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Influence of Non-Technical Components on Software Development

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ABSTRACT

The success or failure of Software Project management consists of two components, namely the technical and non-technical components of software development. Non-technical related components of software development process tend to be under managed. Further research on success and failure of software projects developed in-house are sparse. Therefore a study was conducted in India among the industries that are into in-house software development, to investigate the influence of the non-technical components of the software development process, on success and failure of software development from the practitioners' perspective. The study reveals that practitioners' consider the level of customer/user involvement, software process management, and estimation & schedule contribute most to project success and failure.

Keywords: Failure, In-house, Non-technical components, Software development process, Success.

1. Introduction

To have a successful software project, it is essential to identify what constitutes success. Projects succeed when enough factors go well to allow a project's objectives to be satisfied. Project success and failure can rarely be described in absolute terms. If failure is no accident then success is no accident. Failure and success provide different perspectives on improvement: failure tells what not to do in future, where as success shows what should be done again.

A review of extant literature shows that studies on success factors have been predominantly conducted in the Western settings [2], [3], [9], [15], [16], [18]. Literature reveals that decades of individual and collective efforts by project management researchers since the 1960s, have not led to discovery of definite set of factors leading to project success [4], [6], [9], [18]. The reasons could be attributed to methodical differences, the culture, and factors pertaining to the work role. Nevertheless, studies on project success factors in India are at a primitive stage.

In recent years, researchers in project management have become increasingly interested in success and failure factors [2], [3], [7], [9], [19].

Knowledge and understanding of success and failure factors, as well as how to measure them and the interactions between these factors have great importance for project management effectiveness.

The success or failure of Software Project management consists of two components, namely the technical and non-technical components of software development. The technical issues of software development include those directly related to hardware and software. Non-technical issues relate to people and process-related components of the development process. Non-technical related components of software development process tend to be under managed. The cause of most project failure has little to do with technological issues, despite the tendency among project managers to focus on technical issues involved in software development [13].

There is a lack of quantitative research into the non-technical components of software development projects, specifically from the perspective of software practitioners [13]. Further research on success and failure of software projects developed in-house are sparse [9], [19]. Therefore a study was conducted in India among the industries that are into in-house software development to investigate the software development success and failure. This study investigated the influence of the non-technical factors of software development process, on success and failure of software development from the perspective of software practitioners.

Previous software engineering studies have suggested a number of non-technical components that contribute to the eventual success and failure of software development, however, the joint occurrence are captured only with three factors [14], [19].

The non-technical components/factors can be broadly categorized as

1. Sponsor/management support and participation (people and process-related)
2. Customer/user support and participation (people and process-related)
3. Requirement management (people and process-related)
4. Estimation and schedule (people and process-related)
5. Project manager and relationship with development staff (people and process-related)
6. Software process management (process-related) and
7. Software development personnel (people-related).

Research on the joint occurrence of all the non-technical components of project management is sparse. This research investigated the above stated list of non-technical components of software development process and the joint effect of the chosen non-technical components that determines the success and failure of software development.

2. Purpose and Significance of the Study

Over-management of technical issues and under-management of non-technical people related issues is the problem that software development is facing. Managing technical issues tends to be more straightforward than managing non-technical, people, who come with their unique personalities, strengths, weakness and opinions. Therefore managing non-technical, people-related components tend to be difficult. As a result non-technical issues more often plague software development than technical problems.

Moreover in-house developed software tend to get deviated from estimates and schedule due to various reasons like; more attention for maintenance and support for already implemented projects, lack of resources, lack of required participation of stakeholders due to their day to day activities and other priorities.

This study will help to fill the current quantitative, survey-based research gap on the non-technical components of the software development process specifically from the perspective of software practitioners of India. This study is also intended to enlighten project managers with regard to the importance of practitioners' overall perception of project success. Therefore an understanding of the importance of software development success and failure will have significant implication for the organization and the software practitioners.

3. Research Methodology

A. Research Focus

The research focus is to study software development success and failure of in-house developed software projects in India. The research focus is also to study the level of non-technical components and to predict the success and failure of software development by the selected non-technical components from the software practitioners' perspective.

B. Research Questions

- Q1. What is the level of non-technical components?
- Q2. What non-technical factors predict software development success and failure from the software practitioners' perspective?

C. Objectives of this study

1. To study the level of non-technical components/factors.
2. To predict the software development success and failure by the selected non-technical components from the software practitioners' perspective.

D. Research Model

In this context the researcher has developed a model to be tested (Fig 1). The model treats the chosen non-technical components as predictors or independent variables and success and failure of the software development as the dependent variable or the grouping variable. This is a predictive model where the chosen non-technical components are tested for prediction of success and failure of software development.

E. Methodology

The major purpose of this investigation is to capture the factors that predict the success and failure of software development.

It was decided that a descriptive study using primary data would be appropriate to investigate the objectives. The instrument used to collect the data was a questionnaire.

Instrumentation

For the purpose of studying the objectives, a questionnaire has been used as an instrument to collect the data. The questionnaire has two parts; the first part measures the short profile of the respondents and the second part measures the study variables.

The variables chosen for this study are Management support, customer/user, requirement, estimation and schedule, project manager/staff, software process management and personnel. The items capturing each factor have been adopted from earlier

research [19]. The items that constituted adequate coverage of the factors under study were decided and agreed upon by the researcher.

The second part of the instrument captured the study variables and the items of the study variables, which were adopted from [19], management support scale consisted of 7 items, customer/user consisted of 8 items, requirement consisted of 8 items, estimation and schedule consisted of 11 items, project manager/staff consisted of 16 items, software process management consisted of 22 items, and personnel consisted of 18 items.

Validity test

The questionnaire was subjected to face and content validity whose determination was judgmental.

The face and content validity of the items were conducted with 8 experts. The content validity ratio (CVR) was applied to each item, using the formula developed by [11].

$$\text{Content Validity Ratio} = \frac{N_e - N/2}{N/2}$$

where N_e = number of panellists indicating "essential" and
 N = total number of panellists.

All items scored less than 0.50 on the content validity ratio have been removed from the study. Based on the face validity and content validity ratio, the final number of items in each of the factors taking part in this study was decided.

Accordingly, the number of items included in each of the factors is as follows:

Management Support	: 7 items
Customer / User	: 8 items
Requirements	: 8 items
Estimation and schedule	: 11 items
Project manager / staff	: 13 items
Software process management	: 20 items
Personnel	: 16 items

These items were made on a 5-point scale anchored by 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree and 5 = strongly agree and the mean of the items under each factor was used as a composite measure of the respective factors.

Sampling frame

The geographical area of Coimbatore city (India) was chosen as the Universe. The main reason for choosing Coimbatore city is that the investigator is located here and is familiar with the place. Familiarity is found to be essential for gaining accessibility to the respondents as well to solicit genuine participation by the respondents.

Administration and justification of the sample

A list of companies having an in-house software development department was prepared. 58 companies were chosen. From this list, only those companies which had at least a project leader to lead a project had been selected; the project managers/project leaders should have undertaken led and completed at least one software project. A total of 41 companies were identified. After identifying the companies, snowball sampling technique was used to select the respondents. Accordingly, 141 software practitioners were identified.

A thorough follow-up was done in person and over telephone to expedite the process of filling up the questionnaire. Yet few questionnaires were not returned and few were unusable and incomplete, yielding a response rate of 71.42% (100 usable questionnaires). Filled-in questionnaires from 34 companies alone were returned. The final sample size is of considerable size when compared to some relevant prior studies [5], [9], [14]. The industry sectors of respondents' organizations are manufacturing sector, Textile & Sugar mills and hospitals.

Techniques used for analysis

The techniques used for analysis were mean, standard deviation, correlation, and discriminant analysis. Mean and standard deviation were used to study the level of non-technical components. Discriminant analysis was used to predict the success and failure of software development by the study variables from the practitioners' perception.

4. Analysis and Interpretation

The data collected from the respondents was tabulated and analyzed using appropriate statistical techniques mentioned in the research methodology.

Testing the objectives

This section contains tabulation of techniques used to study the objectives mentioned above.

Objective 1: To study the level of non-technical components/factors.

To study this objective mean, standard deviation and intercorrelations among the study variables were found which are shown in the Table I. The results indicate moderate correlations and there is no evidence of multi-collinearity [8].

The Table I shows that the mean score for management support is 3.33, customer/user 3.48, requirement 3.38, estimation and schedule 3.40, project manager/staff 4.41, software process management 3.77 and personnel 3.46.

Objective 2: To predict the software development success and failure by the selected non-technical components from the software practitioners' perspective.

Stepwise Discriminant Analysis (DA) is performed to predict the success and failure of software development by the study variables from the perspective software practitioners. The stepwise DA resulted in a 3 – step discriminant model.

From the Table II the significance levels of the individual variables reveal that on a univariate basis, Customer/User, Requirement, Estimation and schedule, Project manager/staff and Software process management and Personnel, display significant differences between the group means. Management support is not significant across success and failure of software development. Visual examination of the group means provide information about the differences between the groups, however the statistical significance of any specific comparison is not known. This is important in discriminant analysis, though only two groups are involved in this model.

The Table III presents the three steps of the stepwise discriminant model. In the first step, the variable Customer/user entered the model. In the second step Customer/user entered discriminating between the success and failure along with Software process management. In the third step Customer/User entered discriminating between success and failure along with Software process management and estimation and schedule.

Since stepwise discriminant analysis is performed, Mahalanobis D^2 (Min D^2) is used to evaluate the statistical significance of the discriminatory power of the discriminant function(s) and to determine the variable with the greatest power of discrimination. This is used over Rao's V because it is based on generalized squared Euclidean distance that makes adjustments for unequal variances. It is also preferred because the researcher is interested in the maximal use of the available information and also of its computation in the original space of the predictor variable rather than a collapsed version as used in other measures.

At each step, the variable that maximizes the Mahalanobis distance between the two closest groups is entered.

The Table IV gives a summary of the 3 steps involved in the discriminant analysis. The variables customer/user, software process management, and estimation and schedule enter the discriminant function. Discrimination increased with the addition of each variable, achieving by the third step a substantial ability to discriminate between the groups. This is indicated by the Mahalanobis D^2 value which is significant. As the variables enter in each step from 1 to 3, the respective stepwise models are significant indicated by the significance of the F – value, shown in Table IV. The overall results are also found to be statistically significant and continue to improve in discrimination as evidenced by the decrease in Wilks' Lambda value (from 0.664 to 0.462). The Table IV describes the 3 variables that were significant discriminators based on their Wilks' lambda and minimum Mahalanobis D^2 .

The multivariate aspects of the discriminant model are explained by the Canonical Discriminant Functions reported in the Table V. As two groups are involved, the model produced one discriminant function. The discriminant function is significant displaying a canonical correlation of 0.759. The functions are statistically significant as measured by the Chi-Square statistic = 74.62, and that the function accounts for 100% of the variance explained. The total amount of variance explained by the function in the dependent variable is 57.61%.

To assess the contributions of the seven predictors, the researcher has examined the structure matrix, which is indicative of each variable's discriminating power (shown in Table VI).

It is found that Customer / User have the largest discriminating power with coefficient 0.66 followed by Software process management 0.49 and Estimation and schedule 0.35.

The predictive accuracy of the discriminant function is assessed using the classification matrix. The Table VII shows that the discriminants function in combination achieve a higher degree of classification accuracy. The hit ratio for the analysis is 92.0%. The final measure of classification accuracy is Press' Q calculated to test the statistical significance that the classification accuracy is better than chance.

The Press' Q statistic calculated is compared to the critical value based on Chi-square distribution. The calculated value is more than the critical value at a significance level of 0.05. Therefore, the classification results are significantly better than that which would be expected by chance.

5. Findings and Discussion

It is found that practitioners' consider the level of customer and user involvement contributes most to project success and failure. Practitioners perceive the next important factors to be software process management and estimation and schedule.

The findings of this study suggest that involvement of customers/users should occur in all phases of software development. The level of customer involvement may enhance the confidence of the practitioners. Researches in the West report that customer/user is the most important factor predicting success and failure [1], [2], [10], [12], [17], [19].

Software Process management influencing success and failure suggests that the plan for the software development, and monitoring and control is an important management activity. While planning is cautiously done at the start of the project, risk management and monitoring and control are exercised at every phase of the project.

Effective estimation is one of the most challenging and important activities in software development to attain success. A good schedule is reasonable and achievable and all efforts to compress the schedule might not lead to success. Estimation and scheduling parameters such as size, effort, time, cost and quality are reliably estimated and scheduled such that success and failure is predicted by estimation and schedule. The researcher views that estimation and schedule is also an important factor in prediction of success and failure.

6. Conclusion

The success and failure of software project is not only a unique pattern in Western countries but also it pertains to countries like India too. Given the cultural differences in attitudes, values, and behaviours towards work, this study enables to see the pattern that is emerging in industrializing and economically progressing countries like India. The study is one among the pioneer research gleaned from several success and failure literatures providing insight into the importance of the non-technical factors in understanding the software development success and failure.

The results from this study will help project managers and other project stakeholders to predict the likelihood of project success, in evaluating their on-going projects and improve managerial decision-making as lessons learnt are applied to other software development projects. Findings regarding the failure will help the organizations and the software practitioners to take corrective measures and march towards successful software development.

Appendix

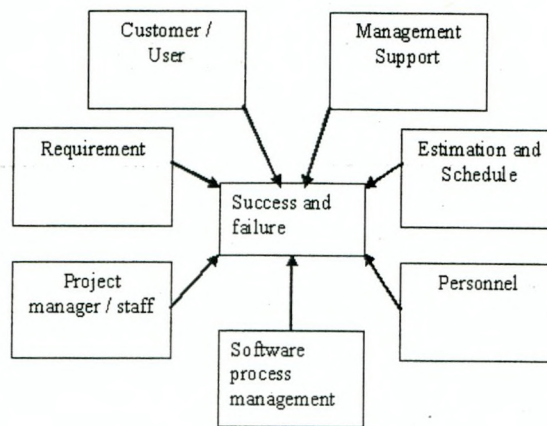


Fig. 1.1: Success and Failure Model (Research Model)

Study Variables	Mean (S.D)	1	2	3	4	5	6
1. Management support	3.33(.70)						
2. Customer / User	3.48(.43)	-.01					
3. Requirement	3.38(.52)	.12	.12				
4. Estimation and schedule	3.40(.37)	-.06	.14	.33*			
5. Project manager/ staff	4.41(.87)	.12	.12	.26*	.27*		
6. Software process management	3.77(.37)	.12	.10	.42*	.30*	.30	
7. Personnel	3.46(.31)	.14	-.13	-.22**	.21**	.42**	.34**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 1.1: Mean, Standard Deviation and Inter-Correlation among the Study Variables

Study Variables	Wilks' Lambda	F	df1	df2	Sig.
Management support	1.000	.00	1	98	.955
Customer / User	.664	49.63	1	98	.000
Requirement	.933	7.03	1	98	.009
Estimation and schedule	.875	13.98	1	98	.000
Project manager/staff	.932	7.14	1	98	.009
Software process management	.775	28.41	1	98	.000
Personnel	.970	5.15	1	98	.026

Table 1.2: Tests of Equality of Group Means

Step	Study Variables	Tolerance	F to Remove	Min. D Squared	Between Groups
1	Customer / User	1.000	49.632		
2	Customer / User	.938	57.239	1.557	Success and Failure
	Software Process Management	.938	35.066	2.721	Success and Failure
3	Customer / User	.936	54.941	2.031	Success and Failure
	Software Process Management	.920	26.337	3.763	Success and Failure
	Estimation and Schedule	.937	5.418	5.647	Success and Failure

Table 1.3: Study variables in the Analysis

Step	Study Variables Entered	Wilks' Lambda	Min D Squared				
			Statistic	Between Groups	Exact F		
					df1	df2	Satatic
1	Customer / User	.664	2.72*	Failure and Success	1	98	49.63*
2	Software Process Management	.488	5.65*	Failure and Success	2	97	50.98*
3	Estimation and Schedule	.462	6.30*	Failure and Success	3	96	37.34*

Table 1.4: Summary of Study Variables Entered/Removed

Function	Eigen Value	% of Variance	Canonical Correlation	Wilks' Lambda	Chi-Square	Df	Sig
1	1.167	100.0	.759	.462	74.62	3	.00

First 1 canonical discriminant functions were used in the analysis.

Table 1.5: Eigenvalues

Study Variables	Canonical Discriminant Function
Customer / User	0.659*
Software Process Management	0.498*
Estimation and Schedule	0.350*
Requirement **	0.286
Project manager / Staff **	0.166
Personnel **	0.059
Management Support **	0.070

Table 1.6: Structure Matrix

* Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions variables ordered by absolute size of correlation within function.

** This variable not used in the analysis.

Success and Failure from Practitioners' Perspective	Predicted Group Membership			Total
	Success or Failure	Failure	Success	
Count	Failure	23	1	24
	Success	7	69	76
%	Failure	95.8	4.2	100
	Success	9.2	90.8	100

Table 1.7: Classification Results

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