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The influence of intervening conditions on the over-and underestimation of risk

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THE INFLUENCE OF INTERVENING CONDITIONS ON THE OVER- AND UNDERESTIMATION OF RISK

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ABSTRACT

Project risk management is the systematic utilisation of a process by project managers to identify, analyse and respond to risks posed by events and conditions that are not definitely known in advance but which may adversely affect IT project success. However, although best practice standards in project risk management are applied in information technology (IT) project management, IT project managers seem unable to accurately predict and manage risk. Thus, this study aims to investigate the extent to which project managers in IT project over- and underestimate risk and to what degree their failure in accurately managing risks influences is caused by risk related factors. Findings indicate that project managers tend to considerably under- and overestimate risk. The underestimation of risk is found to have been caused by factors such as lack of knowledge or the preference to wait until risk materialises. An important implication of the research is that the prevention of these causative risk related factors may enable IT projects to increase the accurateness of their predictions regarding project risk and subsequently to increase the effectiveness of project risk management.

Keywords: Project Management, Risk, Effectiveness

1. INTRODUCTION

A project is an undertaking to create something that does not yet exist (Young, 1998), ideally with a defined scope which needs to be delivered in a defined time at an agreed cost (Buttrick, 1997). Projects may be considered to have failed when expected scope, cost and time targets are not met, expected benefits are not realised, or a stakeholder is dissatisfied with an aspect of the process or outcome. In particular IT projects, the provision of a service to implement systems and solutions, including a variety of hardware and software products (Howard, 2001), have a high rate of failure (McGrew & Bilotta, 2000; Whittaker, 1999). According to practitioners surveyed by Whittaker (1999), IT project failure is most commonly attributed to lack of top management involvement, a weak business case and inadequate risk management. The primary contributing factor to project failure was identified as project risk management (Whittaker, 1999). Project risk management is the systematic process of identifying, analysing, and responding to risks as project related events or conditions which are not definitely known, but have the potential to adversely affect a project objective (Project Management Institute, 2000). Despite the use of well established and accepted project risk management processes such as PMI 2000, Prince 2 or PRAM, project managers commonly perceive these processes as not effective for managing project uncertainties (Pender, 2001; Whittaker, 1999). Research has shown that individuals misestimate risks (e.g. Estrada, 2000). Individuals may under- and overestimate risks and may take precautions with respect to risks that do not materialise as predicted. However, there is little agreement as to what extent individuals, in particular project managers in the IT industry, under- or overestimate risk and what factors drive the discrepancy between planned and materialised risk. This study builds upon prior work on risk related conditions such as lack of knowledge which constrain the effective management of project risk. It examines the influence of theses specific conditions on the extent to which IT project manger's misestimate project risk.

2. THE CURRENT SUCCESS RATE OF IT PROJECTS

The various statistics on the outcome of IT projects indicate that projects generally tend not to be completed on time or on budget (Kartam & Kartam, 2001; Schmidt, Lyytinen, Keil, & Cule, 2001; The Standish Group International Inc., 2004). One survey revealed, that only twenty-six percent of all IT development projects are on time and budget (Hormozi, McMinn, & Nzeogwu, 2000). The TechRepublic Study by the Gartner Group shows a similar picture. In 2000, 1,275 North American IT specialists were asked about the outcome of internal IT projects. The analysis of the data showed that forty percent of all IT projects were considered to have failed. The projects considered to have failed, by the Gartner Group, were on average suspended after fourteen weeks and at which time approximately $1,000,000 had on average been invested. Whittaker (1999, p. 29) argued: "(Inadequate) risk management remains the highest ranked factor contributing to project failure, …".

3. ALTERNATIVE MODELS OF BEST PRACTICE PROJECT RISK MANAGEMENT STANDARDS

The basic structure of 'best practice' project risk management processes in IT-project management does not differ significantly between those established by the British Standards Institution (British Standards Institution, 2000), The Government Centre for Information Systems (CCTA - The UK Government Centre for Information Systems, 1995) or the U.K. Association for Project Management (Chapman, 1997; Chapman & Ward, 2000) (Gaulke, 2002). Regardless of the number of phases and definition of phases the processes have one activity in common: "an activity that deals with planning actions that will be implemented in order to reduce the exposure to risk" (Ben-David & Raz, 2001, p. 14).

All the project risk management processes aforementioned heavily rely on planning. Three components of risks are planned before any actions are taken: threat, consequence, and the modifying factor (response). A threat (a source of danger) may, for example, be environmental turbulence (i.e. constantly changing, highly uncertain and ambiguous), which could have adverse results on resources. Resources are components of a project such as budget, personnel and material that could be affected by threats (Burghardt, 1995). Consequences relate to the potential of risk to negatively influence on the project outcome (Project Management Institute, 2000). Risk can lead to losses that range from trivial to large (Crockford, 1986). Modifying factors increase or decrease the likelihood of its threat becoming a reality or the probable consequence of such a reality. A project manager may modify or change risk by reducing the likelihood of a threat to materialise or the severity of its consequences or both through executing response actions.

The result of risk processes such as those defined by the PMI (Project Management Institute, 2004) and CCTA (CCTA - The UK Government Centre for Information Systems, 1995) is a decision based on the expected utility of different choices (Ekenberg, Boman, & Linnerooth-Bayer, 2001; Kahneman & Tversky, 1979; Pender, 2001). Expected utility is "a weighted average of the utilities of all the possible outcomes that could flow from a particular decision, where higher-probability outcomes count more than lower-probability outcomes in calculating the average" (Borge, 2001, p. 21). The utility of decision making choices are weighted by their probabilities and outcomes (Arrow, 1983; Borge, 2001; Kahneman et al., 1979). Expected utility theory (EUT) has generally been accepted in risk literature as a model of rational choice for taking risky decisions (Anand, 1993; Borge, 2001; Jaeger, Renn, Rosa, & Wehler, 2001; Kahneman et al., 1979) and is considered a very fruitful framework for decision-making under risk (Einhorn & Hogarth, 1986). Rationality can be defined as "agreeable to reason; not absurd, preposterous, extravagant, foolish, fanciful, or the like; intelligent, sensible" (Simon, 1978, p. 2).

As part of project risk management, project managers identify, analyse and respond to risk that may or may not occur as predicted. Pablo (1999, p. 102) and Jemison (1987, p. 1088) argued that risk is an *ex ante* construct (planned risk), which leads to an actual *ex post* outcome (actual risk). Planned risk can

be lower or greater than the actual risk (Ritchie & Marshall, 1993). Project managers may attach greater risk to a project than the project actually inherits or they may predict greater effects than actually exist. That is, in the process of project risk management, project managers may misestimate risks. Project managers can misestimate risk in two ways: they can first under- and/or second overestimate risk. The underestimation of risks could adversely influence a project outcome if threats arise that project managers did not identify in advance or have greater than expected consequence on the project outcome. On the other hand, project managers may overestimate risk, as project managers predict threats that do not materialise, do materialise but with lower predicted consequence or are met with a response that has a higher effect than actually necessary.

4. RESEARCH INTO FACTORS LEADING TO OVER- AND UNDERESTIMATION OF RISK

When project risk management is used, problems in its application tend to arise. Some researchers reported that project managers have difficulties in analysing risks (e.g. Bryne & Cadman, 1984; Teo, Quah, Torrance, & Okoro, 1991). Building upon previous research, Kutsch and Hall (2006) conducted an investigation into the kinds of barriers or intervening conditions, defined as risk-related factors interfering with the orderly management of project risk by project managers, which impacted on the effective management of project risk in IT projects. In the analysis of a number of in-depth interviews, they established a five-fold typology, describing intervening conditions that intervened or interrupted the rational management of risk during their projects. Those intervening conditions show a high degree of similarity to the problems that were identified in the literature review. These are summarised in Table 1.

Intervening conditions	Definition	Description
Denial of risk	The refusal by risk actors to reveal risks to other stakeholders that may hold negative or discomforting connotations.	**Risk as a "taboo** Denial of risk in order not to expose stakeholders to something perceived as negative. Denial of risk in order not to jeopardise long-term relationship with stakeholders. Denial of risk in order not to be perceived as a "doomsayer". Denial of risk in order to present the project as being "certain" and "certainly" successful for stakeholders.
Avoidance of risk[1]	Lack of attention to risks	**Lack of trust in risks** Avoidance of risk because of mistrust between risk actors. Avoidance of risk because of colliding confidence levels about risk estimates between risk actors. Avoidance of risk because of colliding perceptions of risk actors about the legitimacy to manage certain risks.
Delay of risk	Failure to consider or proactively resolve risk	**Colliding risk management preference** Delay of risk because of different expectations of risk actors about how to manage risk (proactive or reactive).
Being ignorant of risk	Incomplete knowledge of risk	**Lack of information** Ignorance of risk because of the inability to scan and interpret the environment.
Ignoring risk		Ignorance of risk because of deliberate limited scanning of the environment.

Table 1: Overview of intervening conditions

In the typology shown in Table 1, denial of risk by risk actors relates information that project stakeholders found troubling because of its discomforting character. Avoidance of risk, on the other

[1] Not to be mistaken with avoidance as a risk response strategy

hand, applies to risks estimates that are conflicting. Delay of risk emphasises the preference of risk actors to adopt a reactive approach to risk management and to wait until risk resolves itself. Finally, the intervening condition of 'being ignorant' describes the action of risk actors of 'ignoring', the deliberate inattention of project managers towards risk. It is different from 'being ignorant of risk' in that project managers may be aware of risks, but they may exclude them from management as they are considered beyond the scope of their responsibility.

Intervening conditions as described above appear to constrain project managers in their ability to effectively manage risk. They pose "barriers to preventive action" (Adler, Kegeles, & Genevro, 1992, p. 234). Lack of knowledge, for example, as a criterion of being ignorant of uncertainty seems to lead to risks being overlooked by project managers. Overall, this intervening condition imposes a constraint on the management of risk by project managers despite the benefits of managing risks for the purpose of reducing uncertainty (with the possibility of adverse consequences on the project performance). These mediators may be not be created deliberately by risk actors but can also be described as "affective impulses" (Slovic, Finucane, Peters, & MacGregor, 2002, p. 10). As Freudenberg (1992, p. 249) suggests: "Instead, the problem is that a variety of factors that are far more subtle - unseen, unfelt, and yet unfortunate in their consequences - exert an influence that could scarcely be more disturbing even if they were based on deliberate malice".

Regarding the issue of over- and underestimating risk, few attempts have been made to investigate the discrepancy between predicted or planned risk and actual risk or the over- and underestimation of risk. Tversky and Kahneman (1974) investigated the impact of individuals' experiences of event on their estimation of similar future events. Those with a more recent experience tend to believe that the events will be more likely to happen again, therefore overestimating its probability of occurring. Estrada (2000), for example, came to the conclusion that investors investing in the European securities market underestimated the risk of stock returns. Other results indicate, that individuals overestimate low risks and underestimate high risks (Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978). Misestimating risk and their probabilities has also been the subject of other studies. Wright and Ayton (1989) come to the conclusion that personal events which could unfold within a time frame of four weeks were associated with an increased probability. Milburn (1978) focused on non-personal events and argues that in the last four decades undesirable events were considered to occur less likely.

Nevertheless, the findings of these and other studies show first that there is little agreement among researchers whether and to what extent individuals tend to over- or underestimate risks. Second, such studies mostly assess under- and overestimation of the probability of events occurring, but taking into account that risks include three dimensions (threat, consequence, response) they neglect to determine whether consequences and especially responses were under- and overestimated. Third, the findings fall short in explaining the effectiveness of project managers in accurately estimating risk in the specific research context of IT projects. The studies were mainly conducted in research contexts significantly different to the one in this study. Finally, such studies fail to explain the influence of risk related intervening conditions such as these described before on the project manager's degree of over- and underestimation of risk. Hence, as shown in Figure 1, this study aims to investigate to what extent intervening conditions lead to the project manager's perception of over- and underestimating risk.

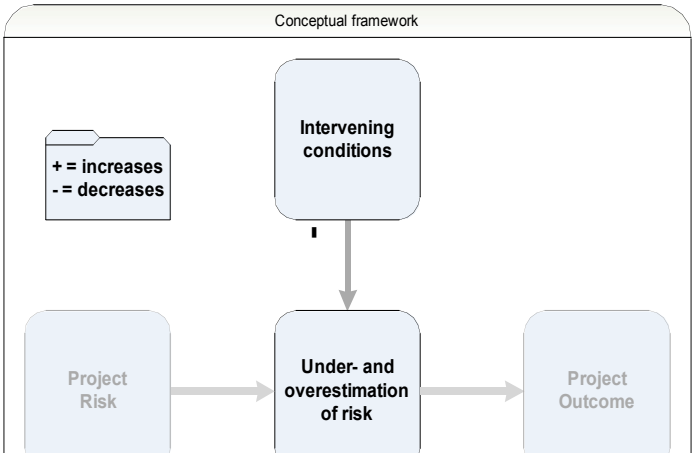

Figure 1: Conceptual framework

The investigation of whether and to what extent intervening conditions constrain the IT project manager in effectively predicting risk is of importance as over- and underestimated risk may ultimately influence the project outcome.

5. METHODOLOGY

5.1. Research Context

The research problem was empirically investigated in the context of IT projects within organisations such as Computer Service Providers (CSP). Firms in this line of business included Unisys and IBM as stand-alone providers. In addition, many firms have this function provided as an in-house support function. Typical services that are provided, include "planning, operation, implementation and use of computer hardware, computer software and computer personnel" (Howard, 2001, p. 2). Examples of projects include 'Roll Outs', the implementation of 'User Help Desk' structures or 'Outsourcing' projects. In 2001 in the UK, services alone represented £20 billion in turnover for the stand-alone CSPs of which approximately 50% of this service volume were delivered through project work (Howard, 2001, p. 8) with the help of project risk management.

5.2. Sample

The sample of respondents for the survey stage was determined randomly using a cluster sample. The unit or cluster in the first pilot stage of the explanatory phase included two CSPs. The sample size for the pilot survey was approximately 70; the population of which consisted of project managers in IT related projects who are employed for one particular CSP. The second cluster sample in the main stage of the survey was composed of 2200 project managers who are member of the Project Management Institute Risk Management Specific Interest Group (RiskSig) and the specific risk interest group of the Association for Project Management. Slightly less than a third of these registered project managers, approximately 750, are specialists in conducting IT projects and these were invited to take part in the survey. A total of 102 useable responses were received, a response rate of more than 7%.

The profile of the sample is shown in Table 2. The sample consisted predominantly of IT project managers involved in Roll Out projects. Such projects include the implementation of computer systems. This implementation may involve the installation of hard- and software and often the migration of data from an old to a new system. Furthermore, a relative high number of projects lasted between 6 – 12 months. The minimum value of the projects was £47,000, with the majority of projects being in excess of £1m.

	Number of IT project manager involved	*Percentage*

Type of project		
Outsourcing	16	15.7
Implementation of user help desk structures	3	2.9
Software development	24	23.5
Roll Out	39	38.2
Other types of IT projects	20	19.6
Time Frame		
> 24 months	26	25.5
12 – 24 months	20	19.6
6 – 12 months	32	31.4
< 6 months	24	23.5
Project Value		
> £1,000,000	46	45.1
£100,000 - £1,000,000	39	38.2
£10,000 - £100,000	14	13.7
< £10,000	3	2.9

Table 2: Profile of sample

In each case, the survey participants were asked to respond to a list of questions regarding whether the project they were currently involved with, or their most recent project.

5.3. Design

Project managers may attach greater risk to a project than the project actually merits. In the process of project risk management, project managers may misestimate risks, their *ex ante* estimation about risk may be lower or higher that the *ex post* outcome of risks (actual influence of risk on the project outcome).

The degree of misestimating risk, that is to say the divergence between *ex ante* estimated and *ex post* materialised risk can be determined by its degree of over- and underestimation. Bearing Milliken's recommendation to distinguish between three types of uncertainty in mind, underestimation of risk (*ex ante* estimated risk < *ex post* outcome of risk) by the project manager implies, that

- either uncertainties with probable negative effects have not been identified but actually materialised, **and/or** probabilities have been assessed as lower than their actual value (underestimation of state uncertainty)
- and/or consequences of identified uncertainties have been assessed as lower than their actual value (underestimation of effect uncertainty),
- and/or responses have a lesser impact than predicted (underestimation of response uncertainty).

Overestimation of risk (*ex ante* estimated risk > *ex post* outcome of risk) by the project manager means that

- uncertainties have been identified but not actually materialised **and/or** probabilities have been assessed as higher than their actual value (overestimation of state uncertainty),
- and/or consequences of identified uncertainties have been assessed as higher than their actual value (overestimation of effect uncertainty),
- and/or responses have a bigger impact than predicted (overestimation of response uncertainty).

In terms of design of the survey, respondents were asked to answer to what extent six types of over- and underestimation occurred in their IT project on a Likert Scale 1 (not at all) – 5 (to a great extent). In detail, the questions about the degree of over- and underestimations were stated as follows: "To what extent a) did predicted risk events actually NOT materialise? b) were the actual consequences of risk events MORE severe than predicted? c) were the actual consequences of risk events LESS severe than predicted? d) did actual risk mitigation actions BETTER than predicted? e) did actual risk mitigation actions WORSE than predicted? f) unpredicted risk events actually materialise?"

Concerning the intervening conditions, the questions were derived from a previous study investigating intervening conditions (Kutsch et al., 2006). The respondents were questioned as to what extent those intervening conditions occurred in their projects. Specifically, they were asked to what extent risks were perceived as being uncomfortable for one or more project stakeholders (denial of risk), outside the scope of risk management (ignoring risk), not agreed on by one or more stakeholders (avoidance of risk), managed once they materialised rather than before (delay of risk), and not visible until they materialised (being ignorant of risk).

6. FINDINGS

Concerning each intervening condition influencing the application of project risk management, Table 3 provides an overview of the extent to which each intervening condition occurred in the investigated projects.

Variable	*Mean (SD)*
Denial of risk	3.59 (1.15)
Ignoring risk	3.00 (1.20)
Avoidance of risk	2.65 (1.89)
Delay of risk	3.18 (1.23)
Being ignorant of risk	3.12 (1.27)

Table 3: Mean values of intervening conditions variables (Scale: 1 – not at all, 5 – to a great extent)

On average, most of the intervening conditions apart from avoidance, occurred "to some extent". The next step is to determine the relationship between intervening conditions (see Table 4).

Variable		1	2	3	4
1	Denial of risk	1			
2	Ignoring risk	.047	1		
3	Avoidance of risk	.124	.207	1	
4	Delay of risk	.046	.434**	.278**	1
6	Being ignorant of risk	-.093	.294**	.271*	.473**

**. Correlation is significant at the .01 level
*. Correlation is significant at the .05 level

Table 4: Correlations between intervening risk conditions

Denial of risk is not significantly correlated with other intervening conditions. However, both types of ignorance of risk are significantly correlated with delay of risk, while avoidance of risk is less significantly related with Being ignorant of risk and delay of risk. Although it is difficult to determine which variable causes which (George & Mallery, 2003), risk actors' attention towards reactive risk management or the mere inattention towards proactive project risk management is likely to lead to the ultimate ignorance of risks. Project managers may not even attempt to identify threats for the reason that they are not interested in pursuing a proactive risk management approach. Hence, delay of risk may ultimately trigger ignorance of risk by risk actors.

A factor analysis resulted in the extraction of one factor including the variables of ignoring risk, avoidance of risk, delay of risk and being ignorant of risk can be extracted. Denial of risk as a variable was dropped. However, no conceptual reason behind this decision can be stated with confidence.

Regarding the concepts of over- and underestimation, their mean scores are displayed in Table 5:

Variable	*Mean (SD)*
Underestimation of state risk	3.23 (1.13)
Underestimation of effect risk	2.97 (1.28)
Underestimation of response risk	3.06 (1.49)
Overestimation of state risk	2.99 (1.18)
Overestimation of effect risk	2.53 (1.31)
Overestimation of response risk	3.34 (1.32)

Table 5: Mean values of over- and underestimation of risk variables(Scale: 1 – not at all, 5 – to a great extent)

Apart from overestimation of response risk, project managers tended to under- and overestimate risk to some extent. Their predictions about the existence of threats effect and responses tended to vary from the actual threats, effects and responses. The findings regarding the degree of over- and underestimation may reflect the lack of effectiveness and the level of difficulty project managers encountered during the process of managing risks.

While the results of underestimation of state, effect risk and overestimation of state and response risk are similar, the amount of overestimation of effect risk is significantly lower. This could be explained by the fact that due to the pressure to portray an IT project in a positive light, the effects of risks were kept to a minimum.

A subsequent step before the factor analysis was to determine the correlation between all over- and underestimation of risk variables (see Table 6).

Variable		1	2	3	4	5
1	Underestimation of state risk	1				
2	Underestimation of effect risk	.371**	1			
3	Underestimation of response risk	.291**	.234**	1		
4	Overestimation of state risk	.181	.154	.203	1	
5	Overestimation of effect risk	-.185	.150	-.027	.344**	1
6	Overestimation of response risk	-.165	-.103	.099	.303**	.334**

**. Correlation is significant at the .01 level
*. Correlation is significant at the .05 level

Table 6: Correlations between over- and underestimation of risk variables

The results show that all overestimation of risk variables and all underestimation of risk variables are significantly related. A factor analysis underlined this pattern of correlations. The first factor or composite consists of all three underestimations of risk, the second of all overestimation of risk variables.

In the previous sections, I provided descriptive statistics about the means and relationship of variables used in the survey and the extraction of composite variables. This section is concerned with providing an overview of the composite variables and the analysis of how the developed composite variables influence each other. Table 7 shows the means and the reliability Alpha factor of each composite variable.

Variable	*Mean (Cronbach's Alpha)*
Overestimation of risk composite	2.95 (0.647)
Underestimation of risk composite	3.26 (0.524)
Intervening conditions composite	2.98 (0.663)

Table 7: Mean values and reliability analysis of composite variables (Scale: 1 – not at all, 5 – to a great extent)

Overall, project managers thought to have over- and underestimated risk to some extent. Regarding the issue of external reliability is important in relation to multiple-item scales as part of the survey questionnaire (Bryman & Cramer, 2001). In this respect, the Cronbach's Alpha was calculated. As a rule of thumb, scales with a Cronbach alpha over 0.8 (Bryman et al., 2001) are internally consistent; however this may decrease to 0.5 in exploratory research (e.g. Hair, Anderson, Tatham, & Black, 1998). The results of the reliability analysis show, that except for the underestimation of risk composite all coefficients are over 0.5, therefore showing a satisfying reliability.

As the final step, regressions were run to identify the causal relationship between the composite factor of over- and underestimation of risk and risk related intervening conditions. As can be seen in Table 8,

the composite variables of over- and underestimation and intervening conditions have been defined as the dependent variables.

	Dependent Variables	
Independent variables	Overestimation of risk composite	Underestimation of risk composite
Intervening conditions composite	.330	.417***
R^2	.012	.174
Adjusted R^2	-.001	.164
F	.111	16.252***

Regression coefficients are standardised. *p<.05 **p<.01 ***p<.001

Table 8: Regressions on perceived effectiveness, over- and underestimation of risk and intervening conditions composite variable

The findings on the influence of intervening conditions of delay, ignorance and avoidance of risk on over- and underestimation of risk state that intervening conditions significantly and positively affect the degree of underestimation of risk. The non-significant relationship between intervening conditions and overestimation of risk remains open to debate. However, one possible explanation is that due to the influence of intervening conditions, risks are downplayed and (deliberately) overlooked rather than vice versa.

7. THEORETICAL AND PRACTICAL IMPLICATIONS

PMI and other organisations such as the Association of Project Management argue that their project management processes are generally accepted as best practice standards, thus implying a widespread consensus about the effectiveness of their processes. Williams (2004) argued that project management is a self-evidently correct discipline. However, the findings revealed that the application of project risk management is thought to be less effective from the IT project manager's point of view, that is to say, to precisely predict and manage project risks. The findings show that risk related intervening conditions have a significant adverse impact on the project outcome. Consequently, the underlying assumptions of the project risk management process and the degree of rationality assumed according to EUT can be questioned.

Due to the influence of intervening conditions, risks may always remain inadequately managed and cause disruptions to projects. Two suggestions to compensate for the impact of materialised risk are firstly, the arrangement of multi-layer reserves to absorb the impact of unforeseen events (Pender, 2001) and secondly, adding contingencies to establish a fit between the environment and the project's structural and process characteristics (Barki, Rivard, & Talbot, 2001). The adaptation to unforeseen situations may include project managers being flexible and dealing with situations only as they arise and with information only when it becomes available (Pavlak, 2004). With the prospect of unsuspected changes in the project, the project manager may want to prepare himself to be able to react to any unpredicted disruptions in the project. In this respect, flexibility is considered an important way of dealing with risk (e.g. Carlsson, 1989; Dreyer & Gronhaug, 2004; Eppink, 1978; Gustavsson, 1984; Holt, 2002; Leuuw & Volbreda, 1996; Sharfman & Dean, 1997; Slack & Correa, 1992). In project management, flexibility is considered to be a critical success factor. However, although the concept of flexibility addresses residual risk caused by intervening conditions on the management of risk, it has been given little attention in project risk management literature so far (Hornby, 2001).

8. CONCLUSIONS

In this study, the extent to which project managers in IT projects under- and overestimated risk and what factors caused their failure to accurately predict risk was investigated. The degree of underestimation shows that the effectiveness of project risk management was not optimal, that is to

say, IT project managers failed to minimise the degree of over- and underestimation of risk. It appears that because of the apparent tendency towards underestimation of risk in IT projects by risk actors, risks are under regulated. One could argue that project managers should increase their degree of 'precaution'. However, to what degree an increased precaution may enable IT project managers to achieve their project objectives remains open to debate .

As in any other survey research, a research strategy related limitation concerns the aspect of "positive bias" of the respondents. Interviewed project managers might have given information about mediators and risk actions in IT projects, which in retrospect are often seen in a more positive light by them than at the time those mediators occurred and actions were taken. IT project managers may have chosen to present their applied project risk management in a better perspective in order not to be considered by the interviewee as a 'bad' project manager. If this is confirmed to be true, the degree of over- and underestimation may be even greater.

In addition, the accuracy of the scales used in this research remains open to debate. The scale development was predominantly based on the initial exploratory results and relied far less on existing empirical evidence due to the scarcity and insufficient credibility of existing measurements. Inadequate scale development of the intervening condition of denial of uncertainty may have resulted in its exclusion from the intervening condition composite. Even with the inclusion of the denial of uncertainty as a separate variable, regressions revealed that denial of uncertainty does not have a significant influence on any of the used variables. Possible inadequateness in accurately developing a scale for the intervening condition of denial of uncertainty may have resulted in the insignificance of this type of intervention.

A limitation regarding the level of generality relates firstly, to the sample that included a narrow segment of project managers; those IT project managers, who were members of the professional organisation of PMI. Second, limited generalisabilty arises through the use of subjective data. The IT project manager's reality which has been investigated in this study may not be transferable to other individuals. Consequently, tendencies which have emerged and been tested about concepts such as intervening conditions cannot be generalised beyond the chosen sample cluster (Bryman, 2001; Robson, 2002). In these circumstances, the degree of generalisation is limited to the respondents of the survey, thus these findings may only apply to the IT project managers who were part of the cluster sample and not to any other IT project manager or project manager involved in projects such as construction or pharmaceutical projects.

Further research may investigate the influence of intervening conditions in other research context such as construction industry. In addition, the impact of under- and overestimation of risk on the actual project outcome as suggested in the conceptual framework (see Figure 1) could shed further light on the impact of the project manager's inability to match perceived with actual risk.

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