Proceedings of International Conference on Strategies in Volatile and Uncertain Environment for Emerging Markets
July 14-15, 2017
Indian Institute of Technology Delhi, New Delhi
pp.489-495

Dimensions of Risk and Performance of Software Projects

Nimisha Singh[1] and A K Dey[2]

Abstract

Management of any project requires specific objectives and resource requirements to be stated at the beginning of the project but most projects are not so deterministic as they face uncertainty due to external environment, technical complexity and organizational issues. An extensive body of literature has indicated the impact of requirement stability on project success. This article develops a concept of social context risk and its impact or project management risk and eventually on project performance. The objective of the paper is to identify various dimensions of risk and performance for software projects in India and to establish their linkages. Based on survey of software project professionals, data was gathered on projects. We then applied Structural Equation Modeling (SEM) to model the relationship between risk dimensions and project performance. The results indicate that social context risk measured by two constructs i.e. development team and client has an effect on project management risk measured by two constructs i.e. management and requirement.

Keywords: Project Management Risk, Project Performance, Project Risks, Risk Management, Software Project Management

1. Introduction

Projects are created to initiate a change such as developing new products, processes, or to create a new organization. Generally, software projects are considered to be successful if they meet the objectives of scope, budget and quality (Bakker *et al*., 2009) whereas the success of an organization is defined as winning in the market in terms of financial and economic performance (Jugdev and Muller, 2005). Some of the factors that increase the likelihood of project success are effective leadership, conducive organizational environment, realistic requirement, schedule and effort estimates, sufficient and diverse team (Linberg, 1997), business orientation, leadership involvement, employee participation, knowledge exploitation and knowledge exploration (Dyba, 2000), software development practices involving planning and estimating before project starts, managing changing requirements during the project execution and minimizing risks (Jones, 2004).

In times of increased competition, uncertainty and rapidly changing environments, projects face the pressure of being completed in extraordinarily short time (Szep and Lugosi, 2015). Clients expect high quality, reasonable priced software system that follow industry standards, and have short time to market. This is making it difficult for software companies to maintain productivity levels (Li *et al*., 2008).

1. Assistant Professor, Birla Institute of Management Technology
E-mail: Nimisha.singh@bimtech.ac.in
2. Birla Institute of Management Technology
E-mail: Ak.dey@bimtech.ac.in

Although there are reports indicating success rate of information system projects, the project failures are still a major concern (Baccarini *et al*., 2004; Wienclaw, 2014). There are various reasons for projects to overrun budget, schedule or not deliver required value. Various studies have been done over the years for identifying, analyzing and mitigating risks. As organizations continue to invest time and other resources in software projects, they need to understand the nature of project, identify gap between current capabilities and capabilities needed to make it a success (Shenhar and Dvir, 2007). Managing a software project is a complex issue drawing on many personal, team and organizational resources (Rose *et al*., 2007). If decision makers have access to timely and accurate data about the project during its development, they can make better decisions in their strategies, tactics and related policies (Fu and Ou, 2013). Thus, we are motivated to study the relationship between dimensions of risk and project performance.

2. Literature Review

In the dynamic business environment characterized by fast cycle times, unstable technologies, and market changes, the survival of an organization depends on its ability to align IT capabilities with business goals (Keil *et al*., 2002). Objective of a software development project is to deliver a successful project (Shenhar *et al*., 2007). System objectives set by senior management are less likely to change and with a shared understanding on system objectives, there is a less likelihood of changes to that understanding thereby reducing the schedule slippage (Gladden, 1982). Success of a software system is the degree to which it meets its objectives, making identifying the objective the most important activity. Focusing on what the software system should do without understanding the organizational context produces a low level requirement and significantly impacts software quality (Lapouchnian, 2001). Goals provide rationale to elaborate requirements, operationalize them and provide the criteria to validate the correctness and completeness of the requirements specifications (Shenhar *et al*., 2001).

Software creation is governed by abstract set of rules which exist solely as an idea that is refined iteratively and becomes visible at its completion (Zmud, 1980). The iterative process of software development includes design, implementation and test (Gladden, 1982); involves requirement identification, requirement analysis, product design, coding, unit testing and system testing (Foo, Muruganantham, 2002). New requirements emerge if the project starts before the system requirements are complete (Gladden, 1982). Software requirements are under constant pressure for change as they can be changed more easily (Jurison 1999) which cause requirement volatility. Requirement volatility is majorly caused by changes in customer's needs (or market demands) or developer's increased understanding of the product, and changes in organizational policy (Nurmuiani *et al*., 2004).

The risks may come from the task characterized by uncertainty and complexity or from resource requirements, or skills or policy constraints (Raz *et al*., 2002) which hamper the productivity. This productivity can be enhanced by refining the development process which in effect will reduce the effort spent on corrective actions (Chiang and Mookerjee, 2004) as the software quality is dependent on the quality of the process itself (Prikladinicki *et al*., 2003). The earlier, the project is discovered to go off-track, the adjustments can be made more effectively and efficiently (Proccacino *et al*., 2002).

Various studies have been done to define project success. Project managers consider their role successful if the project is completed on time, within budget and meets specification which is the operational mindset that helps finish the job efficiently but may have disappointing business results (Shenhar *et al*., 2001). Cost, quality, customer service and time to market are some of the important areas that companies focus on and have performance indicators such as financial, accounting or economic measures to determine whether they are meeting their goals (Jugdev

and Thomas 2002). Project success can be assessed in terms of "project efficiency, impact on customer, business and direct success and preparing for future" (Pinto and Covin, 1989). These studies indicate that organizations have started considering the project success beyond the measures of scope, time and budget and started to focus on success measures beyond project completion.

3. Objectives of the Study

Based on the literature review and the gaps identified, we propose the following objectives of the study:

1. To identify dimensions of risk and performance in software projects in India
2. To evaluate the relationship between various risk dimensions
3. To evaluate the relationship between risk dimensions and project performance

4. Model of Risk and Performance

A model is developed to examine the relationship between risk and project performance. The five dimensions of software project risks are the building blocks to create higher order latent constructs. Key constructs of project management- project planning, project specifications and project control- have been associated with the success and failure of software projects (Keil *et al*., 2003). Thus the project management risk construct is measured by the underlying risk dimensions: management and requirements. A software project is carried out in a social context characterized by client and development team (Wallace *et al*., 2004). The context driven issues, one of the driving forces to bring strategic change through system implementation are organization culture, politics, management and client (Yeo, 2000). Thus social context risk construct consists of two underlying dimensions- team and client risk.

Project performance is described in terms of 1) process performance i.e. how well the software development process has been undertaken and 2) product performance which describes the performance of the system developed (Nidumolu, 1995; Wallace *et al*., 2004). It is important to consider both aspects because even though the software delivered may be of higher quality but the project may have exceeded time and cost projections. On the other hand, well-managed projects which are within time and cost may deliver poor products.

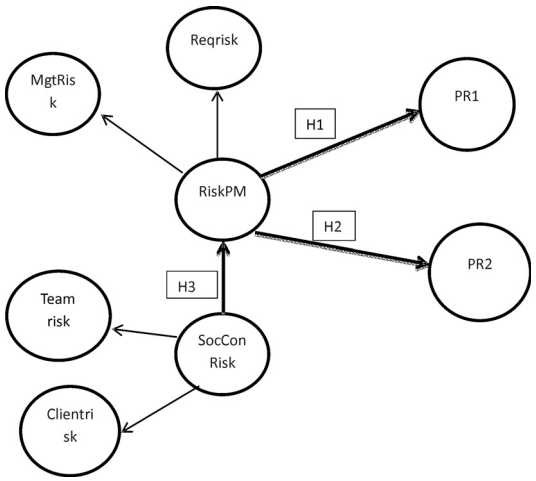

Figure 1: Model of Risk and Performance

Dimensions of Risk- Team risk, Client Risk, Management Risk (Mgtrisk), Requirement Risk (Reqrisk)

Dimensions of Project performance- Product Performance (PR1), Process Performance (PR2)

One of the reasons for project failure is not addressing risk during project planning process and a weak business plan (Whittaker 1999). As project management affects both product and process performance, a poorly managed project is likely to experience cost and schedule overruns. Also, poorly managed projects may produce a system that does not satisfy client needs, is of poor quality and is difficult to maintain (Wallace, Keil and Rai, 2004). Thus we state the hypotheses:

H1**:** Project management risk has direct significant effect on process performance

H2: Project management risks has direct significant effect on product performance

A project manager coordinates activities of the project team and makes sure that team members have necessary skills to carry out the project (Wallace *et al.*, 2004). Coordination between client and IS staff affects the project positively. Higher degree of client participation in the project promotes a sense of involvement in the process that helps tailor system's attributes as per client's specifications (Nidumolu, 1995). A project is situated in a social context where the client may be resistant to change and there is a conflict between the client team and the development team. A software project creates a technical artifact based on a set of requirements. If the development team or the client are not committed, set of requirements will not be accurate and make a weak business plan. Thus we state the hypotheses:

H3: Social context risk has significant effect on project management risk

The next section describes the process used to measure and validate the modeled constructs.

5. Methodology

Extant literature review was carried out to indentify risk factors affecting software projects. The 43 risk items and 11 project performance items identified through literature review were placed on an instrument and administered to software project professionals where responses were collected on Five-point-Likert-type scale. The pilot study was carried out with 40 software project professionals to who were asked to identify the risk factors in their last executed project.

Four major IT hubs in India- Delhi-NCR, Bangalore, Hyderabad and Chennai (Sharma *et al.*, 2011) were selected. As risk perception is also affected by experience, needs and expectations, we considered project professionals with 4- 15 years of experience for data collection.

Coefficient alphas and item-total correlations were calculated for each scale to identify the problematic items. 27 risk items and 10 project performance items remained after analyzing the coefficient alphas and item total correlation. The modified instrument was sent to a total of 600 respondents, of which 134 responses were received. 24 responses were found to be incomplete and hence discarded.

6. Analysis of the Model of Risk and Performance

Isolated models of each dimension were analyzed to assess that the items to tap into their associated dimensions of risk. Items with loadings less than .6 were deleted. The scales were refined upon examination of standardized loadings which resulted in 14 risk items and 6 items of project performance. Confirmatory Factor Analysis (CFA) was performed to test that variables load highly on pre determined factors established by Exploratory Factor Analysis (EFA).

The measurement model in this study is second-order factor model that includes two higher-level latent constructs- Project Management Risk and Social Context Risk. We proposed second order construct model as the measurement model based on the empirical confirmation of the relationship between the first- and second order constructs. Before proceeding with SEM, data was checked for collinearity, multivariate normality and homoscedasticity. To rule out that two variables measure the same thing, data was tested for multicoliiniearity. The VIF > 10.0, indicates that the variable in question may be redundant. The multicollinearity test indicated by VIF value for the output coefficients was less than 10. Value of Sig for dependent variables >.05 indicating that there is no problem of heteroskedasticity.

The relationship between variables and constructs as well as relationship between second-order latent constructs was evaluated by Structural Equation Modeling by using AMOS. Table 2 shows standardized regression weights. The overall fit statistics for the structural model given by GFI, CFI are .838 and .931 respectively which are considered to be acceptable. The normed chi-sqaure (CMIN/ DF) is 1.413. The RMSEA is .062 and the standardized RMR is .0764.

Table 2: Standardized Regression Weights

			Estimate
Pmgtrisk	<---	socconrisk	.805
Mgtrisk	<---	Pmgtrisk	.783
Req	<---	Pmgtrisk	.755
Client	<---	socconrisk	.732
Team	<---	socconrisk	.942
PR2	<---	Pmgtrisk	-.694
PR1	<---	Pmgtrisk	-.610

The unstandardized regression weights indicate that all the paths are significant. Standardized regression weights (Table 2) are fairly high indicating the high explanatory power of the proposed model.

7. Discussion and Implications

The results suggest that social context risk determined by team and client risk has a direct positive significant effect on project management risk. As the social context risk increases due to disagreement between client and development team, the project management risk determined by requirement and management risk will also increase. The project management risk as hypothesized has a direct significant negative effect on both process and product performance. In order to decrease the negative impact on project performance, the social context risks also need to be managed. From a managerial point of view, such risks need to be managed by implementing processes that will increase cohesiveness among diverse teams. Technically supported tools and methods focus on meeting the traditional objectives. There is a need to focus on “soft skills” as well. For example training the project team on leadership, motivation, interpersonal communication, group dynamics to increase client involvement may contribute to

stable requirements, thereby leading to better project outcomes.

References

- Baccarini, D., Salm, G., and Love P. E. D. (2004) Management of Risks in Information Technology Projects, *Industrial Management & Data Systems*, 104 (4), 286–295
- Bakker, K., Boonstra, A., and Wortmann, H. (2009) Does Risk Management Contribute to Project Success? A Meta Analysis of Empirical Evidence, *International Journal of Project Management.*
- Chiang, I. R., and Mookerjee, V. S. (2004) Improving Software Team Productivity, *Communications of the ACM*, 47 (5).
- Dyba, T. (2000) An Instrument for Measuring the Key Factors of Success in Software Process Improvement, *Empirical Software Engineering*, 5, 357– 390.
- Foo, S., and Muruganantham, A. (2000) Software Risk Assessment Model, *Proceedings of IEEE International Conference on Management of Innovation and Technology*, 536–544.
- Fu H., and Ou J. (2013) Combining PCA with DEA to Improve the Evaluation of Project Performance Data: A Taiwanese Bureau of Energy Case Study, *Project Management Journal*
- Gladden, G. R. (1982), Stop the Life Cycle, I Want to Get Off, *Software Engineering Notes*, 7 (2).
- Jones, C. (1994) Assesment and Control of Software Risks, Yourdon: Englewood Cliffs, NJ.
- Jugdev, K., and Thomas, J. (2002) Project Management Maturity Models: The Silver Bullets of Competitive Advantage, *Project Management Journal*, 33 (4).
- Jugdev, K., and Muller, R. (2005) A retrospective Look at our Evolving Understanding of Project Success, *Project Management Journal*, 36 (4).
- Jurison, J. (1999) Software Project Management: The Manager's View, *Communications of AIS*, 2.
- Keil, M., Tiwana, A., and Bush, A. (2002) Reconciling user and Project Manager Perceptions of IT Project Risk: A Delphi Study, *Info Systems J*, 12, 103– 119.
- Keil M, Rai A, Mann J E C, and Zhang P (2003) Why Software Projects Escalate: The Importance of Project Management Constructs, *IEEE Transactions on Engineering Management*, 50(3).
- Lapouchnian, A. (2001) Goal Oriented Requirements Engineering: An Overview of Current Research, *Proceedings RE'01, 5th IEEE International Symposium on Requirements Engineering*, Toronto, 249–263.
- Linberg, K. R. (1997) Software Developer Perceptions about Software Project Failure: A Case Study, *The Journal of Systems and Software*, 49, 177–192.
- Li, J., Conradi, R., Slyngstad, O. P. N., Torchiano, M., Morisio, M., and Bunse, C. (2008) A State-of-the-Practice Survey on Risk Management in Development with Off-The-Shelf Software Components, *IEEE Transactions on Software Engineering*.
- Nidumolu S. (1995) The Effect of Coordination and Uncertainty on Software Project Performance: Residual Performance Risk as an Intervening Variable, *Information Systems Research*, 6(3)
- Pinto, J. K., and Covin, J. G. (1989) Critical Factors in Project Implementation: A Comparison of Construction and R& D Projects, *Technovation*, 9, 49– 62.
- Prikladnicki, R., Audy, J. L. N., and Evaristo, R. (2003) Global Software Development in Practice: Lessons Learned**,** *Software Process Improvement and Practice*, 8, 267– 281.
- Raz, T., Shenhar, A. J., and Dvir, D. (2002) Risk Management, Project Success, and Technological Uncertainty, *R & D Management*, 32 (2).
- Rose, J., Pedersen, K., Hosbond, J. H., and Krammergaard, P. (2007) Management Competences, Not Tools and Techniques: A Grounded Examination of Software Project Management at WM-data, *Information and Software Technology*, 49, 605–624
- Sharma, A., Sengupta S., and Gupta A. (2011) Exploring Risk Dimensions in Indian Software Industry, *Project Management Journal*, 42(5), 78- 91.

- Shenhar, A. J., Dvir, D., Levy, O., and Maltz, A. C. (2001) Project Success: A Multidimensional Strategic Concept, *Long Range Planning,* 34, 699–725.
- Shenhar, A. J., and Dvir, D. (2007) Reinventing Project Management-The Diamond Approach to Successful Growth and Innovation, *Harvard Business School Press*, MA.
- Wallace L., Keil M., and Rai A. (2004) How Software Project Risk Affects Project Performance: An Investigation of the Dimensions of Risk and an Exploratory Model, *Decision Science*, 35 (2)
- Wienclaw, Y. A. (2014) Project Management, *EBSCO Research Starters*, Great Neck Publishing.
- Yeo, K. T. (2002) Critical Failure Factors in Information System Projects, 20, 241–246.
- Zmud, R. W. (1980) Management of Large Software Development Efforts, *MIS Quarterly* June.