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Identifying and Evaluation of Risks in Software Projects in Indian IT Industries

Vanita Bhoola[1], Shivanand B Hiremath[2], Debasis Mallik[3]
[1]Doctoral Student, *National Institute of Industrial Engineering (NITIE),Vihar Lake-Mumbai 400 087, India.*vanita@spjimr.org
[2]Professor, *National Institute of Industrial Engineering (NITIE),Vihar Lake-Mumbai 400 087, India.* hiremath.nitie@gmail.com,
[3]Associate Professor, S.*P. Jain Institute Management and Research, Andheri (W)– Mumbai 400 058, India. debasis.mallik@spjimr.org*

Abstract-*Keeping a wary eye on risks has become an integral part of project management, not only in manufacturing firms, but also in software companies. This paper focuses on risk categories that influence project success in software companies originating from human resources, environment and organizational culture, or are project specific. To identify and assess the effectiveness of these four categories, authors conducted a survey of 50 Information technology (IT) firms to investigate their risk management practices during software development lifecycle of a project. Exploratory design using the survey research methodology that includes structured questionnaires and interaction of 50 IT companies. The survey asked the participants about the outcome of specific project, issues in technical manpower and commitment of the top management. Data collected was analyzed using statistical models. The study finds three factors that played crucial roles in ensuring project success in Indian software projects. In contrast with similar international studies this study identifies factors like application of project risk management process, qualified project manager, and quality of client acceptance which are significant to project success. The study also focuses on three major Indian software firms with global presence to understand the implications of the above findings.*

Keywords –*Risk; Risk Management; Project Management; Project specific risks; software risks*

1. INTRODUCTION

The Information Technology (IT) sector contributed 7.5 percent to the Indian GDP in 2012. This is 20 percent higher than 1998, according to a report by the National Association of Software and Services Companies (NASSCOM). Though exports dominate 77 percent of total industry revenue, the contribution of domestic market in the revenue growth is also significant. Managing risks in software development projects cannot be ignored, as it is a potential event that can negatively affect the project.

Risks involved in projects are the major cause of project failures leading to an undesirable project outcome that affects software quality, schedule and cost (Kappelman et. al., 2006). There are several models developed for software risk management, since risks in software keeps changing frequently due to various factors a contribution to these models and the reassessment of the risk requires further study. This study included software development projects across domains viz. retail, utilities, healthcare, banking & financial services, and Insurance.

2. LITERATURE REVIEW

Risk is any potential situation or event that could negatively affect a project‘s ability. Risk is an exposure to loss or injury or a factor, thing, element, or course that involves uncertain danger (Antonov, A. et. al., 2006, Galorath, D.D. et. al., 2006). Barki et al. (1993, 2001) have defined risk as the degree of exposure to negative events and their probable consequences and a combination of the probability of an undesirable event with the magnitude of each and every foreseeable consequence.

Purao et al. (2007) states that risk is a particular aspect of the development, task, process, or environment, which, if ignored, will increase the likelihood of project failure. Gefen et al. (2008) laid down unforeseen contingencies related to changes and additions to the software specifications during the development period as the definition of software risk while; Wallace et al. (2004) defined it as a set of factors or conditions that can pose serious threat to the successful completion of a software project. Masri et al (2010) states risk sources would lead to risk events. This, in turn, increases the negative variance from expected outcomes with predetermined magnitudes as well as the degree of which risk management mechanisms influence risk sources and the variance of expected outcomes. Thus, it can be clearly seen that valuable attempts have been made to specify definition of the software project risk.

Software development projects have a dismal track-record of cost and schedule overruns and quality and usability problems (Kwak, Y.H et. al., 2004), Further, it becomes

very difficult to predict the success of project because the scope of the project keeps changing depending upon the market; hence the resources have to be re-allocated leading to schedule slippage and cost overruns. Many software projects involve multiple entities such as companies, divisions, etc., that may have varying interests. There is often a feeling of disconnection between software developers and their management, each believing that the others are out of touch with reality resulting in misunderstanding and lack of trust (Kwak, Y.H et al, 2004). According to Doherty and King, 2003 and Warkentin et al., 2009 organizational risks stemming from organizational culture, structure and business processes impacts the technical software development issues, creating a wide range of potential trouble points. A study revealed that 65percent of the project failures were due to management issues (Mcmanus. J, 2004). Software Projects have to be reconfigured again and again in terms of the requirements that keep changing thereby making maintenance of applications extremely difficult. (Nasscom, 2007). Apparently, this implies that software project development is extremely risky. Therefore, managing the involved risks is of primary importance in software project development, especially in the large-scale software projects (Yong, H. et al, 2006). Risks are involved at every level and all areas in an organization. Managing Risks effectively is a key to any business success. Strategic decisions can impact a project to a very large extent. Software Project risks have long been claimed to be a major cause of software project failure and empirical evidence exists to support it.

3. FACTORS AFFECTING SOFTWARE PROJECT RISK

Project risk management in the software sector was captured using primary data sources.The questionnaire that was designed for the same has two categories of questions

A Risk Classification Framework

Project Specific

1. Improper Planning and Processes
2. Lack of Project Management Methodology
3. New Technology being introduced
4. Lack of Single point accountability
5. Lack of Technical Knowledge
6. Inappropriate Staffing
7. High Level of attrition
8. Lack of commitment from project team
9. Ineffective Project Monitoring and Controlling
10. Lack of mechanism and validation and verification
11. Inadequate tools on Software Quality Assurance
12. Improper Requirement Gathering
13. Unclear scope/objectives
14. Changing requirements
15. Improper change management
16. Unrealistic schedule and budget
17. Misunderstanding of requirements
18. Unrealistic expectations
19. Gold plating
20. Inaccurate estimation of schedule or cost
21. Ineffective Project Communication
22. Project Estimation and Planning
23. Tools and Technology

Human Resources

1. Employee Turnover
2. Over Staffing Project Teams
3. Skilled Team
4. Unclear Responsibility & Accountability Structure
5. Role of Project Manager
6. Relationship Between HR and Business results
7. Job Matching
8. Dissatisfaction with Job, Stress and Poor Health
9. Motivational effect of Bonuses and Commissions
10. Global Experience and Adequate training
11. No adequate incentives of Risk management

Organizational Culture

1. Lack of Top Management commitment
2. Corporate Culture not supportive
3. Inadequate user involvement
4. Friction between Clients and Contractors
5. Lack of Client Responsibility and Ownership
6. Organizational Structure
7. Organizational Responsibility
8. Reward Mechanism
9. Risk Aversion
10. Warmth and support
11. Leadership Strategies
12. IT Governance Theory into practice

Environmental factors

1. Inadequate third Party performance
2. Competition Alter schedule
3. Change in Scope due to change in Business Model
4. Natural Disasters
5. Business Uncertainty and Use of external Management consultants

Source : **As per papers referred to and interviews conducted at different software industries**

Figure. 1. Risk Classification Framework

–one, qualitative questions leads to subjective opinions expressed by industry leaders and two, questions leading to quantitative inputs, that helped forming a regression model to understand how project risk factors influence project success. Identifying these factors through surveys, interviews were the beginning of the research study. To validate this data the initial part was carried out. A scoring model was used. Risks identified were depending upon various studies and the number of times it appeared. Based on these rankings a list of 51 variables affecting the software projects were prepared as in Figure1.

The four factors – Project specific, human resource, Environmental and Organizational Culture factors risks were taken as independent variables in the regression while the overall success as dependent variable. Before this process, correlations of the dimensions with the success of the project and the three performance construct were computed.

Some of the risk factors have been identified by various researchers. Some factors are very commonly encountered and having strong impact on the project's chance of success. Some of the risk factors are controllable by the project managers whereas some cannot be controlled; some have direct impact on project outcomes (Keil, 1998).Thus on the basis of this proposition, risk as been classified on the basis on importance and control.

4. RESEARCH METHODOLOGY

Based on the literatures the authors categorize the risks into the four categories: Project Specific factors relates to issues which include project planning, execution monitoring & control and closure of the project. The Human Resource factors relates to access and relevance of human resource within and outside the organization. This implies that resources which do not suit the requirement of the project, but are made available, may impact the success of the project adversely. Under the category of Organizational Culture it is attempted to understand the organization's processes which would impact project execution and decision making by the project team. Environmental factors deals with the change in the current status of stakeholders and factors external to the organization, which can impact the success/failure of the project. These studies have been selected on the basis of the in-depth analysis of the risks and the elaborateness of the risks in the respective research papers. Each risk was individually evaluated and categorized based on the secondary data.

In this process we are left with 51 variables – out of which 23 are Project Specific, 11 variables are related to Human Resources, 12 are Organizational Culture and lastly, 5 variables were considered under the area of Environmental Factors. These 51 variables were largely considered from literature review, with an effort to include all the various facets of the four pillars of project risk management.

4. 1. Description of the sample

NASSCOM, a trade association of Indian IT and BPO Industry with over 1200 members of which 250 are global companies from US, UK, EU, Japan and China, is used for its listing of revenue generating IT companies in the Indian context. Respondents belonged to various software project categories including business application, web application, e-commerce, ERP implementations and maintenance services, CRM, and engineering applications. The profile of the respondents was project leads, tech leads, consultants, senior software engineers. The research focuses on identification of risks with reference to Project specific, human resource, Environmental and Organizational Culture factors, during lifecycle of project.

A structured questionnaire was used for conducting this survey. The questionnaires have been distributed to NASSCOM listed IT companies in two ways. The first way is through electronic mail where a total of 97 electronic mails have been sent to individuals working in IT companies who are in the business of software products, IT enabled/BPO services and e commerce. A total of 50 hard copies were distributed to project managers of various IT companies who are in the business of software development and software services.

The purpose of the study was to investigate how different risk factors influence project success. As this is a causal relationship, we used Multiple Regression Technique, where we considered Project Success as the dependent variable and variables under four categories - Project Specific, Human Resource, Environment and Organizational Culture as the independent variables.

4.2. Profile of Respondents

The first section of the instrument gathered information about the personal profile of the respondents which included designation, types of projects worked total experience. All items are measured using a 5-point Likert scale with 1 representing strongly disagree to 5 representing strongly agree. A total of 147 questionnaires were distributed using electronic mails (97) and hard copy of the questionnaires (50). The first follow-up notices have been sent to all respondents through electronic mail the second and third reminders have been sent one and two weeks respectively after the first reminder notice. A total of 93 respondents have responded to the questionnaire. Out of which 70 responses were complete, the rest 23 responses being incomplete or invalid.

4.3.Description of Variables

Dependent Variable:

Project Success (PS): Project success is the dependent variable. Project success in software sector, in today's changing environment, does not necessarily mean handing over software after achieving the defined targets of time, scope and cost.

Measurement: We followed a two-pronged approach while measuring project success. Simply asking project leaders/managers to rate on their project success on a 10-point scale was the first procedure. Using a Likert scale we had also taken inputs from the project leaders/managers in

terms of the extent of cost, time, scope and schedule overruns, if at all. Hence, a 10-point scale which is self-proclaiming measure of project success coupled with a set of four questions on meeting deadlines successfully, were jointly used to measure PS. Later the two approaches were combined and converted to a single measure capturing project success on a 10-pointscale.

Independent variables:

As mentioned in Risk Classification framework section, the total number of independent variables under the four sub-categories is 51. The number of independent variables was too many as compared to the number of observations that we had for the study. Hence, we had to reduce the number of independent variables. The obvious choice was to use factor analysis. Factor Analysis helps in grouping similar variables with high correlation. Correlation is a measure that captures the degree of togetherness between two variables. It ranges between – 1 and + 1, where – 1 indicates perfect negative correlation and + 1 indicates perfect positive correlation, "0" implying that two variables are uncorrelated.

Factor analysis, as a statistical process, requires a ratio of 10:1 (as an ideal case) or at least (5:1) as a workable case for considering observations with respect to variables. Hence, with 51 variables, we would have required more than 250 observations. Our sample being small – consisting of 70 observations, application of Factor Analysis was a far cry. The alternative to factor analysis was to directly look at the correlation amongst the variables – dependent and independent. Table – II depicts the correlation amongst the variables. Following this table, we removed those variables, which had a correlation of a magnitude less than ±0.30 with the dependent variable, i.e., Project Success. Unless the correlation between the dependent and the independent variables is more than ±0.30, it is difficult to establish a causal relationship between the above. In this process, we were then left with 9 independent variables, which were finally considered for the study.

Table 1. Variables and its description

Variables	Description
PS	Project Success
PS_PLAN	Project Planning - Time, Cost, Scope, Schedule
PS_ACCPT	Quality of Client Acceptance (leading to successful handover of project)
PS_RSKMGD	Implementation of Project Risk Management Processes
HR_TMCOMM	HR Team Communication
PS_BOBJ	Project Business Objective Well defined and Achieved
HR_INEPM	Ineffective Project Manager due to improper qualification
HR_EMP_TRT	Employee treated fairly and justly
PS_SGNOFF	Proper Sign-off taken from customer
OC_TOPS	Top Management Support

The correlation table hence generated is as follows:

Table 2. Correlation matrix

Table of correlations

	PS	PS_SUC	G_PS_ACCPT	PS_RSKMGD	HR_TMCOMM	PS_BOBJ	HR_INEPM	HR_EMP	PS_SGNOFF	OC_TOPS
PS	1.000									
PS_PLAN	0.480	1.000								
PS_ACCPT	0.340	0.385	1.000							
PS_RSKMGD	0.490	0.535	0.255	1.000						
HR_TMCOMM	-0.302	-0.084	-0.073	-0.156	1.000					
PS_BOBJ	0.306	0.172	0.169	0.125	-0.225	1.000				
HR_INEPM	-0.499	-0.271	0.043	-0.244	0.352	-0.160	1.000			
HR_EMP	0.346	0.267	0.078	0.253	-0.202	0.052	-0.423	1.000		
PS_SGNOFF	0.317	0.507	0.754	0.363	-0.139	0.203	0.030	0.162	1.000	
OC_TOPS	-0.320	-0.052	-0.047	0.019	0.205	-0.222	0.512	-0.097	-0.036	1.000

The above Correlation matrix is an abridged version of the entire correlation matrix which was initially prepared for 51 variables, out of which Project Success was the dependent variable. In this Correlation Matrix we observe that all the independent variables are having a correlation of ±0.30 and above with the dependent variable (as observed in the first column).

We used both multiple and step-wise regression as our statistical models.

A Multiple Regression Model assumes that there is a relationship between a single dependent variable, which is metric and several independent variables which can be metric and non-metric in nature. However, In our analysis all the variables were measured in a 5-point Likert scale. Though this is ordinal scale, we have treated these variables as metric data. Typically "Y" is denoted as the dependent variable and the independent variables are denoted by "X_1, X_2, X_3, …, X_n". The model can be represented as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon$$

The model says that the values of Y can be represented by a mean level – $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n$ – that changes as X_1, X_2, X_3, …, X_n change, combined with random fluctuations, described by the error term ε, that causes the values of Y to deviate from the mean level. The β values are called the regression coefficients or parameters. These are unknown and determined from the regression output. β_0 is the intercept term of the model and the other β values are the regression coefficients of the independent variables.

A Multiple regression output typically provides a predictive output by displaying the values of the coefficients. Other than this, we can come to know about the overall explanatory power of all the independent variables taken together, on the dependent variable, commonly called the R-Square value. It is also possible to get an understanding about the relative explanatory power of the individual independent variables from the regression output. This can be achieved by observing the p-values and the t-values of the independent variables, as generated by the regression output.

The entire data for the analysis was collected from Primary survey, by using a questionnaire addressed to respondents. There were instances where spikes were observed in the data due to non-availability of information. For example, for a particular variable the data was observed to fluctuate between 6 and 8.5, but there are a few observations where the data shows "0" value. This "0" is not the true value of the variable – it has been used due to non-availability of information. In various occasions there was a problem of non-availability of data due to the problem of respondents' not responding to all questions in the questionnaire. Needless to say, this has an adverse impact on the final results and analysis, as it increases the variability of the variable. Hence, we have replaced such missing values by an extrapolation procedure as generated by SPSS Software.

4.4. Empirical Findings

It was observed that multiple regression results produce an R-Square of 0.5240, representing 52.4 percent explanatory power of overall project success, as captured by the independent variables considered for the study. Three independent variables emerged as significant in the multiple regression results, as given in Table 3.

As observed from the table above, variables – Implementation of project risk management process (PS_RSKMGD, at 5 percent level of significance), Quality of client Acceptance (PS_ACCPT, at 10 percent level of significance) and Ineffective Project Manager due to improper qualification (HR_INEPM, at 10 percent level of significance) have emerged as significant in influencing overall project success. PS_RSKMGD and PS_ACCPT have a positive coefficient, which implies that they have a direct influence on overall project success, i.e., if the values of independent values are higher it will positively impact overall project success.

However, HR_INEPM has an inverse relationship with overall project success. The Multicollinearity Test by using Tolerance and Variance Inflation Factor shows that there is no multi co linearity problem in the data, as all the Tolerance values are higher than 0.10. Tolerance captures the variability in an independent variable that is not captured by one or more independent variables. Subsequent to the application of multiple regression, we conducted Stepwise Regression, to check whether the results are in tandem with each other. We find the same independent variables emerging as significant even after using Stepwise Regression. However, there is a drop in the R-Square from 52.4 percent to 46.5 percent.

In the section Factors affecting software projects an international perspective the findings state that the most frequently studied risks as per the international findings are in the dimension of planning and control and they are misunderstanding of requirements, lack of management commitment and support that affect project results these results deviates from the findings of the authors of this paper. The Indian context focuses on the three factors namely application of project risk management process, qualified project manager, and quality of client acceptance criteria. The authors study below also explains the reasons for this deviation.

The literature review conducted by Arnuphaptrairong (2011) over a span of 27 years from 1981 to 2008 on software risk survey conducted by eminent researchers suggests that the most frequent risks that occur are in the dimensions of planning and control. Some of the most evident risks in the international software projects are misunderstanding of requirements, lack of top management commitment and support, lack of adequate user involvement, failure to gain user commitment, failure to manage end user expectation, changes to requirements, lack of an effective project management methodology,

which implies that project managers should be more careful of these risks. A pattern analysis study of software project risks by Han and Huang(2007) across high, medium, and low-performance projects showed planning and control, requirement risk and improper management of team as the key findings of their study across 115 software projects. Addison and Vallabh(2002) rankings of risks as per the empirical study ranks unclear scope and project objectives, misunderstanding of requirements and failure to gain user involvement as their top 3 software project risks. These finding are different from the findings of this paper.

Table 3. Unstandardized coefficients and collinearity statistics

	Unstrdzd Coeffs.				Co linearity Statistics	
Coefficients(a)	B	Std. Error	t-value	p-value	Tolerance	VIF
(Constant)	6.0495	1.0244	5.9054	0.0000		
PS_SUC	0.2043	0.1547	1.3205	0.1924	0.5480	1.8249
PS_ACCPT	0.3122	0.1748	1.7859	0.0798	0.4282	2.3356
PS_RSKMGD	0.3313	0.1461	2.2671	0.0275	0.6621	1.5104
HR_TMCOMM	-0.1611	0.1936	-0.8318	0.4093	0.8242	1.2132
PS_BOBJ	0.2029	0.1572	1.2907	0.2024	0.8799	1.1365
HR_INEPM	-0.3862	0.2207	-1.7502	0.0859	0.4788	2.0884
HR_EMP	0.1632	0.1871	0.8725	0.3869	0.7581	1.3191
PS_SGNOFF	-0.1286	0.1877	-0.6854	0.4961	0.3471	2.8813
OC_TOPS	-0.2458	0.2207	-1.1134	0.2706	0.6621	1.5104

5. INTERPRETATION OF THE FINDINGS OF THE STUDY ON THREE INDIAN SOFTWARE INDUSTRIES

The authors engaged with Business heads of three leading companies in the software industry. They have at least 10 years of experience in having dealt with hundreds of large enterprise projects. The authors observed that in all the three companies, PMI certification was not a pre-requisite for project managers leading projects. It is not included as a mandatory requirement for hiring employees for the project management job profile.

The authors studied the in-house or external training spends budgeted by the companies for imparting project management certification or methodology awareness to the project teams. There is no proactive training program created on project management skills across all the studied companies for employees working on projects. In at least two of the companies studied, there was a formal process of reimbursements for training certifications pursued and completed by the employee individually. Project Management certification was one of the skills in the reimbursement program. However both these companies did not have Project Management certification as a pre-requisite for hiring or for assigned medium-large projects. One of the companies studied neither had a training program nor was it having reimbursement budgets for employees pursuing PMI certification individually. The authors inferred that this was chiefly due to the attitude of the companies in adopting Risk management frameworks for conducting projects.

Study of three companies revealed that while each of them had a Risk Management process; one of them implemented only on client requirement, one only at a governance level. The third company used it for mere documentation purpose. Properly trained people using an effective risk management process can contribute to the risk management process actively especially in the identifying risk process as they have the highest exposure to project ground realities.

The authors observed that in one of the companies the project was delayed by almost two years, due to the acceptance criteria, not being well defined leading to a lot or rework and project delay. On the contrary the other two companies studied were very satisfied with high degree of acceptance criteria acknowledged by the client. In this case there was continuous engagement of the client at various phases of the project especially in the initial acceptance criteria definition phase.

The two observations above had direct linkages. Project Management qualification as a skill was not sought after due to the optional nature of adoption of risk management frameworks. The study also revealed that costs associated with hiring PMI certified project managers and budgets reserved for training programs, increased the price of the projects; which might make the player less competitive which is being marketed as a unique selling point.

6. CONCLUSIONS AND FUTURE SCOPE

This study demonstrates that success factors have indeed evolved according to the type of project and the environment that the project is operating. While success factors have evolved over time, the three factors that play

significant roles in ensuring project success in software projects are application of project risk management process, qualified project manager, and quality of client acceptance criteria.

The study also highlights that in India, operational challenges have a larger impact as compared to the findings from international studies, as mentioned in section 4.4. In this context, it is worthwhile to mention that a major shortcoming of the study is the sample size. If we could have considered a larger sample comprising of 500 project managers/leads, probably the study would have been more robust and comprehensive. Application of Factor Analysis on the independent variables, could have made the study parsimonious. A subsequent study with a higher sample size conducted across industries can be a good starting point. It would also be very interesting to conduct a comparative analysis based on the results of the current study with similar parameters in other emerging economies. The authors also propose to evaluate the factors that would emerge out of the study and investigate the relationship between the categories of risk.

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