Chapter 21
Measurement and Governance of Health of Information Technology Projects Through Use of Discriminant Analysis Technique

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21.1 Introduction

In their paper [1] authors have discussed financial impact on IT industry due to failure of the projects. If the projects are not controlled properly and proper mitigation are not placed in, then organizations faces financial losses. These losses can go into multimillion dollars is what authors have shown. Many times the investment in an IT project can be small, but if that project fails then it can lead to very high losses to organizations [2].

There are many factors that contribute to success or failure of the project. This includes "Soft Skills" of project manager [3] [4], how scope gets impacted due to evolvement of requirements over time [5] to failure of projects in spite of use of appropriate governance of the projects [6]. In their paper, [1] authors, through literature survey, studied the challenges in governance of Information technology projects and it was found that there are six major aspects which are responsible for failure of the IT projects. Also, authors checked if Discriminant analysis can be used to statistically separate projects from one another in terms of failure. Discriminant analysis has been used in various fields like construction projects [7], Psychology [8], Finance [9] for the classification of given object into various groups.

With the above background, the current study has been carried out based on the pilot survey. Project data for 100 projects have been collected from 50 practicing project managers during this pilot study. An attempt has been made to establish a discriminant analysis model. SPSS tool was used to complete the statistical analysis.

Why this study is critical: Six important aspects that impact health of the project was established based on the earlier study of research papers and subsequent research

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papers published by authors. During the further research and use of discriminant analysis a model has been established. This model is useful and project managers can use this model to check the possibility of project success at any stage of the project. Governance of health of the project can be achieved through the use of this model. Based on the output of the model appropriate actions can be planned to bring back the given project on track. Since this is a critical action which will lead to saving the project from failure and hence this research work is very crucial for IT industry.

The high-level mission statement: With issues in execution of IT projects, financial burden comes on organization and extent of this burden is very high. The aim of this research is, using discriminant analysis, establish a model and test the hypothesis that the aspects identified can predict success or failure of the project. Project Managers can check the health of the project and take corrective actions by making use of this model.

21.2 Research Methodology

Figure 21.1 shows, the overall design framework based on the research methodology framework [10]. The secondary data has been collected through the questionnaire and the corresponding survey. Using these variables, a relation between these variables was established. The questionnaire is used to measure scores for each independent variable and used as data input in the SPSS tool.

Various parameters which were considered to determine acceptance or rejection of the null hypothesis were: (a) Wilk's Lambda (b) Eigenvalues (c) the relative importance of independent variables (Standardize Canonical Discriminant Function Coefficient) and (d) the group centroids. These parameters and tests are based on

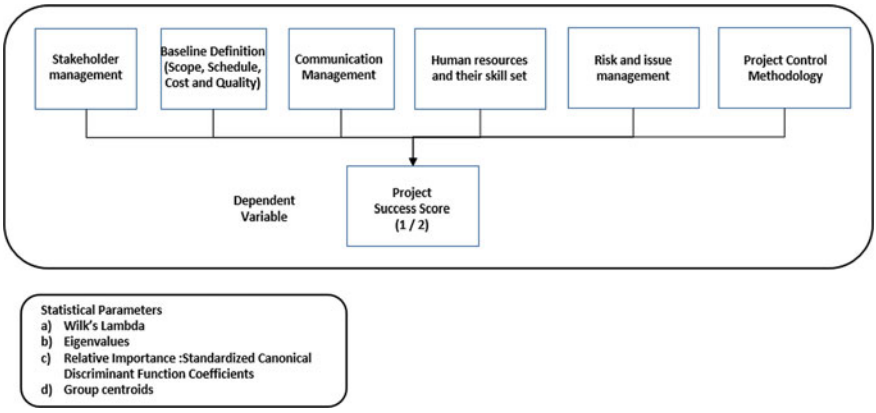

Fig. 21.1 Research design framework

discussions in various papers on discriminant analysis [11] and discussions in books on statistics [12].

As shown in Tables 21.1 and 21.2, below are the dimensions of the independent variables identified as established by authors [1]. These dimensions were used for questionnaire development. It was ensured that the questions will cover these dimensions.

Table 21.1 Dimensions Set 1

Stakeholder management	Baseline definition	Communication management
Types of project stakeholders	Clarity about scope and deliverables	Communication with stakeholders
Communication with stakeholders	Accuracy of the estimation	Communication system to connect to virtual teams
Stakeholder management	Scope creep	Unavailability of documentation
Perception of stakeholders about the final objective of the project	Definition of scope, schedule, cost boundaries	Effective communication/lack of communication
Stakeholder mapping	Scope boundaries and concent of stakeholders—contract clarity about final deliverables	

Table 21.2 Dimensions Set 2

People and their skills	Management of issues/risks	Methods for project governance
Resource management	Management of risks and mitigation plans	Project governance methodology
Adequate resource allocation/resource shortage	Risk allocation	Software and tools for governance of projects
Contractor's inadequate experience		Missing skills in methods for project control
Skills of people and the availability of people		Earned value analysis
		Project evaluation or maturity models

21.2.1 The Hypothesis Formation

Based on the variables and their types (viz. Dependent, Independent) hypothesis was defined. The corresponding variables were: Management of stakeholders, Definition of Scope/Schedule/Cost/Quality boundaries, Communication Management, Skills of people working, Issue/Risk management, Methods for project governance. The Authors [1] established that projects can get into troubled or can be completed successfully due to these six aspects.

Hypothesis statements:
Null Hypothesis H_0: Management of stakeholders, Definition of Scope/Schedule/Cost/Quality boundaries, Communication Management, Skills of people working, Issue/Risk management and Methods for project governance have no impact on the project success, i.e., discriminating power in these variables is not significant.

Alternate Hypothesis H_1: These six aspects have an impact on the project failure, i.e., significant discriminating power exists.

21.2.2 Data Collection Method

Questionnaire feedback from project managers from IT industry was the key input. The feedback from Project Managers was collected through the structured questionnaire. This questionnaire was shared with the participating project managers through an online URL using Google forms. For each independent variable following were the number of questions asked (as shown in Table 21.3). The questionnaire was designed in such a manner that it will determine whether the project will be successful or will be in troubled status. Following were the number of questions asked for each independent variable.

Table 21.3 Variables: independent

Independent variable	No of questions
Methods to govern projects	6
Managing issues/risks	7
People and their skills	6
Management of communication	5
Cost/Schedule/Scope/Quality boundaries	12
Managing stakeholders	8
Total questions	44

21.2.3 Sample Size for the Pilot Study

As per report from PMI-EY survey [13] it is projected that India will have approximately 400,000 Project Managers by 2022. Hence it can be inferred that there will be minimum 400,000 IT projects that organization in India would be executing assuming 1 project per Project Manager. Hence the sample size needed for broader study would be 384 projects [10]. As a part of the broader survey this pilot study was conducted for 50 project managers. Each project managers have shared data for two projects, i.e., the paper is based on data of 100 projects.

21.2.4 Reliability and Validity of the Questionnaire

After the questionnaire was developed, it was required to get the questions validated. Two methods were used to validate the questions (a) Review by Experts and (b) sample survey by sending this questionnaire to project managers from IT organizations—The questionnaire was sent to total 10 reviewers. It was studied if the project managers were able to understand the questions and were able to answer those. Feedback from Experts and observations of project Managers chosen for this pilot survey were suitably incorporated in the questionnaire.

21.3 Analysis and Findings

21.3.1 SPSS Output and Analysis of the Results'

21.3.1.1 Group Statistics Table

The group statistics table shows a good variation between mean values indicates that the selected independent variables (six) may be good discriminators as the difference in mean is large. (20–40%) [14] (Fig. 21.2).

21.3.1.2 Equality of the Group Means Test

Based on the Wilks' Lambda value shown in below table, it can be concluded that Variable "Baseline Definition" and "Stakeholder Management" could be the most important discriminating factor [11] (Fig. 21.3).

Group Statistics

S		Mean	Std. Deviation	Valid N (listwise) Unweighted	Weighted
1	S_BD	38.58	6.440	50	50.000
	S_CM	17.10	2.178	50	50.000
	S_HR	18.76	3.450	50	50.000
	S_PC	19.10	5.027	50	50.000
	S_RM	23.50	3.177	50	50.000
	S_SM	26.84	3.930	50	50.000
2	S_BD	22.30	8.379	50	50.000
	S_CM	12.12	4.650	50	50.000
	S_HR	13.78	4.325	50	50.000
	S_PC	13.42	6.643	50	50.000
	S_RM	14.98	6.968	50	50.000
	S_SM	16.04	6.537	50	50.000
Total	S_BD	30.44	11.055	100	100.000
	S_CM	14.61	4.394	100	100.000
	S_HR	16.27	4.627	100	100.000
	S_PC	16.26	6.519	100	100.000
	S_RM	19.24	6.882	100	100.000
	S_SM	21.44	7.632	100	100.000

Fig. 21.2 Group statistics

Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
S_BD	.452	118.652	1	98	.000
S_CM	.676	47.037	1	98	.000
S_HR	.708	40.515	1	98	.000
S_PC	.808	23.243	1	98	.000
S_RM	.613	61.892	1	98	.000
S_SM	.494	100.247	1	98	.000

Fig. 21.3 Equality of group means test

21.3.1.3 Eigenvalues and Wilks' Lambda

The explanation of proportion of variance can be elaborated by Eigen Value. Higher the value indicates that the function is very strong. Correlation value 1 means the

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.972[a]	100.0	100.0	.815

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.336	103.479	6	.000

Fig. 21.4 Eigenvalues and Wilks' Lambda

function is excellent. The value in this study was found to be 1.972 which indicates a very good correlation (Fig. 21.4).

Below are the values of various parameters which was calculated using SPSS

(A) Wilk's Lambda: 0.336.
Chi-Square: 103.479.
DOF: 6.

Since Wilk's Lambda is much lower than 1 it indicates that the variability within group is very small with respect to total variability. It can be concluded that group mean differs from each other.

(B) At Level of confidence of 95% value of a = 0.05.
P value which we have is 0.000.

Since 0.05 > 0.000, null hypothesis should be rejected and accept alternate hypothesis. Which means that six aspects have significant power for discrimination.

21.3.1.4 Test for Independent Variable's Relative importance

In the below table, SPSS output of Standardized Canonical Discriminant Function coefficient has been mentioned. Higher the power indicates higher standardize discriminant coefficient.

Highest discriminating coefficient value is observed for "Cost/Schedule/Scope/Quality boundaries": 0.615. Other KPIs can be ranked based on the decreasing value of coefficient and the sequence of importance is "Management of Stakeholders", "Management of Issues/risks", "People and Skills", "Communication Management" and "Methods to control projects". This indicates that "Cost/Schedule/Scope/Quality boundaries" has a best predictor of whether the project will get into a troubled status or not (Fig. 21.5).

Fig. 21.5 Standerdized canonical discriminant coefficient

Standardized Canonical Discriminant Function Coefficients

	Function 1
S_BD	.615
S_CM	-.093
S_HR	.227
S_PC	-.329
S_RM	.284
S_SM	.574

Fig. 21.6 Functions at group centroids

-1.390 0 +1.390

Functions at Group Centroids

S	Function 1
1	1.390
2	-1.390

Unstandardized canonical discriminant functions evaluated at group means

21.3.1.5 Functions at the Group Centroids

Below table shows the functions at the group centroids. Since the number of cases for success and failures are same, we can take average of these extreme points to come to center which is "0". So, if the value of *B* for any project lies between 0 and −1.390 then given project has high possibility of failure (Fig. 21.6).

21.3.1.6 Graphical Representation of the Discriminant Function

Below are the graphs which SPSS has plotted, and graphs clearly indicates that the six aspects have significant power to differentiate (Fig. 21.7).

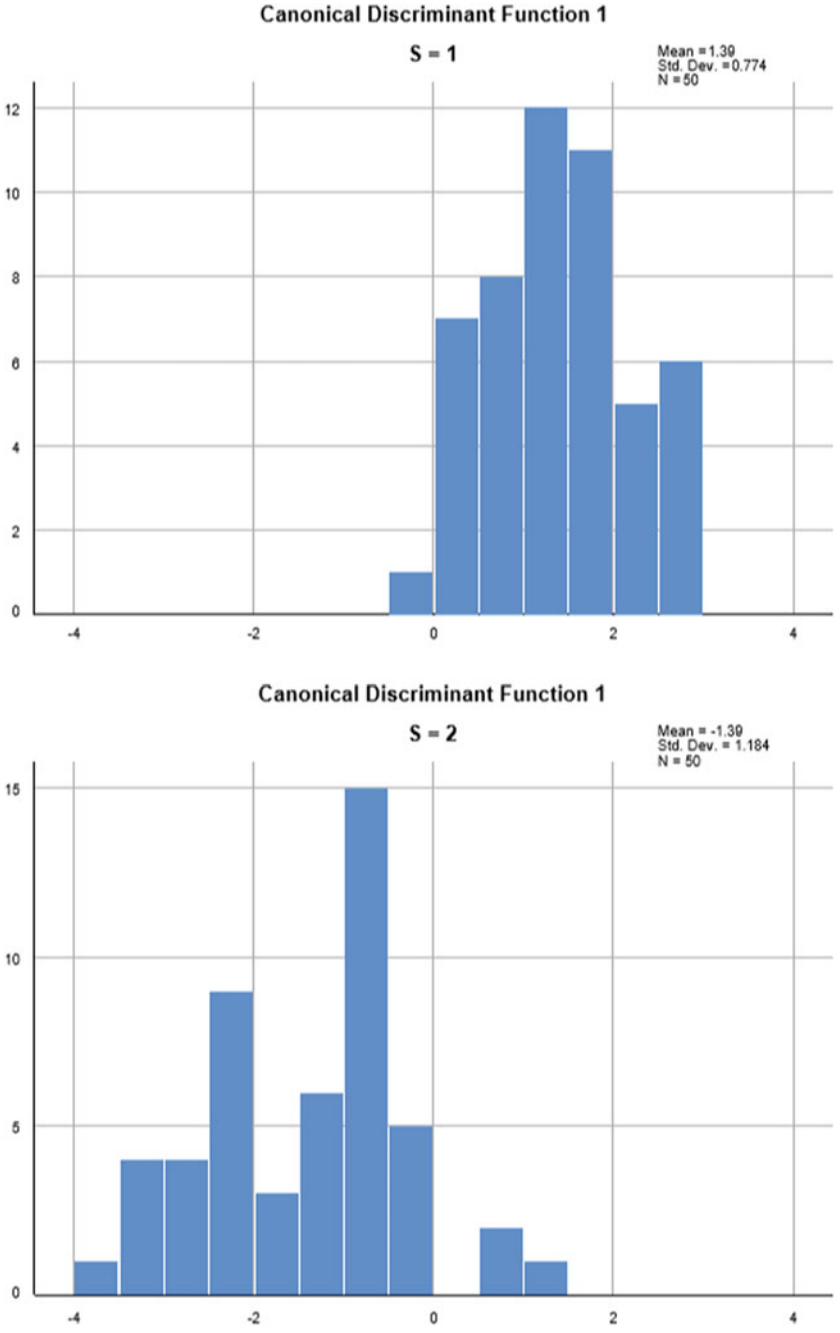

Fig. 21.7 Graphical representation of discriminant function

21.3.1.7 Outliers in Data Collected

In this pilot study, data from 50 project managers was collected for 100 projects. Marks were given to each answer ranging from four to zero depending upon the option selected by Project Managers. Sum of marks were calculated for each parameter and then the sum total for a given project was calculated. As shown in the Table 21.4 it was observed that for three project managers (six projects) the total score for the successful project was less than the total score for troubled projects. In other words, despite equal or better control of troubled project, compared to successful project, the said project went into troubled status. Which also means that for these projects there were some other factors which caused these projects to get into troubled status. So, it seems that these four projects were outliers.

When the Discriminant analysis was done on the complete set of data including above six data points the key statistical values Wilks' Lambda and Eigenvalues were as below (Fig. 21.8).

Whereas the values of the above 2 parameters were as below when the discriminant analysis was done by removing these outliers (Fig. 21.9).

If we compare these two sets then it clearly shows the impact of outlier on the discriminant analysis and that discriminant analysis is very sensitive for outliers. Pathology like outlier has an adverse impact on the accuracy and interpretation of discriminant analysis [15]. From which it can be inferred that if from the discriminate equation if it is wrongly predicted that project will be successful then the cost of wrong prediction will be high as project manager might get misguided. Hence, these four data points were removed from the sample data collected [11].

Discriminating function can be expressed as

$$B = a + a1A1 + a2A2 + a3A3 + a4A4 + a5A5 + a6A6.$$

B = Dependent Variable
'a' = constant
'$a1 \ldots a6$' are coefficients
'$A1 \ldots A6$' are independent variables.

Therefore $B = -5.458 + 0.82$(Cost/Schedule/Scope/Quality boundaries) $-$ 0.026(Communication Management) + 0.058(People and skills) − 0.056(Methods of project governance) + 0.052(Management of Issues/Risks) + 0.106(Management of stakeholders) (Fig. 21.10).

21.4 Discussion

With more and more digitization and connected world coming into play there is a constant need of organizations to take up IT projects to meet their end goal. Organizations are investing in these IT projects in a big way. On the other hand, financial losses for IT projects are very high due to failure of the projects. Hence, there is need

Table 21.4 An Outliers

Project manager	Total score	Baseline definition	Communication management	Human resources and skills	Project control methodology	Risk and issue management	Stakeholder management	Total score
A	Successful project	35	13	19	13	22	27	129
	Troubled project	39	13	19	20	22	21	134
B	Successful project	43	17	19	14	23	31	147
	Troubled project	41	20	20	14	23	31	149
C	Successful Project	18	7	8	10	17	25	83
	Troubled project	42	16	23	24	27	29	161

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.353[a]	100.0	100.0	.758

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.425	86.418	6	.000

Fig. 21.8 Wilks' Lamda and Eigenvalues before removing outliers

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.972[a]	100.0	100.0	.815

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.336	103.479	6	.000

Fig. 21.9 Revised Eigenvalues and Wilks' Lambda

Fig. 21.10 Revised canonical discriminant function coefficient

Canonical Discriminant Function Coefficients

	Function 1
S_BD	.082
S_CM	-.026
S_HR	.058
S_PC	-.056
S_RM	.052
S_SM	.106
(Constant)	-5.458

Unstandardized coefficients

to check and govern what are the possible reason for failure of IT projects so that the risk of failure of an IT project can be minimized or a mitigation plan can be designed by Project Managers and management team.

With that background in phase 1 of research undertaken by the authors [1], it was established through the literature survey that there six main parameters (independent variables) on which success or failure of a project depends. These parameters are Cost/Schedule/Scope/Quality boundaries, Communication Management, People and their skills, Methods of project governance, Management of Issues/Risks, Management of stakeholders.

A sample of 50 project managers and their 100 projects were taken for this pilot study to establish the model to measure the impact of these factors using discriminant analysis. In the above discussion, the model has been established. It was observed that Cost/Schedule/Scope/Quality boundary has maximum influence on the success of the project.

By using this model project managers can measure the possible outcome for their project based on the current situation on these six factors. If the model predicts that project might get into troubled status and may fail, then accordingly project manager can take appropriate measures to avoid failure of the project. Project Manager can use this model at any point in time during the execution of the project which can help project manager to keep appropriate control over the project.

21.5 Conclusion

In this study an analysis of the data collected from the survey of 50 project managers (and their 100 projects) was carried out. The corresponding questionnaire was developed to collect the data of the six independent variables which influence the success or failure of a project. Using discriminant analysis, it was established and the Null Hypothesis that variables do not have discriminating power was rejected. SPSS software was used to analysis the data collected. A model which was derived out of the analysis is $B = -5.458 + 0.82$(Cost/schedule/scope/Quality boundaries) $-$ 0.026(Communication Management) $+$ 0.058(People and skills) $-$ 0.056(Methods of project governance) $+$ 0.052(Management of Issues/Risks) $+$ 0.106(Management of stakeholders).

And if the value of the dependent variable B lies between 0 and -1.390 then that given project has a high possibility of failure and vice versa.

It has been established through this pilot study that the six parameters do influence the success or failure of the project and that further study can be undertaken. Moreover, this model can be used to calculate discriminant score to categories a project into a successful or troubled project. Project managers can then take corrective actions.

Future scope: Authors will be expanding the survey and will be taking more samples to further enhance the study and to finalize the model. Moreover, authors are also working on deriving a proposed suggestion through the use of this discriminant analysis by helping project managers to pin point the area where improvements are

required to bring the project on track. There few areas for further research were identified like why the quality of subcontractor resources in India is not up to mark and what organization can do for the same.

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