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A Methodology for the Categorisation of Software Projects in Nigeria Based on Performance

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Software engineering projects in Nigeria have been classified generally as a failure, challenged or successful with no proof that the projects fall into these categories. The main focus has been on cost and time overrun, and attention has not been given to check whether projects truly fall within the given categories. Discriminant analysis was employed to determine how the 30 selected projects in the public sector in Nigeria can be correctly classified. This study developed a method for determining the actual category of software engineering projects concerning the characteristics of projects as a failure, challenged, or successful. The developed model was used to reclassify the thirty (30) projects, and it was discovered that twenty- one (21) projects were correctly classified giving 70% of correctly classified projects while nine (9) were wrongly classified giving 30%. It is possible for projects to satisfy the established success criteria (requirements met on time and within budget) whereas the stigma of failure still exists in its result.

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Keywords: Software engineering projects; project performance; stakeholders; time and cost overrun; discriminant analysis.

1. INTRODUCTION

Software projects success/failure rate has been on the increase since 1994 when Standish Group revealed the first ever Chaos report of software project woes. Many organisations had carried out studies to ascertain the level of success/failure rates in software engineering projects. In 2014, Standish Group [1] studied 50,000 software projects and reported that 71% of the projects either challenged or failed to accomplish the project objectives and only 29% were successful. The report also revealed that large projects had a higher failure rate of 94%, medium projects had 91% failure rate. Over 50% of the projects studied had cost and time overrun. According to Florentine [2], Innotas by Planview carried out studies in 2013 on success/failure rates of software engineering projects and reported that 50% of the projects studied experienced failure within the last 12 months. McKinsey and Company in collaboration with the BT Centre of University of Oxford studied 5400 IT projects in 2012 and concluded that 45% of the projects studied experienced cost overrun, 7% experienced time overrun and 56% delivered fewer functionalities than expected [3]. All these studies used time and cost and functionalities to determine the performance category of a project. Software project performance has been a thing of concern to stakeholders due to the resources invested into such projects.

Project Management Institute [4] tagged a project successful when it is completed on schedule and within budget, that is, the resources assigned from the inception were enough to carry out the project and the features and functionalities specified for the project were correctly implemented. Montequin et al. [5] said that challenged projects are those, which either delivered late or over budget with fewer features and functions than initially specified, and failed projects are cancelled before completion or implementation. Most software projects reported in Standish Group Chaos research as a failure or challenged experienced time and cost overrun and content deficiency or incomplete features and functions [1].

On time delivery of software engineering projects and within budget is becoming more important to stakeholders in this era of fast- moving business environment. The duration and budget of software engineering projects are the main concerns of stakeholders [6]. Project time and cost overrun is a globally well-known problem in every industry such as road construction [7], software [8] and building [9]. Cost and time overrun instigate projects failure, abandonment, and therefore make the project challenged. Stakeholders are disappointed when a project could not achieve the desired objectives [6]. Unfortunately many software engineering projects in Nigeria exceed scheduled durations and estimated budgets [10]. Eberendu [10] also discovered that over 86% of software engineering projects in the public sector in Nigeria had experienced poor project performance. Even the projects classified as a failure, challenged or successful may not be as categorised. Project managers capitalise on already known factors to determine whether a project had failed, challenged, or succeeded. It is likely for a project to fulfil all established success criteria (requirements met on time and within budget) whereas the stigma of failure still exists in its result. Also, perception can be a reality, that is to say, project stakeholders might think a project has failed, but chances are good that it has failed or it has not failed. The study tries to answer the question of how the software engineering project performance in Nigeria can be classified to determine whether a project has failed, challenged or succeeded. To achieve this, discriminant analysis is used to develop a model that predicts the category a project belongs when it is completed.

2. RELATED LITERATURE

The definition of project performance depends on the expertise of the project team and the type of project they are handling. Mir and Pinnington [11] saw on-time and within budget has been of great concern to project organisations and stakeholders are dissatisfied when projects are not delivered as expected. One of the main causes of failure in software project development is time and cost overrun, and developers are concerned with project overall profitability [5]. According to Senouci et al. [7] project cost is determined by the cost of individual project activities and the cost baseline is derived from the estimated cost and the actual cost of the project. Software project organisations need to have a way of estimating cost during software development [8] and the cost estimation method is used to ensure that projects are developed within the estimated budget [12].

Time management is a success factor for gaining competitive advantage in today's business. The time or duration of a project represents the scheduled dates of each project activities and their milestones [13]. Beleiu et al. [14] opined that most clients consider timely completion of a project as the major factor of success. According to Bloch et al. [3], the time taken by a project or task depends on some factors such as the competence and skills of the development team, and availability of resources [15]. Jørgensen [16] said that software projects had been criticised due to failure to deliver projects within deadline and it takes a well-organised project team to deliver projects on time and within budget. If project team reduces project duration, there is need to increase manpower (labour), tools and equipment, and improved management [17], which increases the cost [16]. Senouci et al. [7] concluded that when cost is tampered during project development, duration and quality are compromised. A direct relationship exists between project cost and effectiveness [9]. On the other hand, minimising cost jeopardises deadlines too. Proper utilisation of project time and cost determines how the product should be [8]. El-Emam and Koru [18] revealed that projects that experience cost under run are usually behind schedule. According to Atkinson [19], assessing the extent to which projects follow schedule and budget is an indication of whether the team will meet stakeholder expectations or not. According to Bowen et al. [9], project managers usually classify projects performance depending on whether the projects were delivered on-time and within budget. Even after the projects were delayed or cost overran, many projects are categorised as successful [11]. Velayudhan and Thomas [20] found out that using time and cost to determine project performance is inadequate because time and cost have significant relationship and they suggested the need to develop a model.

2. METHODOLOGY

A total of 30 software engineering projects in the Nigerian public sector were selected and analysed based on what was tagged "project status": successful, failed, or challenged. Discriminant analysis was used to describe the characteristics that are specific to distinct project groups and classify the selected projects into pre-existing groups (failure, challenged, and success). Discriminant analysis is an approach recommended to maximally separate groups, determine the most practical way to separate groups and remove variables which do not relate to a particular group [21]. According to Uddin et al. [22], discriminant analysis forms one or more weighted linear combinations of discriminator variables called discriminant functions and have the general form:

$Z = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n$, where Z is the discriminant score, *α* is the constant or Y-intercept of the regression line, *β* is the discriminant function coefficient or the weight of the variable, *x* is the discriminator variable or respondents raw score for the variable, and *n* is the number of discriminator variables.

3. RESULTS AND DISCUSSION

A total of 30 projects were used in this study, and the organisation had already tagged them as successful, challenged or failed. The projects comprised 7 failed, 14 challenged and 9 successful projects. The data were analysed using discriminant analysis, and the result is clearly illustrated as follows:

Table 1. Prior probabilities for groups

ProjStu	Prior	Cases used in analysis	
		Unweighted	Weighted
-1.00	.333	7	7.000
0.00	.333	14	14.000
1.00	.333	9	9.000
Total	1.000	30	30.000

The system assigned probabilities to each group of project outcomes: Failure is assigned -1, challenged is assigned 0 while success is assigned 1 as shown in Table 1. Each of these groups was given equal probabilities of 0.333 and weights were assigned to the cases used in the analysis.

Table 2. Canonical discriminant functions coefficient

Project status		Function	
		1	2
-1.00	Failure	1.102.	2.059
0.00	Challenged	1.082	1.266
1.00	Successful	0.332	1.982
Constant		-7.557	-7.667

Table 2 shows the coefficient of the three types of project status discriminating variables that have likelihood of exerting significant effect on project performance. The above coefficients are further used to formulate the project performance discriminant model (equation 1 and 2):

$$Z = -7.557 + 1.102X_1 + 1.082X_2 + 0.332X_3 \quad (1)$$

$$Z = -7.667 + 2.059X_1 + 1.266X_2 + 1.982X_3 \quad (2)$$

Where Z is the discriminant score and X_1, X_2, and X_3 are the variables

Table 3 presents the parameters for testing the significance of software project performance discriminant model (equations 1 and 2). The obtained Eigenvalues are 0.335 and 0.297, which are less than 1, shows that the discriminant model does have the good discriminant ability. The canonical correlations (0.501 and 0.479) show that the three project status jointly exerts 50.1% and 47.9% relationship with software project performance. This is in agreement with Uddin, et al. [22], who posits that the value of canonical correlation shows the level of relationship between the discriminant function and the dependent variable. The canonical coefficients are squared to indicate the percentage of variances explained by the discriminant models in predicting project performance. Hence $(0.501)^2 = 0.251001$ and $(0.479)^2 = 0.229441$ implies that equations 1 and 2 explains 25.1% and 22.94% of the variations in Software project performance, i.e. whether a Software Engineering Project succeeded, challenged, or failed.

The Function at the Group Centroids gives the average discriminant score of each of the three groups which established the threshold for classifying the cases, and it is presented in table 4. Using result in function 1, the centroids were 0.684 for failed projects, challenged projects = 0.157 and successful projects = -0.777. Since the three groups (Failure, Challenged, and Success) are not equal (there are 7 failed projects, 14 challenged projects and 9 successful projects from the dataset), the weights on the centroids are used to find the dividing point.

Thus, the dividing rule will be

$$\frac{n_1(lowerCentroid) + n_2(UpperCentroid)}{n_1 + n_2}$$

The group centroids between successful and challenged projects

$$= \frac{-0.777 * 9 + 0.157 * 14}{9 + 14}$$

$$= \frac{-6.993 + 2.198}{23} = -0.2848$$

The group centroids between challenged and failed projects

$$= \frac{0.157 * 14 + 0.684 * 7}{14 + 7}$$

$$= \frac{2.198 + 4.788}{21} = 0.3327$$

Fig. 1 denotes that if the score of a new project is negative and below -0.2848, such project will be classified as successful; but if the score lies between -0.2848 and 0.3327, then the project will be classified as challenged, any other positive score outside this range will classify the project as a failure.

The decision rule is formulated as follows:

a) A project is predicted and classified as successful if the discriminant score Z falls between -0.777 and -0.2848
   i.e. $-0.777 < Z < -0.2848$
b) A project is predicted and classified as challenged if the discriminant score Z falls between -0.2848 and 0.3327
   i.e. $-0.2848 < Z < 0.3327$
c) A project is predicted and classified as a failure if the discriminant score Z falls between 0.3327 and 0.684
   i.e. $0.3327 < Z < 0.684$

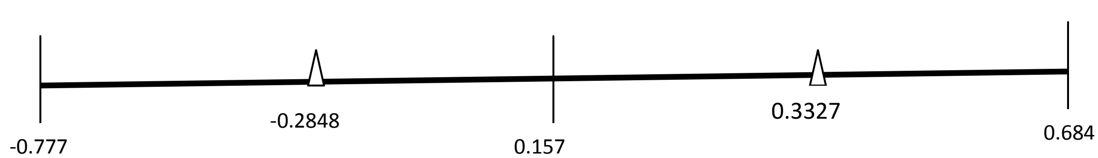

Fig. 1. Group Centroids to formulate the decision rule

Table 3. Parameters for significant tests (equations 1 and 2)

Test of Function(s)	Wilks' Lambda	Chi-square	df	Eigenvalue	Canonical correlation	Sig.
1 through 2	.577	14.553	4	.335[a]	.501	.006
2	.771	6.892	1	.297[a]	.479	.009

Table 4. Function at the Group Centroids

Project status	Function	
	1	2
-1.00	.684	.681
0.00	.157	-.533
1.00	-.777	.299

Using result in function 2, the centroids for projects that failed is 0.681, challenged projects = -0.533 and successful projects = 0.299. Since the three groups (Failure, Challenged, and Success) are not equal (there are 7 failed projects, 14 challenged projects and 9 successful projects from the dataset), the weights on the centroids are used to find the dividing point.

Thus, the dividing rule will be

$$\frac{n_1(lowerCentroid) + n_2(UpperCentroid)}{n_1 + n_2}$$

The group centroids between successful and challenged projects

$$= \frac{0.299 * 9 - 0.533 * 14}{9 + 14}$$

$$= \frac{2.691 - 7.462}{23} = -0.2074$$

The group centroids between challenged and failed projects

$$= \frac{0.299 * 14 + 0.681 * 7}{14 + 7}$$

$$= \frac{4.186 + 4.767}{21} = 0.4263$$

Fig. 2 denotes that if the score of a new project is negative and below -0.2074, such project will be classified as challenged; but if the score lies between -0.2074 and 0.4263, then the project will be classified as successful, any other positive score outside this range will classify the project as a failure.

The decision rule is formulated as follows:

a) A project is predicted and classified as challenged if the discriminant score Z falls between -0.533 and -0.2074
   i.e. $-0.533 < Z < -0.2074$
b) A project is predicted and classified as successful if the discriminant score Z falls between -0.2074 and 0.4263
   i.e. $-0.2074 < Z < 0.4263$
c) A project is predicted and classified as a failure if the discriminant score Z falls between 0.4263 and 0.681
   i.e. $0.4263 < Z < 0.681$

To verify the predictive capacity of the discriminant function, the values of the data collected is substituted in the discriminant function, and the decision rule is used to classify the overall project performance.

3.1 Testing the Validity of Discriminating Power of Equations 1 and 2

The 30 projects used in this study were also classified as '-1' for those projects that experienced failure, '0' for those that are challenged and '1' for those that are successful, but the system prediction showed the different result of the overall project performance. The system used the decision rules to reclassify the projects to different groups. According to the reclassification, 21 projects (70%) were correctly classified while 9 were wrongly classified 30% as displayed in Table 6.

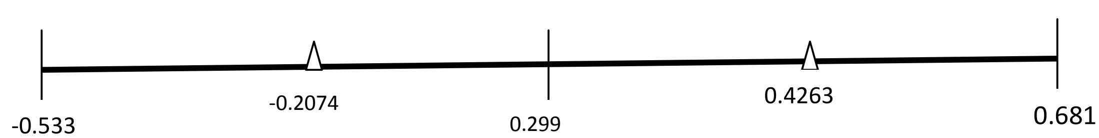

Fig. 2. Group Centroids to formulate the decision rule

Table 5. Reclassification result of project status

Projects	Prior classification of project status	Reclassification of project based on analysis 1	Discriminant scores from function 1 for analysis 1	Discriminant scores from function 2 for analysis 1	Probabilities of membership in group -1 for analysis 1	Probabilities of membership in group 0 for analysis 1	Probabilities of membership in group 1 for analysis 1
FUTO	0	1	-2.41618	-0.93377	0.01407	0.21331	0.77262
ECR	0	1	-1.72301	-0.55748	0.04009	0.26715	0.69275
DCCA	1	1	-1.06273	-0.38482	0.09107	0.34743	0.5615
LAG-PAY	1	1	-1.73201	-0.62615	0.0381	0.27722	0.68468
LAG-PMIS	1	1	-1.60131	0.54381	0.08236	0.13526	0.78238
UNIBEN	1	1	-1.45798	-0.22446	0.06579	0.25449	0.67971
UNIMAID	1	1	-1.82626	-1.17311	0.02423	0.35989	0.61588
UNIBUJA	0	0	-0.45174	-1.73077	0.05161	0.73049	0.21789
NIS-IP	0	-1	-0.00731	1.26475	0.50038	0.14786	0.35175
CLEAR	0	1	-0.19212	0.79398	0.3733	0.21528	0.41142
NHIS	0	0	0.62931	-1.18308	0.1717	0.70707	0.12123
IFEM	0	0	0.59688	-0.5124	0.29158	0.54132	0.1671
FTMS	1	-1	0.26509	1.26601	0.57886	0.14794	0.2732
DBSET	-1	-1	0.86488	0.47693	0.57115	0.27717	0.15169
SIAMS	1	-1	0.69823	0.8733	0.61775	0.20235	0.1799
NUCDB	0	-1	0.01732	1.36653	0.52354	0.13497	0.34149
AK-ELIB	-1	-1	0.64897	0.66973	0.56542	0.24334	0.19124
NPC-BIO	0	0	1.17059	-0.2849	0.44087	0.45893	0.1002
E-AGRIC	1	1	-0.73145	1.22978	0.28543	0.12892	0.58566
US-SCH	-1	-1	-0.13016	1.42637	0.48781	0.12641	0.38578
US-ELIB	-1	-1	0.86902	1.18537	0.71103	0.14575	0.14322
NIMC	-1	0	1.17544	-1.18767	0.22607	0.70193	0.072
JAMB-BF	1	-1	0.45976	1.18703	0.61734	0.15671	0.22595
KADPOLY	0	0	0.56295	-0.8274	0.22477	0.62258	0.15265
DISICS	-1	-1	-0.1154	2.0779	0.58134	0.0678	0.35086
BENSU	-1	-1	1.47736	0.11666	0.59933	0.32603	0.07465
IPSSS	0	0	0.11712	-0.8635	0.16718	0.61202	0.2208
IMT	0	0	1.09639	-1.2608	0.20387	0.72118	0.07495
FRSC-DL	0	0	0.92281	-0.71039	0.29657	0.58956	0.11387
FUOKE	0	0	1.87552	-2.01744	0.1422	0.83544	0.02236

Table 6. Comparing prior classification and reclassification

Project Status	Predicted Group Membership		Total	%
	Correct	Incorrect		
Successful	6	3	9	30%
Challenged	9	5	14	46.7%
Failure	6	1	7	23.3%
Total	21	9	30	
(%) Percentage	70	30	100	

The details of the comparison between prior classification and reclassification are given in Table 5. Table 5 also indicated the probabilities of a project either being in Group -1 for those that experienced failure, Group 0 for challenging projects, and Group 1 for successful projects. It also shows that a project might be tagged as a failure, that is, being in Group -1 but there are some little corrections to be made for it to be in Group 0 or Group 1 and that gives its probability of being in the other groups. For instance, additional resources or improved stakeholder management could have helped the project to move from failure or challenged group to success group. A project that was classified as success might have met some of the expected functionalities, and the unmet functionalities might linger to the next phase attracting extra cost and time and that gives the probability of its membership in Group -1 and Group 0. Most software engineering projects are tagged as successful if it is delivered within budget and on time while some of the functionalities are yet to be implemented.

Table 6 compared the predicted group membership and the actual membership using the developed model and the differences gave 30%, 46.7%, and 23.3% of successful, challenged and failure respectively. This gives a high result that using the developed model; the project manager can come out with correct classifications of successful projects, challenged projects, and failed projects. It also showed that the estimated model is good for predicting overall project performance.

4. DISCUSSION

The prediction, based on this discriminant function, as compared with the actual information from the data collected. The original value was the same in some cases as that of the score used in the data collected, but some showed misclassification. The literature revealed many cases of projects that fall short of stakeholders' expectations regarding schedule, budget, performance, and customer satisfaction, yet the developed team tagged the project as successful. This work conforms to Velayudhan and Thomas [20] suggestions that a model needs to be developed instead of using time and cost overrun to determine the project performance as the case of projects in Nigeria. Also, this agrees with Mir and Pinnington [11] who suggested using other methods for determining project performance instead of time and cost overrun. Montequin et al. [5] based their argument on projects' performance concerning expected cost, time and features; using this method to classify project performance that will give an accurate result. The study revealed that a project might be termed successful by its development team, but other stakeholders might prefer the old system. This gives management the impression that the system could not perform as expected. This scenario was seen in the case of Nigerian Permanent Voters Card (PVC) system that gave the project poor reputation and makes other stakeholders conclude that the project is a failure. This study also conforms to Atkinson [19] who suggested that other methods should be used to determine whether a project is successful or not.

5. CONCLUSION

This work has suggested a prediction model to determine overall project performance using discriminant analysis for software engineering projects in Nigeria. The discriminant function thus developed was subjected to predict how many of these projects were successful, challenged, or failure. The proposed model gives us a better way of evaluating project performance, and it should attract the attention of project stakeholders, project management practitioners and project management researchers who will further analyse the model and refine it to the benefit of the society.

Although this study used a small sample size of 30 projects; the result may differ if the sample size becomes larger. Further work can be carried out with an increase in the sample size or using complex projects. Additional studies can be carried out to develop a new prediction model using Naïve Bayesian Classification, artificial neural network model, or Decision Tree method.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Standish Group Chaos Report, Standish Group; 2015.
2. Florentine S. IT project success rates finally improving. CIO Newsletter; 2017.
3. Bloch M, Blumberg S, Laartz J. Delivering large-scale IT projects on time, on budget, and on value. Article - McKinsey Quarterly; 2012.
   (Accessed 25 June, 2018)
   Available:https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights
4. Project Management Institute. A guide to the project management body of knowledge (PMBOK Guide) PMI Standard Committee: Project Management Institute; 2013.
5. Montequin VR, Cousillas SM, Alvarez V, Villanueva J. Success factors and failure causes in projects: Analysis of cluster patterns using self-organizing maps. Procedia Computer Science. 2016;100: 440–448.
6. Davis K. Different stakeholder groups and their perceptions of project success. International Journal of Project Management. 2014;32:189–201.
7. Senouci A, Ismail AA, Eldin N. Time delay and cost overrun in Qatari public construction projects. In Creative Construction Conference, Budapest Hungary. Procedia Engineering. 2016;164: 368-375.
8. Suliman SMA, Kadoda G. Factors that influence software project cost and schedule estimation. In Sudan Conference on Computer Science and Information Technology (IEEE CSIT). 2017;1-9.
9. Bowen PA, Hall KA, Edwards PJ, Pearl RG, Cattell KS. Perception of time, cost, and quality management on building projects. The Australian Journal of Construction Economics and Building. 2002;2(2):48–56
10. Eberendu AC. Evaluation of software project failure and abandonment in tertiary institutions in Nigeria. Journal of Information and Knowledge Management. 2015;5(4):29–40.
11. Mir FA, Pinnington AH. Exploring the value of project management: Linking project management performance and project success. International Journal of Project Management. 2014;32:202–217.
12. Rezaian A. Time-cost-quality-risk of construction and development projects or investment. Middle-East Journal of Scientific Research. 2011;10(2):218-223.
13. Ebbesen JB, Hope A. Re-imagining the iron triangle: Embedding sustainability into project constraints. PM World Journal. 2013;2(3).
14. Beleiu I, Crisan E, Nistor R. Main factors influencing project success. Interdisciplinary Management Research. 2015;11(2):59-72.
15. Hussein BA. Factors influencing project success criteria. The 7th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, Berlin, Germany; 2013.
16. Jørgensen M. Failure factors of small software projects at a global outsourcing marketplace. Journal of Systems and Software. 2014;92:157-169.
17. Savolainen P, Ahonen JJ, Richardson I. Software development project success and failure from the supplier's perspective: A systematic literature review. International Journal of Project Management. 2012; 30(4):458-469.
18. El-Emam K, Koru AG. A replicated survey of IT software project failures. IEEE Software. 2008;25(5):84-90.
19. Atkinson R. Project management: Cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria. International Journal of Project Management. 1999;17(6):337–342.
20. Velayudhan DP, Thomas S. Measuring project success: Emergence of dimension.

International Journal of Business and Management. 2016;4(4):48-53.

21. Hair J, Babin B, Money A, Samouel P. Essentials of business research methods. Hoboken, New Jersey: John Wiley & Sons, Inc.; 2013.

22. Uddin N, Meah MS, Hossain R. Discriminant analysis as an aid to human resource selection and human resource turnover minimization decisions. International Journal of Business and Management. 2013;8(17):153-169.

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