CHAPTER 9

SUMMARY AND CONCLUSION

This Chapter gives a summary of the thesis. The research findings are summarized in Section 9.1. Section 9.2 discusses the implications for practice and section 9.3 explains the scope for future research. The limitations of this study are discussed in section 9.4. Section 9.5 contains the conclusion drawn from the study.

Failure of software development projects is a common problem reported from organizations across the globe. These failures can be attributed to various risk factors present in the software development projects. Experts in the area recommend that risk associated with software development projects must be identified and managed throughout the course of a development project. Various research studies have looked at the presence of risk and risk management in software development. But these studies had many limitations.

Most of the studies were reported from developed countries and hence conclusions cannot be generalized. Comprehensive and validated measures of risk and risk management were rarely used in these studies. The results were not validated across different types of projects or different types of organizations. Also, linkages among risk, risk management and project outcome were generally overlooked. No major research work on this theme was reported from India though India is one of the top destinations of software development.

Motivation for this research was derived from these limitations. The major objective of this research was to obtain a better understanding of software development project risk and risk management by identifying the themes that characterize them and link these constructs to the important project outcome measures. After the analysis of data the researcher could come out with some valuable information with regard to these constructs and their inter-linkages.

9.1 RESEARCH FINDINGS

The research was initiated with specific objectives such as to study the nature of risk and risk management, to explore the link between risk and risk
management and to develop a model linking risk and risk management to project outcome. The major findings with respect to these objectives are discussed below.

9.1.1 Developing insights as well as reliable measures for risk and risk management

Software project risk was seen to be a multidimensional construct. Risk could not be directly observed but was indirectly measured through a series of indicators. The indicators were picked up from previous studies. These indicators were divided into a five factor structure namely team risk, planning and execution risk, user risk, external risk and project complexity risk. This finding went well with the previous research. There could be a difference in the number of factors but all the themes were properly captured. The Wallace study (1999) had identified six factors which were named as team risk, requirements risk, organizational environment risk, user risk, process management risk, and project complexity risk. Barki et.al (1993) had demonstrated a 5 factor structure namely organizational environment, technological newness, expertise, application size, and application complexity. Ropponen and Lyytinen (1997) study delineated six components of software development risk namely scheduling and timing risks, system functionality risks, subcontracting risks, requirement management risks, resource usage, performance risks and personnel management risks. The present research captured all these dimensions but under different factor names.

The study also developed a validated measure of software project risk in the Indian context. The researcher followed the accepted procedures in instrument development. Scales were developed for each of these risk dimensions. Various validity and reliability tests were conducted to finalize the instrument. Confirmatory Factor Analysis was used on the final data to confirm the risk factor structure that emerged from the exploratory factor analysis on the pilot data. A second order factor model was hypothesized for risk construct which was positively tested using structural equation modeling. This was in line with the findings of Wallace (1999).

The second construct used in the study namely risk management also was subjected to rigorous analysis. There were no validated measures readily available for risk management constructs. A series of indicators suggested by researchers such as McFarlan (1982), Davis (1982), Boehm 1989 and Alter and Ginzberg (1978) were assembled together to build a measure of software project risk management.
After a series of validity and reliability tests, a four factor structure emerged for risk management. The factors were project planning, execution management, human resource management and user coordination. The four factor structure was confirmed through Confirmatory Factor Analysis. A second order model for risk management was successfully tested through Structural Equation Modelling.

9.1.2 Exploring the link between risk and risk management construct.

Risk management is defined as a discipline designed to reduce or eliminate risks in a project (Boehm, 1989). Literature suggested a negative link between risk and risk management constructs. Most of the empirical studies in this regard looked at few selected risk items linked to selected risk management items. This research used elaborate and validated scales of risk and risk management to explore the hypothesized negative relationship between these constructs.

The research demonstrated the strong negative link between risk and risk management. The first canonical correlation coefficient was 0.6265. A series of ANOVA tests showed that risk scores varied significantly across categories of the following project and organizational characteristics: type of software developed, project duration, onsite / offshore split up, size of the organization and nature of the organization. These findings were generally in agreement with literature.

Regression models were developed for each risk dimension linking it to risk management dimensions and the relevant organizational and project characteristics. These models defined how each risk dimension was influenced by risk management strategies and the project and organizational characteristics. This analysis was in line with the work of many researchers such as Ropponen and Lyytinen (1997), Jiang et al (2000), Addison and Vallabh (2002). The exact nature of these models was different from previous studies. But this was expected as the models were developed many years back and that too in different countries.

Project planning was seen to be the most effective strategy in mitigating the various risk components. It appeared in all the regression models. User coordination strategies were found to have significant correlation with user risk. The most important project / organization characteristics present in risk models were: on site – offshore content of the project, size of the project organization, nature of the organization and project duration. This supplemented the work of
previous researchers in crafting guidelines for specific risk items (Alter et al. 1978; McFarlan 1982; Boehm 1989; Charette 1996).

9.1.3 Model linking risk, risk management and project outcome

The research explored a model linking risk and risk management constructs to each of the project outcome variables namely quality, time overrun and cost overrun. The linkages among risk, risk management and project outcome were explored through testing of various models. The first model was a basic regression model where the project outcome measures were linked only to the risk dimensions. This was in line with some of the previous researchers (Wallace and Keil, 2004; Jiang et al., 2000). Each project outcome variable was taken as the dependent variable with the five risk dimensions as independent variables. All models were statistically significant. But the explanatory powers of the models were limited with poor $R^2$ values. Also the loading signs of some of the risk dimensions were inconsistent with theory.

The second set of models had risk management linked to project outcome directly as well as indirectly with risk as the intervening variable (Nidumolu 1995, Na et al, 2006). Two variants of these models were tested with structural equation modelling. The first variant model called first order model treated the five factors of risk as well as the four dimensions of risk management as independent of the others in their ability to predict project outcome. The second variant models called second order factor models assumed that risk and risk management dimensions were acting collectively as members of a common system where one dimension would not be sufficient in explaining the outcome of a project. The second order factor models were seen to be more parsimonious and consistent with the loading signs. The analysis showed that risk had a direct link with all the project outcome measures. Risk management had a direct link only with quality. The impact of risk management on other outcome measures namely time and cost overruns was through the intervening variable risk. These findings supplemented many of the previous studies (Wallace, 1999; Jiang and Klein, 1999; Nidumolu, 1995; Deephouse, 2005)

9.2 IMPLICATIONS FOR PRACTICE

Software project managers across the globe are faced with the failure of software development projects on a regular basis. Proper identification of risk
associated with software development projects and application of appropriate risk management strategies can reduce project failures.

This study has provided dimensions of software project risk and risk management that project managers might use for managing the project. Software project managers can evaluate a project based on team, planning and execution, user, external and complexity risks. They can counter these risks through risk management strategies namely project planning, execution management, user coordination and HR management.

This study has proposed specific strategies for reducing each risk dimension. But it also demonstrated that individual dimensions of risk are not independent in their impact on the outcome of a project. All the dimensions interact with each other to comprise software project risk and influence the outcome of a project. All the dimensions of risk must be managed in order to reduce the overall risk of a project and improve the chances of project success. Therefore, it is important that the project managers focus on the entire spectrum of potential risks though some level of prioritization can be made based on the levels of risk dimensions.

Organizations may benefit from using the results of this study to develop risk profiles for each of their software development projects. The instrument developed in this study can be used to create a risk profile that represents the assessment of risk associated with a particular project. Potentially high risk projects could be recognized earlier on and more appropriate decisions could be made about the desire to continue with a high risk project. By being able to better assess risk in a project, organizations can do a better job of balancing the number of high risk projects that they are undertaking with a complementary set of lower risk projects.

Organizations can also administer the instrument at multiple points during a project and track the changes in risk in a project as it progresses from beginning to end. Then they could monitor the risk mitigation strategies selected to counteract risk and by re-assessing risk at a later point they could determine the effectiveness of their strategy. Over time, this information would be a very valuable resource for identifying the appropriate risk management tools to be applied at different stages of a given project.
9.3 SCOPE FOR FUTURE RESEARCH

This study provided a good review of the existing research work on software project risk and risk management strategies. Various models linking risk related constructs were also reviewed and compared. This gives a strong theoretical foundation for future academic research.

This study developed and empirically tested two measurement models: one for software development risk and the other for risk management. These measures are grounded in both practice and theory. These measurement instruments identified the most prevalent risk items in software development and risk management techniques which can be used to counter these risks. The existence of validated and reliable measures will enable numerous future researchers to approach these constructs from the same perspective.

The study made extensive use of statistical techniques for developing and testing theories. These statistical techniques were explained in details so as to help new researchers to apply these tools in their research.

The study demonstrated that risk varied across different categories of projects or organizations. But more focused research work needs to be done in modeling risk and identifying appropriate risk management strategies for each of the categories. This knowledge could further assist project managers to tailor their risk management strategies more appropriately.

This research has developed general models linking project risk, risk management and project outcome. But the explanatory powers of the models are limited as indicated by the relatively low $R^2$ values. The field would benefit from a rigorous study of other factors which could have an influence on the relationship connecting project risk, risk management and project outcome. The field still lacks a framework that explains interaction of these constructs within the larger structure of other constructs.

Another potential area of research could involve administering the instrument in this study to different stakeholders involved with the same project and comparing their perceptions of risk and risk management. It is reasonable to believe that different project participants would view risk and risk management differently and the differences in their assessment would provide greater insights into the significance and direction of their differences.
Future studies could help to identify risk and risk management factors throughout the project rather than after a project has been completed as in this research. If prescriptions could be given on managing risks in projects which are at different points of the project life cycle, it will help the project manager to manage the projects better.

9.5 LIMITATIONS OF THE PRESENT WORK

Software project risk and risk management are two emerging domains. Both of them are complex constructs which many researchers constantly work on. Hence it is quite possible that this research may not have captured every aspect of these constructs even though an extensive literature review was conducted and experts in the area were consulted for inputs.

Though the scales developed and used in the study were validated, there is always scope for further refinement in order to increase their level of reliability and their ability to explain the variance associated with the constructs they measure.

NASSCOM directory was used as the sample frame for this study. The results should not be completely discounted for the possible extension to software development projects that take place in organizations outside of NASSCOM. The replication of the study across a broader sampling frame would provide additional validity for the findings and further empirical support for related theoretical studies.

A single-respondent or informant was used in this study. Although it is common to use a single respondent in academic research (Pinsonneault and Kraemer, 1993), it would be more desirable to have multiple respondents from each project independently assessing risk and outcome in order to validate the results.

9.5 CONCLUSION

India has become the major destination of software development and there is no dearth of software projects. However, the study on risk, risk management and project outcome with respect to software development projects was not easy. Lack of published material in the Indian context was the first challenge. This was overcome by the use of international literature and local expert opinion. Data collection posed the next major challenge. The delicacy of revealing project related information and opinion posed a major hurdle. The senior management of the
organization had to be taken into confidence with regard to the confidentiality and the strictly academic nature of the study. The participating companies were promised a consolidated report of the research.

The study has identified major risk and risk management factors in the Indian context. Models grounded in theory are developed and empirically validated. The findings of the study could be used by practicing managers for better risk management. The models developed in this research can be refined and improved further by future researchers. The objectives laid down in the beginning of the research could be finally achieved to a high degree of satisfaction. As in all research, this work too has its limitations mentioned earlier.

This research was a very important learning experience for the researcher. Though the researcher had practical exposure to project management with software development organizations for six years, this research has brought in new dimensions to his understanding of software development risk and risk management. Also, this work has helped him to appreciate the role and application of research methodology in management research.

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