Classification of Implemented Foreign Assisted Projects into Sustainable And Non-sustainable Groups: A Discriminant Analysis Approach

Iwuagwu Carmelius Chibuzo
E-mail cciwuagwu@yahoo.com Tel +2348033306938
Department of Planning, Research and Statistics. Ministry of Education,
Owerri, Nigeria.

Abstract

Four variables of factors affecting the sustainability of foreign assisted projects at the end of implementation were extracted from literature review and informal interview of project management professionals. The managers of these projects were asked to rank these variables according to their relevance and importance in enhancing the sustainability and non sustainability of foreign assisted projects in Nigeria. Discriminant function analysis was applied in carrying out detailed analysis of these factors. Two factors were found to be the most discriminating factors among the four factors. The two factors are delivery of service or benefits and long term institutional capacity. The study also further revealed that continued delivery of services or benefits is the most discriminating factor.

Key Words: Economic transformation, discriminant analysis, foreign assisted projects, delivery of service, long term institutional capacity

1.0 Introduction

Rapid economic transformation in developing countries is often constrained by shortage of capital resources due to poor savings, inadequate foreign exchange earnings and low investment capacities. There is therefore, the tendency for developing countries to use more resources than those available to them. It is this "resource gap" that has given rise to the need for external development assistance from developed world. Nigeria has been a major beneficiary of development assistance in the form of concessionary and non-concessionary loans, outright grants and technical assistance. In Nigeria, most of this assistance comes from **UNDP** and **UNICEF.** These grants are used in financing and implementing some development projects and they are termed foreign assisted projects.

Many of these projects cannot be sustained at the end of their successful implementation and handing over to the beneficiaries. Many of these projects survive for less than two years at the end of implementation and stop functioning.[7]

Many reasons like bad implementation method, frequent change in government, inadequate funding, lack of beneficiaries support and other environmental factors have been advanced for this ugly trend[4],[10].

The study is concerned with building a model which can be used to classify implemented foreign assisted projects into one of two categories sustainable and non-sustainable group. Although the discriminant analysis which is used can be generalized for classification into a number of categories, the present study is limited to two categories.

2.0 Applications

The discriminant analysis has been applied in a variety of investigations. These applications vary from parent selection in plant breeding to the classification of application for bank loan into good and bad creditors.[2][9][11][8][5] Discriminant analysis used to discriminate between two

expenditures groups using the percentages of total household expenditure going to five major budget items as criterion variables.[14] As shown in the study, giving a household's percentage expenditure on each of the five categories of commodities – accommodation, food, transport, household goods and clothing it is possible to use the household discriminant score to determine the household's expenditure class – lower or middle.[14]

Many of the standard applications of the techniques are found in the biological sciences, but it is also potentially fruitful in the social sciences. The technique was applied in an attempt to identify underdeveloped countries with good development potential. In their analysis, 73 underdeveloped countries were classified into three groups according to their past economic performance and a linear discriminant function estimated from a number of social, political and economic variable.[1] Once such a function has been estimated the values of these variables for a new country can be fed into the discriminant function and the country assigned to one of the three groups, for development potential.[1]

The discriminant analysis was used to classify household in Ile-ife into higher and "Lower" income brackets. A linear compound of five criterion variables namely, type of dwelling, rent status, availability of possession of selected household goods, size of household and highest educational level was formed.[8] Education level was found to have the highest weight in the discriminant function. This study was found useful where there are difficulties as directly obtaining authentic information on household incomes.[8]

Discriminant analysis as a predictive tool for corporate technical failure and bankruptcy, his work provided answer to which ratios are important in detecting corporate financial failure potentials.[3] He utilizes a comprehensive list of financial ratios in assessing a firms failure potential[3].

3.0. Sources of Data

The data were obtained from foreign assisted projects **UNDP** and **UNICEF** located in six states representing the six geopolitical zones of Nigeria. The states are Imo, Rivers, Oyo, Borno, Kano and Plateau. The set of data was extracted from Questionnaire administered to the various projects establishments responsible for the day to day maintenance and sustainability of this foreign assisted project when they are handed over to the beneficiaries.

Seventy-one (71) implemented foreign assisted projects of **UNDP** and **UNICEF** made up of 40 sustainable and 31 non-sustainable were used in the analysis. Four criterion variables were used in classifying implemented foreign assisted projects into sustainable and Non-sustainable groups. These criterion variables were:

U_1 = Delivery of service or benefits
U_2 = Political support
U_3 = Long term institutional capacity
U_4 = Maintenance of physical infrastructures

4.0. Discriminant Analysis

The problem that is addressed with discriminant function analysis is how well it is possible to separate two or more groups of individual given measurements for these individuals on several variables.[6] Two methods of discriminant function analysis namely the Mahalanobis distance (independent variable) and stepwise methods were used.

4.1 Mahalanobis Distance Method

Let $\bar{X}_1 = (\bar{X}_{1i}, \bar{X}_{2i} ... \bar{X}_{pi})$ denote the vector of mean value for the sample from the its group calculate using the

$$\bar{X}_j = \sum_{j=1}^{n} X_{ij}/n \quad (1)$$

$$\bar{X} = \begin{Bmatrix} \bar{X}_1 \\ \bullet \\ \bullet \\ \bullet \\ \bar{X}_p \end{Bmatrix} \qquad (2)$$

Let Ci denote the covariance matrix for the same sample calculated using the sample variance given by

$$S_j^2 = \sum_{i=1}^{n} \left(\bar{X}_{ij} - \bar{X}_j \right)^2 / n-1 \qquad (3)$$

In addition, the sample covariance between variable j and k defined as

$$\text{Cjk} = \sum_{i=1}^{n} \left(\bar{x}_{ij} - \bar{x}_j \right) \left(\bar{X}_{ik} - \bar{X}_k \right) / n-1 \qquad (4)$$

This being a measure of the extent to which the two variables are linearly related. The matrix of variance and covariance are given by

$$C = \begin{pmatrix} C_{11} & C_{12} \ldots C_{1p} \\ C_{21} & C_{22} \quad C_{2p} \\ C_{p1} & C_{p2} \ldots \quad C_{pp} \end{pmatrix} \qquad (5)$$

Let C denote the pooled sample covariance matrix determined using

$$C = \sum_{i=1}^{m} \left(n_i - 1 \right) C_i \Big/ \sum_{i=1}^{n} \left(n_i - 1 \right) \qquad (6)$$

Then the Mahalanobis distance from an observation
X' = $(X_1, X_2, \ldots X_p)$ to the centre of group is estimated as

$$D_1^2 = \left(X - \bar{X}_i \right)^{-1} \; C^{-1} \; (X - \bar{X}_i) \qquad (7)$$

or

$$D_i^2 = \sum_{r-1}^{p} \sum_{s-1}^{p} \left(X^r - \bar{X}_{ri} \right) C^{rs} \left(X_s - X_{si} \right) \qquad (8)$$

Where C^{rs} is the element in the rth row and Sth column of C^{-1}. The observation X is allocated to the group for which D_i^2 has the smallest value.

Specifically for this study, a total of three canonical discriminant function were obtained. For the sustainable and non-sustainable implemented foreign assisted projects in Nigeria we have

$$Z = a_1U_1 + a_2U_2 + a_3U_3 + a_4U_4 \qquad (9)$$

And $Z_1 = a_{11}U_1 + a_{12}U_2 + a_{13}U_3 + a_{14}U_4$
(10)

$$Z2 = a_{21}U_1 + a_{22}U_2 + a_{23}U_3 + a_{24}U_4 \qquad (11)$$

Where Z denote the grouping that is for project sustainability and project non sustainability and Z_1 for project sustainability and Z_2 for project non-sustainability.

The a_i and a_{ij} – values are the canonical coefficients/variables.

Therefore it is possible to determine several linear combinations for separating group.[6]

Finding the coefficient of the canonical discriminant functions turns out to be an eign value problem. The within-sample matrix of sum of squares and cross products is calculated using.

$$W_{rc} = \sum_{j=1}^{n} \sum_{i=1}^{n_i} \left(X_{ijr} - \bar{X}_{jr} \right) \left(X_{ijc} - \bar{X}_{jc} \right) \qquad (12)$$

.

And W_{rc} is the element in the rth row and cth column of W

The total sample matrix of sum of squares and cross product T is calculated using

$$t_{rc} = \sum_{j=1}^{m} \sum_{i=1}^{n_j} \left(X_{ijr} - \bar{X}_r \right) \left(X_{ijc} - \bar{X}_c \right) \qquad (13)$$

The in between group matrix is given by

$$B = T - W \qquad (14)$$

Which can be determined.

The matrix $W^{-1}B$ is found. If the eigen value are $A_1 > A_2 > A_3 \ldots > A_i$ the A_i is the ratio of the in between group of sum of squares to the within group of sum of squares for the ith linear combination, Z_i, while the element of the corresponding eigenvector $a_i = (a_{i1}, a_{i2} - a_{ip})$ are the coefficient of Z_i.

5.2 Stepwise Method

In this method, variables are added to the discriminant function one by one until it is found that adding extra variable does not give significant better discrimination. There are many different criteria that can be used for deciding on which variables to include in the analysis and which to miss out.[13] The order in which the repressors are introduced may be determined in several ways, two of the commonest are:

(a) The researcher may specify a prior the order in which he wants the repressor to be introduced

(b) The researcher may want to let the data determine the order.

For this study the WILK's Lambda criterion was used as the criterion for entering the equation.

The Wilk's Lambda (λ) is defined as

$$= \frac{|S_e|}{S_T} \qquad (15)$$

where the matrix Se is the error of squares and cross product matrix S_T is the within sum of square and cross product. (SSCP) matrix for the r samples.

Similarly the matrix S_T is the total SSCP matrix. This is the matrix of sets of squares and cross products of our entire combined samples regardless of which population give rise to the sample items.

As in ANOVA we have the relation

$$S_T = S\lambda + S_e \qquad (16)$$

Where $S\lambda$ is the among SSCP matrix. The SSCP matrix is defined

$$S = \begin{pmatrix} \sum W_1^2 & \sum W_1 W_2 & \cdots & \sum W_1 W_k \\ \sum W_2 W_1 & \sum W_2^2 & \cdots & \sum W_2 W_k \\ \sum W_k W_1 & \sum W_k W_2 & \cdots & \sum W_k^2 \end{pmatrix} \qquad (17)$$

Major statistical packages generally have a discriminant function for the application of the methods as described in Equation 1-17. The data were analyzed using the SPSS Program Discriminant Version 10. Two methods of selecting discriminating variables are available in this software packages namely, the independent (Mahalanobis) method and stepwise procedures. However analysis here was carried out using step wise procedures.

5.2.1 Evaluation of The Performance Of The Model

The evaluation of the performance of the classification of the discriminant model was based on some statistical criteria, validation and out of sample results. The statistical criteria employed included F-value, Eigen value, Wilk's Lambda, Chi-square and canonical correlation.[13] The validation (that is in sample or resubstitution) test utilized the same set of sample observation while the out of sample was based on completely independent set of sample from the ones used in the model estimation.[12]

In each case, we obtained the error rates associated with the model in addition to the overall error rates and overall correct classification rates.

5.3 Cutting Scores

The cutting score is zero. Discriminant scores greater than zero (ie the scores) indicated a predicated membership in the sustainable group. The dependent variable which was continuous scaled took the value zero and 1 for the non-sustainable group and sustainable group respectively.

5.3.1 Relative Discriminatory Power Of The Variables

The magnitude of the discriminant coefficient in the model reveals to some extent the importance of the discriminatory variable. However a major objective procedure of evaluating the contribution of each discriminating variable to the model is based on the relative discriminating power of the coefficient in the canonical discriminant function.[9] The measure of the relative discriminatory power of the variable is given by bi ($\bar{X}_{i1} - \bar{X}_{io}$), the scalar vector

$b_i\sigma_i$ is used to measure how the variables are correlated.

Here b_i = the discriminant function coefficient for the ith variable.

δ_i = The square root of appropriate value in the variance – covariance matrix (standard deviation)

$\bar{X}_{i1}$ = ith variables mean for the Successful project

$\bar{X}_{i0}$ = ith variables mean for t failed project.

(i) **Canonical Discriminant function (W)**

$$W = -11.259+0.449U_1+0.278U_3 \quad (18)$$

7.0 Model Estimation And Interpretation

The data described above was used to estimate the canonical discriminant function. Thus we used stepwise procedure and the result of the discriminant analysis is presented in table 1.

Table 1: Sustainable and Non-sustainable Foreign Assisted Projects

Eigenvalue	Wilkslambda	Chi-square	Significance	F-value	Canonical correlation
9.688	0.094	161.100	0.000	7.520	0.952

(ii) Classification Function coefficients

Variable	Sustainable Projects	Non-sustainable projects
U_1	5.348	2.571
U_2	5.299	3.581
Constant	-102.319	-35.091

(iii) Group Centriods

W	Function
0.00	-3.485
1.00	2.701

Based on the summary statistics presented in table 1,we found that only two variables out of four variables considered were adequate for discriminating implemented foreign assisted projects into sustainable and non sustainable categories. The ratio in order of importance based on the magnitude of their coefficients was (a) U_1 (b) U_3. However a more objective procedure of evaluating the contributions of each discriminatory variable to the model is based on the relative discriminatory power of the coefficients in the canonical discriminant functions. The relative discriminatory power of the variables of this model is shown in table 2.

Table 2: Relative discriminatory power of the variables equation (18)
$W = -11.259+0.449U_1+0.278U_3$

Variable	a_i	σi	$\bar{U}_{i1}$	$\bar{U}_{i0}$	$a_i\sigma i$	$a_i(\bar{U}i_1 - \bar{U}_{i0})$	%
U_1	0.449	5.244	19.625	9.774	2.354	4.423	71.45%
U_3	0.278	3.634	18.550	12.194	1.010	1.767	28.55%
Total						6.190	100%

Table 2 showed that variable U_1 explained about 71.45% of the average discriminant score separation between sustinable and non-sustainable implemented foreign assisted projects while U_3 contributed 28.55% in explaining the average discriminant score separation between foreign assisted project sustainability categories. The scalar vector showed that the variables used in constructing the discriminant model exhibit little or no correlation among them.

7.0 Evaluation of The Classification Ability of The Discriminant Model

In table 1, we present the discriminant model denoted as equation (18) with the associated statistics. The eigen value for the model is 9.688 while the Wilk''s Lambda was 0.94 which is little low and the canonical correlation is 0.952. In order to test the statistical significance of the model (DF), the Wilk's Lambda was converted into chi-square distribution and the model was found to be significant at 100% level. The canonical correlation value (CCV) of 0.952 implied a very high degree of association between the discriminant function and the discriminating variables U_1 and U_3.

The results of the validation test based on the original samples for the discriminant model denoted as W are presented in table 3. This table contains actual and predicted discriminant scores sustainable and non sustainable groups of implemented foreign assisted projects. Based on table 3, only one implemented foreign assisted projects was misclassified in the sustainable group. The project is number 12.

The out of sample result are presented in table 4. Based on table 4, only three (3) out of eleven (11) implemented foreign assisted projects were wrongly negatively classified as non sustainable projects and one (1) out of seven (7) non-sustainable foreign assisted projects was also wrongly positively classified as sustainable project.

Table 3: Classification of Implemented Foreign Assisted Projects based on validation sample (41 sustainable vs 30 non-sustainable)

Project No	Group	Discriminant scores
1	1	2.5457
2	1	3.3788
3	1	3.8922
4	1	1.3703
5	1	4.7253
6	1	1.0926
7	1	2.0968
8	1	2.2680
9	1	2.9945
10	1	2.5457
11	1	2.5457
12	1	-0.2539
13	1	1.8191
14	1	0.5371
15	1	4.1699
16	1	0.6437
17	1	3.1656
18	1	4.1699
19	1	2.7168
20	1	2.2680
21	1	3.6145
22	1	1.8191
23	1	2.8234
24	1	2.9945
25	1	2.8234
26	1	3.1656
27	1	3.8922
28	1	2.2680
29		3.4433
30	1	2.7168
31	1	3.4433
32	1	3.8922
33	1	3.3732
34	1	2.2680
35	1	2.7168
36	1	2.2680
37	1	3.4433
38	1	2.7168
39	1	1.9902
40	1	-0.0914
41	0	3.3958
42	0	-2.2625
43	0	-3.2247
44	0	-3.6735
45	0	-3.7801
46	0	2.6468
47	0	-4.5066
48	0	-3.3313
49	0	-3.3203
50	0	-3.4127
51	0	-3.8867
52	0	-4.3355
53	0	-3.1601
54	0	-3.7801
55	0	-1.9848
56	0	-3.7156
57	0	-3.9933

58	0	-3.5445
59	0	-3.9933
60	0	-3.7156
61	0	-3.9933
62	0	-3.2667
63	0	-3.4379
64	0	-4.8910
65	0	-3.9933
66	0	-4.4421
67	0	-4.4421
68	0	-3.9933
69	0	-4.4421
70	0	-1.6004
71	0	-3.7156

Table 4: Classification of Foreign Assisted Projects Based on out of sample Data (11 Sustainable Vs 7 unsustainable Projects)

Project No	Group	Discriminant Scores
1	1	2.383
2	1	3.623
3	1	-.0632**
4	1	2.832
5	1	3.623
6	1	-1.359**
7	1	2.447
8	1	1.827
9	1	-0.354**
10	1	0.202
11	1	2.554
12	0	3.901
13	0	-2.086
14	0	-2.237
15	0	0.651*
16	0	-3.433
17	0	-3.540
18	0	-4.438

Source: Using the Developed model

$W = -11.259+0.449U_1+0.278U_3$

**……wrong classification

In table 5 we present various error and classification efficiency rates associated with the discriminant model equation (18). the validation sample method was extremely accurate in classifying about 98.59% of the total sample correctly. type 1 error proved to be only about 2.5% while type ii error was about 0%.

The predictive ability of the model based on the out of sample data showed that type i error associated with the model was 25.99%. This implied that about 25% of the sustainable implemented foreign assisted projects were wrongly classified as sustainable projects. however the overall classification efficiency of the model based on the out of sample data was high since 77.78% of the implemented foreign assisted projects were correctly classified while only about 22.22% represented the overall error rate.

The high overall classification efficiency rate of 98.59% and 77.78% for validation and out of sample procedures suggested that the model may be useful as early warning device for predicting and classifying implemented foreign assisted project into different risk categories

Table 5: Classification Result for the Discriminant Model

Count	**Implemented foreign assisted projects**	**Predicted group members**		
		1.00	0.00	Total
Out of sample count	Sustainable (1.00) Non-sustainable (0.00) 1.00 0.00 total	9 1 75.00% 83.33% 66.78%	3 5 25.55% 16.67% 22.22%	12 6 100% 100% 100%
(b) Validation count	Sustainable (1.00) Non sustainable (0.00)	39 0 97.50% 100% 98.59%	1 31 2.50% 0% 1.43%	30 31 100% 100% 100%

8.0 Conclusion and Recommendation

In this study, the discriminant function analysis was used to classify implemented foreign assisted projects in Nigeria into "Sustainable" and non-sustainable groups. A linear compound of two variables namely, Delivery of services or benefits and long term institutional capacity was formed for the sustainable and non-sustainable group. They were found to be the most important factors that discriminate between the sustainable and non-sustainable group. Delivery of services or benefits was found to have the highest weight in the discriminate function. All the coefficients of the variables have the expected sign and the overall discrimininating abilities of the function was found to be quite high as indicated by the various tests of the performance of the model.

8. 1 Recommendations

Based on the above, the following recommendations are offered on the basis of the research funding.

1. For continued delivery of service which is the most discriminating factor for foreign assisted project sustainability government should provide enough budgetary allocation for the maintenance of facilities that ensured continued delivery of service. Part of this budget should be made available to the benefiting communities to enable them manage these projects located in their place effectively. In the case of water projects, the community leaders should be allowed to sell the water at a reduced rate so as to have money to effect necessary repairs without waiting for the government. However, this should be monitored by the government to avoid abuse by these community leaders.
2. Project sustainability will frequently require an active involvement of local and community organization at all the stages of project planning, implementation and operations. The results of the virtual exclusion of beneficiaries often become apparent during the operational phase when beneficiaries only prove unwilling to pay for services or when they refuse to cooperate in project maintenance. Hence the government should promote beneficiaries participation which will have the positive result of ensuring project sustainability.
3. The role of donor agencies is crucial to project sustainability. They should established long term institutional capacity that ensure sustenance when they handover the project. Long term institutional capacity was found to be a very important discriminating factor of sustainability in this research. They should all offer advisory role from time to time to ensure project sustainability

References

[1] **Adelman & L. T Morris (1968)** "Performance Criteria for Evaluating Economi9c Development Potentials – An Operational Approach" **Quart J. Economics,** 82 p. 268-280.

[2] **Aja Nwachukwu (2001)** "A Discriminant Analysis of Commercial Banks Failure: The Case Study of Nigeria" **Journal of Business & Finance** – Imo State Vol. No. 4 2001 pp 26-35.

[3] **Altman – E. (1968)** "Financial Ratios Discriminant Analysis and the Prediction of Corporate Bankruptcy" **The Journal of Finance** Vol. 23, September.

[4] **Cleland D.I. and Kerzner, H. (1985) A Project Management Dictionary of Terms,** Van Nostrand Reinhold, New York.

[5] **Deakin E. (1972):** "A Discriminant Analysis of Predictor of Corporate Failure" **Journals of Accounting Research** Vol. 10 Spring.

[6] **Hope Keith (1968) Method of Multivariate Analysis,** University of London.

[7] **Iwuagwu C.C. (1994):** "The Evaluation of the Effect of the Ten Critical Success Factors on the Performance of ADP Projects", Owerri, **Unpublished M.Sc. Thesis,** FUTO Nigeria.

[8] **Iyaniwuru J.O. (1984)** "Discriminant Analysis as a Technique for a Dichotomous Classification of Urban Income Earners in Ile Ife Nigeria" **Journal of the Nigerian Statistical Association** Vol. 2 No.1, 1984 Pp. 17-26

[9] **Joy M.O. and Tollefson J.O. (1997)** "On the Financial Application of Discriminant Analysis" **Journal of Financial & Quantitative Analysis** (December). Pp 723-739.

[10] Kayoed, M.O. (1978) **The Art of Project Evaluation** Ibadan University Press, Ibadan.

[11] Keleck, W.R. (1980) **Discriminant Analysis Services Quantitative Application in the Social Sciences.** No 19 Suga University Paper.

[12] **Laucherbanch P.A. (1967)** "An Almost Unbiased Method of Obtaining Confidence intervals for the Probability of Misclassification in Discrimination Analysis" **Biometrics** (December) pp. 639-645.

[13] Lewis, Beek (1980): **Applied Regression: An Introduction to Quantitative Application in the Social Sciences** 22 Beverly Calif; Saga.

[14] Olayemi, J.K. & Olayide, S.O. (1977) "Expenditure Pattern in Selected Area of Western Nigeria: A Discriminant Analysis" **Journals of Statistical Research** Vol. 11 1977.