

MEASURING THE EFFICIENCY OF WORLD VISION GHANA'S EDUCATIONAL PROJECTS USING DATA ENVELOPMENT ANALYSIS

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Abstract

In the current era, donors are more interested in value for their money and are now keener about how their hard earned money is being used. As such Non-governmental organisations face crucial decisions as resources become scarcer. Based on these, more efficient use of resources becomes more important than ever before. This work therefore evaluates the performance of Educational Projects of four Area Development Programmes of World Vision Ghana using Data Envelopment Analysis Approach. The Data for the four Area Development Programmes (ADP) and their respective District Education Offices for the year 2010 were obtained. The two inputs that were recognised were number of staff and number of vehicles. We also identified two outputs as BECE pass rate and completion rate at JHS level. The results revealed that two Area Development Programmes (Zabzugu ADP and Gushegu ADP) were identified as efficient. Two Area Development Programmes (Saboba ADP and Nadowli ADP) were marked out as inefficient. To improve the performance of any inefficient Area Development Programme, one of the efficient ADP was set as a benchmark.

Keywords: Area development programme, educational projects, non-governmental organisation, Data envelopment analysis, Benchmark and Performance

Introduction

Resource efficiency underpins every decision pertaining to development programmes. Against this backdrop, all human entities—governmental or non-governmental—make decisions based on the most

appropriate modalities for resource efficiency. The problem of resource scarcity is more pronounced in the three Northern regions of Ghana than its counterpart regions. According to CIDA (2008), poverty levels in these three regions (that is the Northern, Upper-West and Upper East Regions) range between 52% in the Northern Region and 88% in the Upper West Region. In these regions, key indices like access to education, health care, safe drinking water and child nutrition are below national average.

In light of these challenges, World Vision Ghana, a Christian relief, development and advocacy organisation has set up a number of poverty alleviation interventions aimed at developing its catchment areas. World Vision’s operations in Ghana started in 1979. The main sectors of their intervention include, education, health, water, sanitation and hygiene (WASH), agriculture and food security, humanitarian and emergency affairs (HEA), micro-enterprise development activities, gender and development as well as Christian commitment.

Since its inception in 1979, World Vision has impacted several lives in Ghana. However, the problem of acute poverty in Northern Ghana still persists. This coupled with the fact that the scarce resources usually employed in these developmental interventions are gotten from international donors communities mostly in developed countries. In light of this, a research into the extent to which these hard-earned resources are efficiently used in poverty alleviation is more important than ever before.

Methodology

The relevant inputs and outputs factors and the numerical measures for the factors identified are used to formulate the linear programming model. Using input and output factors in Table 1, simple DEA models are formulated. To see the structure of a typical DEA model more clearly, consider the model illustrated in Table 1, which has m DMUs, each with n input factors $X_1, X_2, X_3... X_n$ and outputs factors $Y_1, Y_2, Y_3... Y_p$

Table 1: Structure of typical DEA model

DMUs	Input factors				Output factors			
	X_1	X_2	X_3 X_n	Y_1	Y_2	Y_3 Y_p
1	X_{11}	X_{21}	X_{31}	X_{n1}	Y_{11}	Y_{21}	Y_{31}	Y_{p1}
2	X_{12}	X_{22}	X_{32}	.	Y_{12}	Y_{22}	Y_{32}	.
3	X_{13}	X_{23}	X_{33}	.	Y_{13}	Y_{23}	Y_{33}	.
4	X_{14}	X_{24}	X_{34}	.	Y_{14}	Y_{24}	Y_{34}	.
5	X_{15}	X_{25}	X_{35}	.	Y_{15}	Y_{25}	Y_{35}	.
.
.
.
.
M	X_{1m}	X_{2m}	X_{3m}	X_{nm}	Y_{1m}	Y_{2m}	Y_{3m}	Y_{pm}

Let

$X_{11} \dots X_{nm}$ represent input factors for DMU1.....DMUm
 $Y_{11} \dots Y_{pm}$ represent output factors for DMU1.....DMUm
 $X_1 \dots X_n$ represent input factors 1. ...n.
 $Y_1 \dots Y_p$ represent output factors 1...p.

Also let

$\mu_1 \dots \mu_n$ represent output weights.
 $V_1 \dots V_p$ represent input weights.

Now consider the efficiency of DMU1:

Using the CCR -Ratio Model,

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}$$

$$\text{Efficiency of DMU1} = \frac{\text{outputs}}{\text{inputs}} = \frac{\mu_1 Y_{11} + \mu_2 Y_{21} + \dots + \mu_p Y_{p1}}{V_1 X_{11} + V_2 X_{21} + \dots + V_n X_{n1}}$$

•
•
•

$$\text{Efficiency of DMUm} = \frac{\text{outputs}}{\text{inputs}} = \frac{\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}}{V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}}$$

$$\therefore \text{Efficiency of DMUm} = \frac{\sum_{i=1}^p \mu_i Y_{im}}{\sum_{r=1}^n V_r X_{rm}}$$

Where

$i=1$ to p
 $r=1$ to n
 μ_i =weight assigned to output i
 V_r =weight assigned to input r
 Y_{im} =value of output i for DMU m
 X_{rm} =value of input r for DMU m

What is now sought is the set of weighting factors μ and V which maximise the efficiency measure, subject to constraints on the efficiency of the m DMUs. This lead to the Non Linear Program.

$$\frac{\sum_{i=1}^p \mu_i Y_{im}}{\sum_{r=1}^n V_r X_{rm}} \leq 1,$$

$$\mu_i \geq 0$$

$$V_r \geq 0$$

$$V_r X_{rm} > 0$$

This can be linearised by applying a normality constraint on the weighted inputs and arranging the other constraints. The output can be maximized after constraining the weighted inputs to unity. Therefore,

Maximize $\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}$
 Subject to $V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm} = 1$
 For the constraint on DMUm

$$\frac{\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}}{V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}} \leq 1$$

$$\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm} \leq V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}$$

$$(V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}) - (\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}) \geq 0$$

$$\mu, V \geq 0$$

The above formulation can be used to calculate efficiency involving combination of various inputs and outputs. The relative efficiency score of a DMU will depend upon the choice of weight μ and V . In the traditional basic efficiency measure, the weights are assumed to be uniform across the input and output variables. DEA, however select the weight that maximizes each DMU's relative efficiency score under the condition that no weight is negative, and that resulting efficiency ratio must not exceed one. For each DMU, DEA will choose those weights that would maximize the relative efficiency score in relation to other DMUs.

Results and Analysis

The basic DEA model for measuring the efficiency of educational projects can be formulated as follows:

Maximize $\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}$
 Subject to $V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm} = 1$
 For the constraint on DMU m

$$\frac{\sum_{i=1}^p \mu_i Y_{im}}{\sum_{r=1}^n V_r X_{rm}} \leq 1$$

$$\mu_i \geq 0$$

$$V_r \geq 0$$

$$\frac{V_r X_{rm} > 0}{\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}} \leq 1$$

$$\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm} \leq V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}$$

$$(V_1 X_{1m} + V_2 X_{2m} + \dots + V_n X_{nm}) - (\mu_1 Y_{1m} + \mu_2 Y_{2m} + \dots + \mu_p Y_{pm}) \geq 0$$

Where

- i=1 to p
- r=1 to n
- μ_i =weight assigned to output i
- V_r =weight assigned to input r
- Y_{im} =value of output i for DMU m
- X_{rm} =value of input r for DMU m

The linear programming formulated out of the data:

Max: Zabzugu ADP=40.1 u_1 +92.1 u_2
 Subject to: 5 v_1 +2 v_2 =1

$$40.1u_1+92.1u_2 \leq 5v_1+2v_2$$

$$85u_1+24.2u_2 \leq 6v_1+3v_2$$

$$91.4u_1+65.35u_2 \leq 6v_1+3v_2$$

$$61u_1+62.5u_2 \leq 6v_1+2v_2$$

$$u_1 \geq 0; u_2 \geq 0; v_1 \geq 0; v_2 \geq 0$$

Max: Saboba ADP=85u₁+24.2u₂

Subject to: 6v₁+3v₂=1

$$40.1u_1+92.1u_2 \leq 5v_1+2v_2$$

$$85u_1+24.2u_2 \leq 6v_1+3v_2$$

$$91.4u_1+65.35u_2 \leq 6v_1+3v_2$$

$$61u_1+62.5u_2 \leq 6v_1+2v_2$$

$$u_1 \geq 0; u_2 \geq 0; v_1 \geq 0; v_2 \geq 0$$

Max: Gushegu ADP=91.4u₁+65.35u₂

Subject to: 6v₁+3v₂ = 1

$$40.1u_1+92.1u_2 \leq 5v_1+2v_2$$

$$85u_1+24.2u_2 \leq 6v_1+3v_2$$

$$91.4u_1+65.35u_2 \leq 6v_1+3v_2$$

$$61u_1+62.5u_2 \leq 6v_1+2v_2$$

$$u_1 \geq 0; u_2 \geq 0; v_1 \geq 0; v_2 \geq 0$$

Max: Nadowli ADP=61u₁+62.5u₂

Subject to: 6v₁+2v₂=1

$$40.1u_1+92.1u_2 \leq 5v_1+2v_2$$

$$85u_1+24.2u_2 \leq 6v_1+3v_2$$

$$91.4u_1+65.35u_2 \leq 6v_1+3v_2$$

$$61u_1+62.5u_2 \leq 6v_1+2v_2$$

$$u_1 \geq 0; u_2 \geq 0; v_1 \geq 0; v_2 \geq 0$$

Table 1 : Efficiency scores of the ADPs

DMU	Efficiency
Zabzugu ADP	1.0000
Saboba ADP	0.7024
Gushegu ADP	1.0000
Nadowli ADP	0.7849

From table 1, efficiency score of the ADPs ranges from 0.7024 to 1. The maximum efficiency score was 1 and the minimum efficiency was 0.7024. The average efficiency of all ADPs was 0.8718. Saboba ADP and Nadowli ADP were inefficient while Zabzugu ADP and Gushegu ADP were efficient. Nadowli ADP and Saboba ADP may use Zabzugu ADP or Gushegu ADP as benchmark for improving their efficiency performance.

Table 2: Optimal weights for Gushegu ADP as the target DMU

Name	Original Value	Final Value
Completion rate	1	0.006492848
BECE pass rate	1	0.006221174
Number of staff	1	0.166666667
Number of vehicles	1	0

From table 2, the optimal solution to linear programming (LP) has the value one. The best input weights were 0.166666667 for number of staff and 0 for number of vehicles. Best output weights were also 0.006492848 for completion rate and 0.006221174 for BECE pass rate.

To maximize efficiency, the number of staff should not increase for the same output. The number of vehicles has neutral effect on maximizing efficiency to get the same output.

Improvement for Saboba ADP

To improve the efficiency of Saboba ADP, the following calculations will be useful.

Input target=Actual input for inefficient ADP x Relative efficiency for inefficient ADP

Therefore for Saboba ADP we have:

Input target = (6 staff+3 vehicles) x 0.7024 = 4 staff + 2 vehicles.

This means that Saboba ADP will be efficient if it reduces its number of staff and number of vehicles to 4 and 2 respectively and yielding the same output.

Improvement For Nadowli ADP

Nadowli ADP is considered inefficient. It is possible for Nadowli ADP to perform better in its efficiency as that of Gushegu or Zabzugu ADP. Let us use the following procedure to make Nadowli ADP efficient.

Input target=Actual input for inefficient ADP x Relative efficiency for inefficient ADP

Therefore for Nadowli ADP we have:

Input target = (6 staff+2 vehicles) x 0.7849 = 5 staff + 2 vehicles.

This means that Nadowli ADP will be efficient if it reduces its number of staff to 5 and maintain the same number of vehicles which is 2 for the same output.

Conclusion

The analysis presents the accurate corrective measure for every input and output in order to improve the efficiency of an inefficient ADP. World Vision Ghana may have to reconsider their number of vehicles and staff in

an ADP in order to perform more efficiently. We applied Data Envelopment Analysis, using two (2) inputs and two (2) outputs in our analysis. The ADP resources such as number of staff and number of vehicles were selected as inputs. The outputs being Basic Education Certificate Examination (BECE) pass rate and Basic Education completion rate were selected from each invention District of the ADP in question.

Zabzugu ADP and Gushegu ADP were marked out as efficient. Saboba ADP and Nadowli ADP were discovered as inefficient. Saboba ADP and Nadowli ADP may employ Gushegu ADP or Zabzugu ADP as a benchmark in order to adjust their resources to become efficient. Saboba ADP may become efficient if it reduces its staff by 2 and its vehicles by one. Also Nadowli ADP may turn out to be efficient if its staff is reduced by 1 and maintain its number of vehicles.

It has been noticed that the reduction in the number of staff could worsen the current unemployment situation in Ghana. To avoid this phenomenon, it is suggested that instead of laying-off extra hands and vehicles, World Vision could create other avenues for employment in other areas of intervention. Alternatively, they could scale up their interventions to cover other deprived areas of Ghana.

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