in managing risks in projects. An attempt to correct this situation has been presented in Keil et al. [1998]. The aim of this field investigation was to attain a perspective of risk management as practised in reality, because there is a dearth of studies on real experiences of software processes [Dutta et al. 1998]. The vehicle for this research was the formulation of an interpretivist framework for determining the effectiveness of risk management in field conditions. This framework was applied to an exploratory investigation of risk management practices in several software organizations. The framework is not only a mechanism for investigating the

perceptions and perspectives of risk management, but is also a useful tool that can be used to pinpoint the problems regarding risk management in the context of an organization so that they can be identified and addressed. As a result the preconditions are created for reducing project failure.

In an exploratory investigation the framework was used to determine whether or not risk management is practised successfully, what kind of contextual factors are instrumental in guiding the risk management process and why this is so. It was also important to determine the converse of the previous statement, and the factors and attitudes that cause an organization to ignore risk management practices.

3. JUSTIFICATION FOR CHOOSING AN INTERPRETIVE EPISTEMOLOGY

There were three fundamental motivations for adopting an interpretive approach to this study. Firstly interpretive research can help one to understand the sociological aspects in the software development setting as it focuses on human thought and action in social and organizational contexts. This epistemology was complementary to the central theme of this study, which considers the perspectives and perceptions of software project managers concerning risk management. The strong emphasis on the sociological aspects is essential because the exclusion of human factors in past research may go some way towards explaining the dissatisfaction with conventional information systems development [Avison et al. 1999]. It is believed that this might explain the repudiation of risk management strategies hitherto.

The second reason for choosing an interpretive epistemology relates to the abstruseness of the research area under enquiry. Interpretive research does not predefine dependent and independent variables, but focuses on the complexity of human sense making as the research proceeds [Galliers 1987]. For instance, this study sought to discover the rationale behind practitioners not utilising risk management, which by all literary accounts is a highly positive process and is essential for producing risk-free software. The author does not negate the need for positivist research in software engineering, but supports the belief that the approach should be dependent on the research question concerned. Interpretive research can be the precursor to positivist research, especially in situations where there is a large amount of fuzziness. Interpretive research tries to understand all the nuances of the phenomena at issue, in order to obtain clarification and thus make 'sense' of the situation. Positivist research does not work when the phenomenon under scrutiny is ill-defined. Therefore the nature of interpretive research is such that it can demystify the phenomena in question, leading the way for positivist research to be conducted more astutely.

The debate between positivist and interpretivist research paradigms is vacuous as each approach has its own strengths and weaknesses. Neither paradigm is superior to the other, but if interpretive research is viewed through the positivist lens, it will be accorded an inferior status [Fitzgerald and Howcroft 1998]. Softer research approaches are suitable for exploratory research while hard research methods are suitable for confirmatory research [Fitzgerald and Howcroft 1998]. Monistic models are appropriate for subjects like physics, but not for a fragmented field such as information systems [Banville and Landry 1989] development. The strength of this type of research is its ability to represent reality. Significant advances in knowledge and developing theory can be made in this way [Hamilton and Ives 1992]. The preceding argument, in terms of the research approach being dependent on the research question, is not tantamount to the argument that qualitative research is 'preliminary to the 'real' research of generating hypotheses to be tested using experimental or statistical techniques' [Kaplan and Duchon 1988].

Lastly, this study was reality-based. The value of this type of approach is the explaining of 'what goes on in organizations' [Avison et al. 1999]. This is important, because as Benbasat and Zmud [1999] contend, the relevance of information systems research is being questioned by the business community at large. The business community, according to the same authors, considers issues covered in current information systems publications to be irrelevant owing to three factors. Firstly, the lack of applicability to reality; secondly a lack of contemporaneous issues; and thirdly inaccessibility, as Banville and Landry [1989] argue that 'statistical methods reduce task uncertainty but 'restrict audiences and give access to prestigious audiences'. Banville and Landry [1989] emphasise that fields like business finance, have 'maintained strong connections with the practitioners, whose problems have always been considered worthy research topics and who, being educated by the academics, have always applied to their practical problems the sophisticated methods they have learned'. Benbasat and Zmud [1999] indicate that what 'tends to be absent is rich, loosely-structured dialogues of the opportunities and problems being experienced in practices and discussions of how these might be examined through academic research'. Owing to the convergent relationship between information systems and software engineering, this argument in favour of interpretive research in information systems holds true for interpretive research in software engineering.

One additional benefit of interpretive research is that the focus does not have to be limited by hypothesis testing and tight experimental control. Instead, the external validity of the actual research question and its relevance to practice is emphasized, rather than restricting the focus to what is researchable by rigorous methods [Fitzgerald and Howcroft, 1998]. Banville and Landry [1989] also corroborate this view with the assertion that the 'normal scientist observes only what his paradigm tells him to observe and most of the observations that do not fit in this tight schema either go on unnoticed or are put aside as irrelevant, or better, for the sake of 'progress' as something that cannot be explained yet'.

When a researcher is motivated to understand the experiences of human beings in terms of a particular process, in this case the risk management process, then phenomenological research is the most appropriate methodology to follow.

Phenomena, according to phenomenological research, are embedded in a web of meaning related to human experiences, that is, things learned via intuition and imagination [Moreno 2001]. In this research the subject under scrutiny was the phenomena of software development risks, under the influence of risk management, experienced by individuals in the software development environment. To distinguish the philosophical underpinnings of phenomenology from other commonly used social ideologies, such as ethnomethodology and hermeneutics, a brief description of phenomenology follows.

Interpretive research in the tradition of phenomenology is concerned with the description [Galliers 1987] and analysis of everyday life [Beynon-Davies 1997]. It concentrates on the common aspects of individual experiences in order to identify themes and social meanings related to the phenomena of interest [Moreno 2001]. Its basis lies in the claim that true knowledge is not the physical but the 'realm of pure thought' [Mingers 2001]. 'Phenomenology is based on the 'intuitive grasping of esssences [sic]' of phenomena' where the essences are more concerned with the 'how' and 'why' than the 'which' and 'what' issues [Hirchheim 1992]. The phenomenon is the 'essence of our experience, which remains after accidents, contingencies and presuppositions we bring to our everyday experience in the life-world are stripped away' [Boland 1985]. Thus 'phenomenology is concerned with the methodical study of consciousness in order to understand the essence of experience' [Boland 1985].

The phenomenological disposition involves giving up the natural science attitude and its assumptions [Mingers, 2001]. The emphasis on intuition, imagination and universal structures in obtaining a picture of the dynamics that underlie the experience, account for and provide an understanding of how it is that particular perceptions, feelings and thoughts are evoked in consciousness [Moustakas 1994]

4. DERIVATION OF THE FRAMEWORK FOR RISK MANAGEMENT ANALYSIS

A review of similar studies indicated that research which correlated strongly with the goals of this investigation, was conducted by Ropponen and Lyytinen [1997] and Kontio et al. [1998]. The limitations of each study were compensated for by the strengths of the other. Therefore, it was necessary to include selective questions from both studies. The study conducted by Ropponen and Lyytinen [1997] was not context-specific but was able to objectively assess the effectiveness of a risk management programme. The qualitative interview template provided by Kontio et al. [1998] considered the contextual and historical factors but was unable to objectively determine the effectiveness of using a risk management programme.

This study was interview-based, adopting a phenomenologically oriented approach in which the respondents were asked about their experiences with software development risks under the influence of software risk management, and their perceptions and perspectives of it. Fitzgerald and Howcroft [1998] assert 'while there may be paradigm incommensurability at the overall ontological and epistemology levels, some plurist ecumenical accommodation is possible at the lower methodological level and indeed even at the axiological level.' Therefore 'epistemological monism can coexist with methodological plurism' [Fitzgerald and Howcroft 1998]. This study contained both qualitative and quantitative methods. Qualitative and quantitative methods are viewed as polar opposites, but an integration forms a richer picture and possibly strengthens findings through triangulation [Fitzgerald and Howcroft 1998] which is the cross-validation achieved when different kinds and sources of data converge and are found to be congruent [Kaplan and Duchon 1988].

The qualitative interview-based survey was based on the case study conducted by Kontio et al. [1998]. This study was done to determine the effectiveness of the RiskIt method. The framework for the RiskIt method is similar to other risk management frameworks. Therefore the interview template was used for this study as well. This interview covered many issues, but the questions extracted were those that were particularly focussed on the contextual issues, risk management infrastructure and the perspectives of risk management (see Appendix A). This study would have sufficed as it covered the goals of this study but the issue of validity was problematic as is the case in any interpretive study. Owing to the subjectivity of the nature of the inquiry, it was obvious that the project managers would justify the use or non-use of risk management and thus be inclined to endorse their approach as successful in dealing with risks. It was evident that there was a need for an objective measure to determine how successfully managers were dealing with risks under their particular perception of risk management.

Ropponen and Lyytinen [1997] sought to measure success in managing typical risk items that normally represent major pitfalls in software measurement. This was termed the 'risk performance measure'. The result is the quantitative survey in Appendix A, which is a list of twenty questions based on Boehm's top ten list [Boehm 1991]. In this survey, project managers were asked how often they experienced a particular event caused by a risk coming to fruition. The purpose of using this survey was to determine how well the respondent was coping with risks. However, this study was not context-specific. The other limitation, which is common with positivistic studies, was those aspects outside the boundaries of the research problem that were ignored. For instance, the political risks that were emphasized by some project managers were ignored. These limitations highlight the problem experienced with studies conducted with a positivistic epistemology. It was these particular limitations that provided the rationale for including the unstructured, interview-based, qualitative questionnaire. In this study, the participant was allowed to add any insight deemed necessary to the discussion.

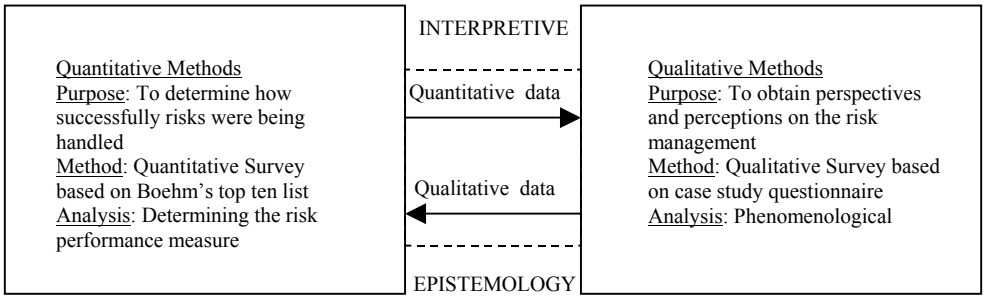

Figure. 1. *An interpretive framework for investigating risk management practices*.

The qualitative survey was used to extract the contextual factors, such as size, nature of the organization and the personal history of the project manager, as well as the perceptions and perspectives surrounding risk management. Thereafter the discourse depended on the level of risk management practised, ranging from ignoring risks to implicitly dealing with risks, to formalized structured processes to deal with risks. The interview emphasizes the cultural aspects such as attitudes to risk management and what types of attitudes foster positive or negative risk behaviour. The purpose of the qualitative survey was to determine how project managers 'perceive' software development risks under the influence of risk management. The subsidiary goals involved determining:

— the factors that result in successful risk management practices;
— the factors that hinder successful risk management;
— the factors that result in 'risk-aversive attitudes';
— the factors that foster risk-aware attitudes.

As a qualitative survey was used to gather this information, the questions had to be recontextualized to coincide with the participant's current practices. For example, if a participant did not practise risk management, the discussion focussed around the factors that lead the participant to negate risk management. The quantitative part of the survey was used to corroborate the qualitative study. For instance, the qualitative survey will ascertain the justification for, and effectiveness of, the use or non-use of risk management, while the quantitative survey will show what effect the use or non-use of risk management has on managing risks. The quantitative survey deliberately does not contain any direct questions about risk management since participants would then structure their answers to justify the use or non-use of risk management.

The proposed framework derived from the two studies discussed above is illustrated in Figure 1. The forward arrow represents the process of determining the risk performance measure from the quantitative survey. It was then compared against the managers' perceptions and perspectives surrounding the usefulness of applying a risk management strategy. The reverse arrow represents how the risk management methodologies affect the risk performance rate. Obtaining qualitative data involved performing phenomenological analysis, which is a method of extracting the essences from a narrative. Initially, the aim is to end up with a list of phrases that are relevant to the experience and abstract them into themes. Thereafter a narrative is created using only themes and essences to form a coherent picture of the actual experience. The next step is to look for explanations to account for that particular experience and finally the two narratives are combined to form a complete picture of the situation. This method helps to reconcile and account for the values obtained from the risk performance measure. For example, if the risk performance measure was low, the analysis involving accounting for the experience can be used to determine 'why' the value is low.

The risk performance measure elicited by the quantitative survey cannot account for experience and the contextual factors, therefore the qualitative survey had to elicit these facts. These contextual factors, in combination with the phenomenological analysis of the experience, formed a richer picture of the experience of the phenomena of software development risks. The qualitative data was hearsay, and therefore had to be measured by some objective mechanism, and the mechanism created by Ropponen and Lyytinen [1997] best served that purpose. It was a means of verifying the account. For instance, a participant might indicate that he does not need risk management as his company successfully deals with risks. If the performance rate is low, then that would indicate that his assessment of the situation is not accurate.

5. RESEARCH DESIGN

The interview approach allows for convergence while still allowing individual perspectives to emerge. Each interview was tape-recorded and transcribed for analysis. There are four reasons why face-to-face interviews were chosen as the data collection method. Firstly, unstructured interviews are characteristic of the philosophical stance adopted, i.e. the

phenomenological stance. Secondly the study of phenomena requires more than one single site and event that are characteristic of action research, case studies, ethnography and grounded theory [Hamilton and Ives 1992]. Thirdly, traditional interpretive methods such as ethnography, case studies and grounded theory are not feasible when dealing with more than one site for the application of the framework, as is the case in this project. These traditional methods are time consuming, and their basic requirement is the process of immersion in organizations. It is difficult to gain long-term access to organizations. The fourth reason is the high level of subjectivity in other methods. As traditional qualitative methods require observational techniques, the researcher inevitably sees what he or she wants to see and the participant demonstrates characteristics of what he or she wants the researcher to see. Therefore, these methods of inquiry are often criticised as highly subjective. The author contends that the best information is first-hand information; and interview techniques were therefore considered more practical in this study.

5.1 Data set

Purposive sampling was used in the study to attain a global perspective of risk management in the South African information technology industry. Therefore, project managers in information technology were selected as the best possible people to give a broader perspective. Project managers are responsible for defining the structure of the software process, and the use or non-use of software risk management will be directly related to their perceptions of it. In quantitative research a larger sample gives more credence to the research. However, with qualitative research taking larger samples, the results in a qualitative analysis of the surveys are turned into a quantitative analysis, as this will be the only way to make 'sense' of the data. This therefore defeats the object of the exercise [Moore 1999]. This study initially opted for ten companies to perform the survey, which is more than the usual number for a qualitative survey but far fewer than for a quantitative survey. Owing to the unavailability of participants, the number of those interviewed was later reduced to seven. The companies interviewed provided different sectors of society with software solutions, from medical information systems, geographical information systems, telecommunication systems, and defence systems to business information systems. The companies ranged in size from eight to fifty people.

5.2 Data Analysis

Inductive data analysis was employed, which involved scanning the qualitative data for categories and relationships among these categories, using transcendental phenomenological analysis. The quantitative data was used to calculate a risk performance measure for each participant, which determined how well risks were being dealt with.

5.3 Validity of the Instrument

Both the qualitative survey and quantitative survey had been fully validated before. Both have been used in published research by Ropponen and Lyytinen [1997] and Kontio et al. [1998]. The validity of interpretive research is largely based on 'acceptance by the scientific community' [Lacity and Janson 1994], where knowledge is validated not by forming arbitrary distinctions between theory and data but by appeal to logical consistency, and agreement with the interpretations of participants [Stone 1990]. Validity in an interpretive approach is achieved through the process of triangulation. In this study the quantitative survey serves to corroborate the qualitative data. According to Checkland [1995] the validity of a soft approach can be justified if it serves the purpose of organizational learning. One can conclude that the proposed framework aims exactly at enhancing organizational learning on how to improve software development risk management.

5.4 Limitations of the Framework

An interpretive approach acknowledges that the researchers have biases and that subjectivity is intrinsically linked to the conducting of the study, i.e. the researcher invariably influences the study by focusing on certain key areas.

6. DISCUSSIONS ON FINDINGS

In order to carry out an experimental validation of the framework, it was applied to an exploratory investigation of risk management practices in several software organizations to determine the perspectives and perceptions of risk management. The following summarized conclusions were found in relation to the research inquiry from the themes extracted from the transcripts.

Factors that resulted in software development risks being managed successfully, irrespective of using implicit or explicit risk management, were firstly the experience of project managers and secondly the nature of the application developed. For example, developing software in similar contexts made controlling risks easier and more predictable.

There are three factors that impede the successful practice of risk management: the misconceptions surrounding the application of risk management; the difficulties encountered when trying to implement it; and ignorance about risk management practices. The misconceptions arose through viewing risk management as being implicit in the planning or specification phase or viewing risk as challenges, therefore negating the need for risk management. The other misconception is that risk management caters specifically for generic risks and therefore cannot be tailored to specific risk concerns. Some of the problems in implementing risk management were the result of difficulties in identifying and

quantifying risk since these processes are difficult to translate into reality. Small companies do not see the need for formal processes as they feel these will stifle creativity. Tertiary-level education in terms of risk management is not enough to allow one to apply it in reality. Software project managers have exacerbated this ignorance by not providing training in risk management and placing more emphasis on technical training.

The negative attitudes towards risk management arose out of the misconceptions alluded to earlier, such as:

— Equating risk management to risk avoidance.
— Equating risk management to crisis management.
— Equating risk management to problem solving.

The ability to identify risk without fear of recriminations is vital. Therefore it is important to promote risk-seeking attitudes to facilitate the risk identification process. The following factors were found to foster risk-aware attitudes:

— Promoting client-centric values because risk identification is about adding value for the client.
— Prioritising learning from past mistakes as this can help individuals overcome past shortfalls.
— Dealing with familiar operating environments improves the project manager's ability to identify and deal with risks. Under these circumstances software developers tend to rely more on intuition than formal processes.

The framework can serve as a tool for exploratory analysis of risk management practices in a particular environment. During the course of the discussions, the project managers surveyed became increasingly aware of the benefits of a risk management strategy and some even indicated their willingness to adopt such a method. It is in the light of these comments that one can maintain that the framework can be used in several ways within organizations to improve their risk management strategies:

— It can be used as a way of testing the reliability or efficiency of a particular risk management strategy.
— It can be a means to alert software managers to the need for a better risk management strategy.
— It can be used as a mechanism to establish and improve a risk management process concentrating on the attributes that need to be addressed in terms of culture, policy, methods, tools, skills, competence, infrastructure and documentation.
— It can be used to determine areas of weakness in terms of schedule risks, system functionality risks, subcontracted risks, requirements management risks, resource risks and personnel risks by categorizing the quantitative survey into these areas.
— It contains both structured and unstructured questions. The structured questions help focus the discussion on software development risks only. The unstructured interview allows free flow discussions, which is a backdrop to effective risk communication.

This framework elicits two types of data, quantitative and qualitative, which can be easily and quickly administered. The calculations involved do not require any specific knowledge of risk analysis or statistical analysis. This analysis does not endorse any particular risk management strategy, since it is important that each organization develops and tailors risk management strategies according to its nature. It therefore also encourages a risk management strategy that goes beyond just a risk management process but a process that considers other issues that are often neglected by risk management frameworks – issues such as culture and policy making and learning from past mistakes.

In Ropponen and Lyytinen's [1997] study, it was concluded that the longer the experience with risk management methods, the better the project manager's performance in estimating the project size, and the less the chances of project delay. There is an indication that experience plays a significant role in uncovering risk, but this is not necessarily owing to experience in risk management as such. It is probably due to having an intuitive handle on what can go wrong and preparing for it. Therefore the author tends to favour one of the other findings that Ropponen and Lyytinen [1997] uncovered, that is, performance in managing risk seems to be a function of better managerial cognition, commitment and the use of a proactive management style, rather than a specific risk management technique.

Ropponen and Lyytinen [1997] found that the factors that influenced development process were size, project management experience and project management training. This study also revealed two other factors, which were the familiarity of the operating environment and the nature of the application. Ropponen and Lyytinen [1997] offered the solution of reducing the size of projects, training project managers and standardising components as a way of minimising risks. The author offers one more solution, which is developing systems for specific environments, thereby increasing the reuse of components, and increasing experience in particular applications.

7. CONCLUSIONS

Any generalisations indicated in this study must be treated with caution given the nature of the study and the number of participants involved in it. Any comments should be considered as observations rather than causal relations. The purpose of this study was to introduce a framework for investigating risk management practices in a particular software company with the aim of gaining a better understanding of the issues related to them and improving them, rather than generalising results.

The participants did indicate that risk management was a positive step. However, they took two opposing views on whether or not it is warranted. One view was that risk management is project management and no actual distinction is made between the two. Project managers indicated that the principles of risk management were applied ‘unconsciously’.

The second view was that risk management was inappropriate to their contexts and unnecessary for smaller companies. It seems that both views are indicative of the necessity for improving the current understanding of what risk management can contribute to organizations.

It cannot be concluded that risk management as practised by the organizations concerned is ineffective, but rather that there are many misconceptions and a lack of knowledge surrounding it. The ignorance factor is perpetuated by the lack of training both at tertiary level and at company level. Another possible reason, which was not uncovered by the research itself, could be that software project managers do not keep up with current trends that are documented in scientific journals. This factor corroborates the premise of this research expressed earlier regarding the need to link practice and research, and the fact that software project managers do not utilise the methods developed under the positivist paradigm because it is seen as being inapplicable to reality and their contexts. The ignorance factor can be overcome by universities adopting a proactive approach to teaching risk management in a reality-based fashion, while the last factor can be influenced by journals facilitating research conducted in the interpretivist paradigm, as in the example of the Management Information Systems Quarterly.

In this study it was found that although project managers had very little knowledge concerning risk management, they expressed keen interest in the concept and felt that it could be a positive influence. However, software risk management can only be positive with the following stipulations: it must have a balanced structure; it must not be too rigid but at the same time it must have sufficient commonalities to facilitate it; the costs of implementing it must not outweigh the cost of applying it; it is also vital that risk management does not take up too much time or resources. As with software process models, risk management suffers the same fate under restrictions. If there is no time, or money, these processes are abandoned along the way. In the research conducted by Ropponen and Lyytinen [1997] it was discovered that spending too much time on risk management is also detrimental. The more structured risk management becomes, the more difficult it is to apply. Risk management tends to be applied intuitively by experienced managers. It is this inductive process that must be facilitated by fostering risk-aware cultures.

The interpretive framework developed served two different but complementary functions for this research. As an experimental validation of the framework, it was applied to an exploratory investigation of risk management practices in several software organizations in order to determine the perspectives and perceptions of risk management. The analysis of the discussions with the participating software managers regarding the interpretive framework adopted for the investigation of risk management practices demonstrated the framework's potential as a tool for enhancing software development risk management.

A. APPENDIX A: THE INSTRUMENT USED IN THIS INVESTIGATION

Part One: Survey Questions (adapted from Ropponen and Lyytinen [1997])
Subjects were given this questionnaire to fill in before the interview. Participants had to choose one alternative based on how often the described scenario occurs:

Hardly Ever	1	Rather Seldom	2	Half	3	Rather Often	4	Almost Always	5

Scenarios:

1. Your project has considerable problems due to personnel shortfalls.
2. Your project is completed according to the timetable.
3. Resource consumption reaches its zenith as you approach your project deadline.
4. Actual project costs and estimated costs are nearly equal in your projects.
5. Your project is cancelled before it is completed.
6. A failure to estimate project size interferes considerably with implementation.
7. Demand for personnel is estimated correctly in your project.
8. Time consumption of your project is constant.
9. Your personnel's expertise in methods, software and equipment is insufficient.
10. The complexity of your project and its effect are easy to manage.
11. Developed software functions and properties meet user's needs.
12. Developed software includes complex, but only marginally useful properties.
13. Software requirements are continuously changed.
14. Your project timetable is changed continually.
15. Users are not satisfied with the implemented user interface.
16. Externally purchased components and equipment meet your expectations in your project.
17. You have unrealistic expectations of the project members' skills.
18. Performance requirements (response time, computing efficiency) are estimated incorrectly.
19. Subcontracted tasks in the project are performed as expected.
20. Software and hardware capabilities are estimated incorrectly.

Part Two: Interviewing Guidelines and Questions
The interviewee would be briefed as follows:
The purpose of this interview is to collect your observations and experiences from the risk management perspective. It is of vital importance that you answer the questions as objectively and candidly as possible. The interview information is used for research purposes only.
Questions
1. The following background information was elicited:
— Interviewee's Name
— Position at Organization
— Years of Experience in Project Management
— Years of experience in risk management?
— How much training have you received in risk management?
— What is the size of your organization?
— What is the nature of your applications?

Interview Questions (adapted from Kontio et al. [1998])
2. In your own words, characterize your project's risk management infrastructure along main attributes:
— Culture – the level of awareness about risk management; attitude towards risk and risk management; risk averse/risk taking,; is the discussion of risks encouraged?, is risk management recognised as a legitimate activity?
— Policy – the stated management commitment to risk management and how it is enforced
— Methods – what methods and techniques are used and supported for risk management?
— Tools – what tools and templates are used in risk management?
— Skills and competence – what risk management skills and competencies exist? What training is available and given to personnel for risk management?
— Support structure – what type of organizational support exists to help perform risk management in projects? How many resources are made available for this task?
— Experience-capture process – what mechanisms exist to capture, accumulate and analyse risk management experience?

3. Concluding Questions
— Overall, what was the impact of risk management in a project?
— What are the most critical problem areas in risk management?
— What techniques would require more clarification or help?

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REFERENCES

AVISON, D., LAU, F., MYERS, M. AND NIELSEN, P.A. 1999. Action Research. *Communications of the ACM* 42,1(Jan.), 94-97
BANDYOPADHYAY, K., MYKTYN, P.P, AND MYKTYN, K. 1999. A framework for integrated risk management in information technology, *Management Decision* 37, 5, 437-444
BANVILLE, C. AND LANDRY, M. 1989. Can the field of MIS be disciplined. *Communications of the ACM* 32,1(Jan.), 48-60
BARKI, H., RIVARD S. AND TALBOT, J. 1993. Towards an Assessment of Software Development Risk. *Journal of Management Information Systems*, 10,2 (Fall), 203-225
BASKERVILLE, R.L. AND STAGE, J. 1996. Controlling Prototype Development through Risk Analysis. *MIS Quarterly* 20,4(Dec), 81-503
BENBASAT, I. AND ZMUD, R.W. 1999. Empirical Research in Information Systems: The Practice of Relevance. *MIS Quarterly* 23,1(March), 3-16
BEYNON-DAVIES, P. 1997. Ethnography and information systems development: Ethnography of, for and within IS development. *Information and Software Technology* 39, 8 (Aug.), 531-540
BOEHM, B.W. 1991. Software Risk Management: Principles and Practice. *IEEE Software* 8,1(Jan.), 32-41
BOEHM, B.W. 2000. Project Termination doesn't equal project Failure. *IEEE Computer* 33, 9(Sept.), 94-96
BOLAND, J. 1985. Phenomenology: A preferred Approach to Research on Information Systems. In Research methods in information systems, proceedings of the IFIP WG 8.2 Colloquium, E. Mumford, R. Hirschheim, G. Fitzgerald and T. Wood-Harper ,Eds. Elsevier, Amsterdam 193-201.
CHAPMAN, C.B. AND WARD, S.C. 1997. *Project risk management: processes, techniques and insights.* Wiley, Chichester
CHARETTE, R.N. 1996. Large Scale Project Management is Risk Management. *IEEE Software* 13,4(July), 110-117
CHECKLAND P. 1995. Model Validation in Soft Systems Practice. *Systems Research.* 12,1(March), 47-54.

CHITTISTER, C. AND HAIMES, Y.Y. 1993. Risks Associated with SoftwareDevelopment: A Holistic Framework for Assessment and Management. *IEEE Transactions on Systems, Man and Cybernetics* 23,3 (May/June), 710-723

DUTTA, S., VAN WASSENHOVE, L.N. AND KULANDAISAMY, S. 1998. Benchmarking European Software Management Practices. *Communications of the ACM* 41,6(June), 77 - 86

FAIRLEY, R. 1994. Risk Management for Software Projects. *IEEE Software.* 11,3 (May/June), 57-67

FITZGERALD, B. AND HOWCROFT, D. 1998. Towards Dissolution of the IS Research Debate: From Polarisation to Polarity. *Journal of Information Systems* 13,4 (Dec.), 313-326

GALLIERS, R.D. AND LAND, F.E. 1987. Choosing an appropriate information system research methodologies. *Communications of the ACM* 30,11(Nov.), 900-902

GEMMER, A.1997. Risk Management: Moving Beyond Process. *IEEE Computer* 30,5 (May), 33-43

HAMILTON J.S. AND IVES B.1992. MIS Research Strategies. In *Research methods in information systems: proceedings of the IFIP WG 8.2 Colloquium,* E. Mumford, R. Hirschheim, G. Fitzgerald, and T. Wood-Harper, Eds. Elsevier, Amsterdam, 132-143

HIRSCHHEIM, R. 1992. Information Systems Epistemology: An Historical Perspective. In *Information systems research : issues, methods, and practical guidelines.* R. Galliers Ed. Blackwell Scientific Publications, Oxford, 28-60

KAPLAN, B. AND DUCHON, D. 1988. Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study. *MIS Quarterly* 12, 4(Dec.), 571-586

KEIL, M., CULE, P.E., LYYTINEN, K. AND SCHMIDT, R.1998. A Framework for Identifying Software Project Risk. *Communications of the ACM* 41,11(Nov.),76-83

KITCHENHAM, B. AND LINKMAN, S.1997. Estimates, Uncertainty and Risk. *IEEE Software* 14,3 (May/June), 69-75

KLEIN, G. AND JIANG, J.J. 2001. Seeking consonance in information systems. *Journal of Systems and Software* 56,2 (March), 195-202

KONTIO, J., GETTO, G. AND LANDES, D. 1998. Experiences in improving Risk Management Processes using the concepts of the Riskit Method. In *Proceedings of the ACM SIGSOFT 6th international symposium on Foundations of software engineering* ACM Press, New York,163-174.

LACITY, M.C. AND JANSON, M.A. 1994. Understanding Qualitative Data: A Framework of Text Analysis Methods. *Journal of Information Systems* 11, 2 (Fall), 137-155

LYYTINEN, K., MATHIASSEN, L. AND ROPPONEN, J. 1998. Attention Shaping and Software Risk-A Categorical Analysis of Four Classical Risk Management Approaches. *Information Systems Research* 9,3(Sept.), 233-251

MINGERS, J. 2001. Embodying information systems: the contribution of phenomenology. *Information and Organization* 1,2 (April),103-128

MOORE, N. 1999. *How to do research: the complete guide to designing and managing research projects* (3rd ed). Library Association, London

MORENO, V. JR. 2001. On the social implications of organizational reengineering. *Information Technology & People* 12, 4, 359-389

MOUSTAKAS, C. 1994. *Phenomenological research methods.* Sage publications, Thousand Oaks

MOYNIHAN, T. 1997. How experienced Project Managers access risk. *IEEE Software* 14,3 (May/June), 35-41

PRESSMAN, R. S. 1997. *Software Engineering - A practitioner's approach* (4th ed), McGraw-Hill, New York

ROPPONEN, J. AND LYYTINEN, K. 1997. Can software risk management improve system development: an exploratory study. *European Journal of Information Systems* 6,1,(Feb.), 41-50

STEEN, M. 1997. Avoiding the Pitfalls of Risk. *InfoWorld* 19, 51/52 (Dec), 75-77

STONE, D.N. 1990. Assumptions and Values in the Practice of Information System Evaluation. *Journal of Information Systems* 4, 3 (Fall), 1-18