THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Measuring Efficiency of Ordinary Secondary Education Provision in Tanzania Schools: Data Envelopment Analysis Approach

Salvius Raphael Mgaya
Assistant Lecture, Department of Computing Science and Mathematics,
The Institute of Finance Management, Tanzania

Abstract:
The study intended to measure efficiency of provision of ordinary secondary education in Tanzania Ordinary Secondary Schools by using Data Envelopment Analysis (DEA) as of the methods commonly used to measure the performance of various Decision-Making Units (DMUs). Seventy (70) Secondary Schools were used as DMUs in this study. The efficiency of the secondary was found using CCR model of DEA. The paper has suggested means in which schools (DMUs)can improve their performance by suggesting those schools which if they can do the same they can utilize efficiently the input and the output.

Keywords: Secondary School, efficiency, data envelopment analysis, DEA, Government, GPA

1. Introduction

Secondary school's education has got its importance as reported by a number of scholars and organizations. Eubanks, D.& Eubanks, L. T. (2009) define secondary education as the learning and training that kids obtain during their teenage years has long been recognized as crucial to development of job skills and other attributes that affect the ability to function productively as a member of society.

There are more than 4660 secondary schools in Tanzania including the government and the private schools that provide education. The education is provided in different levels with the purpose of educating citizens for personal welfares and national development. The Government has set the best vision, objectives and goals for secondary education provision. Also, government stipulates the mission of secondary education provision as, "to nurture the intellectual, scientific, aesthetic, social, moral and technological growth of the learners so that they can fit in their society and ever-changing world" (Institute of Education, 2013).

In Tanzania, ordinary secondary education is meant for four years. This level receives candidates completed primary education. In completion of ordinary secondary education, the certificates of secondary schools are awarded to a successful candidate as a mark of completion. The secondary education opens the chance for the candidate to join further studies in advanced secondary education or other training (Education for All, 2015).

The Tanzania provision of secondary education is guided by a number of national policies and programmes. Among of the policies include the Tanzania Development Vision (2025), the National Strategy for Growth, Reduction of Poverty (NSGRP, 1996), the National Policy on Disability, (2004), Education and Training Policy (1995), Technical Education and Training Policy (1996); Secondary Education Development Plan (SEDP) (2004-2009); and Educational Sector Development Programme (ESDP) (1997) (Education for All, 2015).

Tanzania Government is trying to improve the education provision, in 2016/ 2017 budget on education sector is indicated to be 22.1 percent of total Government Budget. Among of the number of intentions for this money is to implement free basic education country wide, constructions and rehabilitation of education infrastructures country wide and Improving quality of education and build relevant skills at all levels (Ministry of Finance and Planning, 2017).

The Tanzania government and private sector invest a lot in education provision to Tanzanian citizens, such as the employment of teachers, construction and rehabilitation of infrastructures, improving teaching and learning environment, money for management and administration, salaries for teachers and many others as inputs with the target of getting educated citizens as an output.

1.1. Measuring service performance

Despite the education provision, the Government and private sectors should evaluate the relationship between the efforts used in education provision (input) and the output. The most important argument here is that education providers should measure the performance of the services. Through measurement, the services where productivity is declining or is not

up to expectations can be identified and it can improve performance by allocating resources accordingly (de Lancer Julnes, P. 2000).

Education provision is efficient if the education providers use different available inputs, and the inputs should be productive and meaningful if the education providers evaluate and analyse the efficiency of the recourses used is productive (Afonso, 2005). The primary purpose of measuring social performance should be to increase the effectiveness and efficiency of programmes targeted at improving social performance (Salazar et al., 2012).

In order to measure the School performance, assessment can be used to set performance targets, to make resource allocation decisions, and to improve overall school performance. Typically, school effectiveness has been measured in terms of the performance of students in examinations

2. Literature Review

Chaners et al. (1978) argued that decision making unit is not operating efficiently if it is possible to maintain output while decreasing any single input and not increasing any other input. Moreover, considering operation on inputs and outputs efficient is attained if and only if both of these conditions are attained.

Anderson, L., Walberg, H. J.& Weinstein, T. (1998) on the study of efficiency and effectiveness analysis of Chicago public elementary schools argued that DEA is the way to improve the system efficiency by identifying units and technologies that perform at maximum levels and by opening up the possibility of units using the same technology (input) but generating smaller outputs to learn from more productive units

Soteriouet al. (1998) used the data envelopment analysis (DEA) to assess the efficiency of secondary schools in Cyprus. Furthermore, they provided recommendations to improve to inefficient schools by improving the quality of the teachers; such a possible strategy could involve the rotation of teachers among different schools.

Manceb, M. J., and Bandres, E. (1999) employed DEA to evaluate the efficiency of a sample of Spanish secondary schools, paying particular attention to the theoretical specification of the measurement model and to the ex post analysis of the results. The paper also places of interest the characteristics that distinguish the most efficient schools from the least efficient, and emphasises the importance of completing the information supplied by the quantitative methods of educational evaluation (such as data envelopment analysis).

De Lancer Julnes, P. (2000) studied on decision-making tools for public productivity improvement: A comparison of DEA to cost-benefit and regression analyses, the study suggested that the debate over government productivity may be misplaced. Public productivity may be hindered as a result of inappropriate use of decision making tools for the allocation of resources and further they argued that the data envelopment analysis (DEA) is presented as an alternative often more appropriate than such commonly used techniques

2.1. Data envelopment analysis (DEA)

Data Envelopment Analysis (DEA) is one of the methods commonly used to measure the performance of various Decision-Making Units (DMUs). It provides a non-parametric basis for evaluating input-output efficiency even when there are multiple inputs and outputs that are measured in different units (Bose, A., & Patel, G. N. 2015).

As the study employed the Data Envelopment Analysis (DEA) which the data collected from the documentary review were summarized in table showing the output and input values for the different companies.

The original of DEA goes back to Farrell (1957), whose work was extended by Charnes, Cooper and Rhodes (1978) known as CCR model before being modified by Bankar, Charnes and Cooper (1984), hence the name BCC model. Since then, DEA has become the most useful model than any other parametric approaches like stochastic frontier analysis (SFA) in evaluating efficiency (Bange, 2014). DEA provides attainable benchmarks for inefficient decision-making units (DMUs) by generating peers based on linear combination of the efficient DMUs that could serve as benchmarks for an inefficient DMU (Bose, A.& Patel, G. N. 2015).

In this study, the efficiency of ordinary secondary schools was found using BCC model of DEA and the reference set for each DMU (schools) were found.   In decision making, unit DMUs is full efficient if it has a maximum score of 1 (100%) and is termed as frontier DMU. All other DMUs with efficiency score below 1 up to zero are identified as inefficient (Bange, 2014).

3. Methodology

Consider the input oriented for CCR model, in which we need to maximize the output by taking into account the input in the specific Decision-Making Units (DMUs) with relationship to the other variable in the model.

Let "n" be the number of DMUs that need "k" different inputs to create "p" different outputs. Assume X and Y are matrix represents the values for inputs and output for the collected information respectively.

$$X = \begin{bmatrix} x_{11} & x_{12} & ...x_{1n} \\ x_{21} & x_{22} & ...x_{2n} \\ ... & ... & ...\, ... \\ x_{k1} & x_{k2} & ...x_{kn} \end{bmatrix} Y = \begin{bmatrix} y_{11} & y_{12} & ...y_{1n} \\ y_{21} & y_{22} & ...y_{2n} \\ ... & ... & ...\, ... \\ y_{p1} & y_{p2} & ...y_{pn} \end{bmatrix} \qquad (1)$$

Then, the weights for inputs, $u = (u_1, u_2, u_3, ...u_k)$ and output, $v = (v_1, v_2, v_3, ...v_p)$ for each DMU will be evaluated by using the linear programming method and the best performer DMUs will be used as benchmarking to improve the inefficient DMUr, where r is the specified DMU

$$\text{Max}(Z) = y_{1r}v_1 + y_{2r}v_2 + ... + y_{pr}v_p$$

Subject to $x_{1r}u_1 + x_{2r}u_2 + ... + x_{kr}u_k = 1$

$y_{1j}v_1 + y_{2j}v_2 + ... + y_{nj}v_p \leq x_{1j}u_1 + x_{2j}u_2 + ... + x_{nj}u_k \ \text{ for } j = 1,2,3,..n$

$v_1, v_2, ..., v_p \geq 0 \ i = 1,2,3,...p$

$u_1, u_2, ..., u_k \geq 0 \ i = 1,2,3,..k$

The use of Dual
The dual of linear Programming (LP) helps in recognizing the reference set for the inefficient DMUs. These reference sets then help us in identifying the inadequacies existing in the inefficient units. The dual of the above model can be given in the following form:

Min θ
Subject to:

$$\left. \begin{array}{l} y_{11}\lambda_1 + y_{12}\lambda_2 + ... + y_{1n}\lambda_n \geq y_{1r} \\ y_{21}\lambda_1 + y_{22}\lambda_2 + ... + y_{2n}\lambda_n \geq y_{2r} \\ \vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots \\ y_{p1}\lambda_1 + y_{p2}\lambda_2 + \cdots + y_{pn}\lambda_n \geq y_{pr} \end{array} \right\} \Rightarrow \quad Y\lambda \geq Y_0 \qquad (2)$$

$$\left. \begin{array}{l} x_{11}\lambda_1 + x_{12}\lambda_2 + ... + x_{1n}\lambda_n \leq x_{1r}\theta \\ x_{21}\lambda_1 + x_{22}\lambda_2 + ... + x_{2n}\lambda_n \leq x_{2r}\theta \\ \vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots \\ x_{k1}\lambda_1 + x_{k2}\lambda_2 + \cdots + x_{kn}\lambda_n \leq x_{kr}\theta \end{array} \right\} \Rightarrow \quad X\lambda \leq X\theta_0 \qquad (3)$$

θ is free, $\lambda_j \geq 0.$ $j = 1,2,3,....$

Simply the dual model as

Min   θ

subject   to $Y\lambda \geq Y_k$

$X\lambda \leq X\theta_k$

$\lambda_j \geq 0. \quad \theta_k$ Unrestricted

θ is the dual variable corresponding to the equality constraint that normalizes the weighted sum
   of inputs of the primal problem.
λ is the dual variable corresponding to the other inequality constraints of the primal. It acts as a
weight for the firm

3.1. Sample and Data
About 3281 secondary schools including the government and private schools with more than forty candidates participated in doing the national examination in 2016. The study used the secondary data that collected from selected

seventy secondary schools as representative sample for the whole population. All schools were grouped into ten strata based on the GPA level, then the systematic approach used to select the best and last three academically performed schools in the national examination in 2016 to each stratum. Finally, purposely the two schools in the first group were selected since they were less than the number required to each group.

The information (data) for schools selected extracted from the ministry of education, science and Technology website. The schools selected were considered as Decision Making Units (DMUs) that made a total number of 70 DMUs. As the study utilized the DEA, therefore input and output variables were employed. DEA approach provides a means for assessing relative effectiveness of decision making units (DMUs) with minimal prior assumptions on input – output relation in these units (Golany, B.& Roll, Y. 1989).

3.1.1. Input used in DEA

Soteriou at...el, (1998) in their study of Using DEA to evaluate the efficiency of secondary schools: the case of Cyprus, used teachers and students as input in their study. The number of students admitted for examination, number of teachers (science teachers and social science teachers).

Monfared, M. A. S.& Safi, M. (2013) in their study of Network DEA: an application to analysis of academic performance used student as input. The number of candidate at schools registered for ordinary secondary school examination is an input that implies the available facilities at particular schools, these means the registration will depend on the available tables, chairs, number of class rooms teaching and learning materials, toilets and more like.

Bangi, Y. I. (2014) in his study of Efficiency Assessment of Tanzanian Private Universities: Data Envelopment Analysis (DEA) he used academic staff (teachers) as input variable. In the process of education provision; Teachers do facilitate the whole of process of teaching and learning at schools. Teachers guide learners, prepare friendly environment for learning and teaching, identify the learner's needs, prepare learners for future life of learning. Therefore, the teacher is a very important component that the study guided as input.

Regards from these literatures, this study employed number of students registered and teachers as input.

3.1.2. Output used in DEA

In this study the student's performance from the secondary examination results for schools were used as outputs. Gourishankar, V.& Sai Lokachari, P. (2012) in the study of Benchmarking educational development efficiencies of the Indian states: a DEA approach and Soteriou at...el, (1998) on their study of Using DEA to evaluate the efficiency of secondary schools: the case of Cyprus, used students' performance as output in DEA. The secondary national examination performance of candidates was measured by grades awarded by the national Examination Council of Tanzania were used as one of the output from the education provided to the citizens. The grades indicated the level of student understanding in learning process.

4. Results and Discussion

The study was to Measuring efficiency of ordinary Secondary Schools in Tanzania using Data Envelopment Analysis Approach (DEA). Seventy schools were used as DMUs to access its efficiency.

The CCR model of DEA was employed in this study to find out the efficiency of these schools (DMUs) as shown in the table 1. The table shows the performance of each DMU that was evaluated relatively from the Dual linear programming problem. From the table we find each DMU with its reference as the benchmarks for them. The benchmarks are the DMUs with the efficiency of one (efficient = 1). Those references provide the option for inefficient DMUs to increase their efficiency if they need. These means the inefficient DMUs can increase the efficiency items of increasing the output.

As CCR model of DEA was used to find the efficiency of Secondary Schools, it was found that SCH 3, SCH 6 and SCH 12 these are Kaizirege Junior Secondary School, Nyegezi Seminary, Omega Secondary School are efficiently utilizing their inputs in producing the output. Also, it was confirmed that those three mentioned DMUs are the benchmark for most of the schools (DMUs). Moreover, the table 3 shows that different Secondary schools have different benchmark.

If we make reference on benchmark, all schools can become efficient or can perform efficiently as benchmark Schools. The Secondary schools (DMUs) which are performing efficiently, meaning efficiency = 1 are assigned as benchmark. Those Secondary that can follow their benchmark schools will be using their input and output effectively.

5. Conclusion

Education is important to all people because it acts as the key to the real life. Secondary education is provided by private sectors or Government with the good will of educating citizens and non-Tanzanians. But the proper evaluation and monitoring of the program is necessary, this involves evaluation the performance of the program.

There are more than three thousand and four hundred secondary schools in Tanzania owned by Government and Private Sectors. These schools include the governments and private schools, where the owners should make sure the input and output material in schools are efficiently utilized. In this study we have used the number of teachers, number of students registered and students registered for form four examinations as input and the Form four examination performances   as output units and we have suggested the way to improve the ineffective Schools performance from the efficiency.

The Data Envelopment Analysis approach was applied to find out efficiency of the secondary schools. The efficiency of the secondary was found using CCR model of DEA. The paper has suggested means for the schools to improve their performance by suggesting those schools which if they can do the same they can utilize efficiently the input and the output.

In this study we have applied benchmarking as the procedure in which one Secondary School (DMU) is compared with the best performing Secondary School (DMU) so that the lower performing DMU also performs at best level by using its inputs and output efficiency. We have assigned benchmark (Secondary school) for every secondary school which must make as reference so as to become efficient. However, if the school will perform better, it will make better achievements for Government's and managers' aims and Goals.

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Appendix

DMU NO	DMU	DMU NAME	Efficiency	Reference
1	CH1	FEZA BOYS' SECONDARY SCHOOL	0.8496	6, 12
2	CH2	ST. FRANCIS GIRLS SECONDARY SCHOOL	0.7136	12
3	CH3	KAIZIREGE JUNIOR SECONDARY SCHOOL	1	
4	CH4	MARIAN GIRLS SECONDARY SCHOOL	0.3769	6,12
5	CH5	ST MARIE EUGENIE SECONDARY SCHOOL	0.5098	6,12
6	CH6	NYEGEZI SEMINARY	1	1
7	CH7	MZUMBE SECONDARY SCHOOL	0.3616	6,12
8	CH8	KILAKALA SECONDARY SCHOOL	0.5671	6,12
9	CH9	KANDOTO SAYANSI GIRLS SEC. SCHOOL	0.3569	3,12
10	CH10	ALLIANCE BOYS' SECONDARY SCHOOL	0.9511	6,12

DMU NO	DMU	DMU NAME	Efficiency	Reference
11	CH11	ST. PETER'S SEMINARY	0.8782	6,12
12	CH12	OMEGA SEC SCHOOL	1	
13	CH13	MARIST BOYS SEC SCHOOL	0.713	6,12
14	CH14	OSWE SECONDARY SCHOOL	0.5309	3,12
15	CH15	ST. FRANCIS XAVIER SECONDARY SCHOOL	0.395	12
16	CH16	ST. THERESA OF AVILA GIRLS SEC. SCHOOL	0.6724	3,6,12
17	CH17	TABORA GIRLS SECONDARY SCHOOL	0.3479	6,12
18	CH18	ANNAGAMAZO SECONDARY SCHOOL	0.381	6,12
19	CH19	CHIEF WANZAGI SECONDARY SCHOOL	0.4853	12
20	CH20	MASONGA SECONDARY SCHOOL	0.3455	3,12
21	CH21	MWENYEHERI ANUARITE SEC. SCHOOL	0.3267	6,12
22	CH22	UCHIRA GIRLS ISLAMIC SEC. SCHOOL	0.58	12
23	CH23	JOHN PAUL II KAHAMA SEC. SCHOOL	0.2519	12
24	CH24	KONGEI SECONDARY SCHOOL	0.4321	12
25	CH25	MULEBA SECONDARY SCHOOL	0.5185	12
26	CH26	RWEPA'S SECONDARY SCHOOL	0.8365	12
27	CH27	NGARENANYUKI SECONDARY SCHOOL	0.4869	12
28	CH28	IVUMWE SECONDARY SCHOOL	0.1404	3,12
29	CH29	SHINYANGA SECONDARY SCHOOL	0.1952	12
30	CH30	MWEDO GIRLS SECONDARY SCHOOL	0.6462	12
31	CH31	YUSTA SECONDARY SCHOOL	0.6205	12
32	CH32	AL-HUDA ISLAMIC SECONDARY SCHOOL	0.6608	12
33	CH33	KANAWA SECONDARY SCHOOL	0.7157	12
34	CH34	MUHEZA MUSLIM SECONDARY SCHOOL	0.2055	12
35	CH35	MPUGUSO SECONDARY SCHOOL	0.1099	12
36	CH36	MATOGORO SECONDARY SCHOOL	0.4131	6,12
37	CH37	ALI HASSAN MWINYI ISL. SEC. SCHOOL	0.3601	12
38	CH38	LUGARAWA SECONDARY SCHOOL	0.4522	3,6
39	CH39	MASHUJAA SECONDARY SCHOOL	0.2924	6,12
40	CH40	NSHAMBA SECONDARY SCHOOL	0.2149	12
41	CH41	MAWENI SECONDARY SCHOOL	0.1498	3,12
42	CH42	MARETADU JUU SECONDARY SCHOOL	0.4108	12
43	CH43	RUJEWA SECONDARY SCHOOL	0.0845	6,12
44	CH44	DIHIMBA SECONDARY SCHOOL	0.4042	6,12
45	CH45	KIWIRA SECONDARY SCHOOL	0.1752	6,12
46	CH46	KACHWAMBA SECONDARY SCHOOL	0.361	6,12
47	CH47	ELERAI SECONDARY SCHOOL	0.0778	12
48	CH48	PASIANSI SECONDARY SCHOOL	0.1405	12
49	CH49	MAPANGO SECONDARY SCHOOL	0.3205	3,12
50	CH50	NGUJINI SECONDARY SCHOOL	0.4593	12
51	CH51	KIGONGO SECONDARY SCHOOL	0.1387	12

DMU NO	DMU	DMU Name	Efficiency	Reference
52	CH52	MFURU SECONDARY SCHOOL	0.3318	12
53	CH53	MABWEREBWERE SECONDARY SCHOOL	0.3683	12
54	CH54	BALENI SECONDARY SCHOOL	0.2734	12
55	CH55	SINO-TANZANIA FRIENDSHIP SEC SCH	0.1932	12
56	CH56	RAHALEO SECONDARY SCHOOL	0.1989	12
57	CH57	NANGANGA SECONDARY SCHOOL	0.4386	6,12
58	CH58	KAMAGI SECONDARY SCHOOL	0.3893	6,12
59	CH59	MNARA SECONDARY SCHOOL	0.3323	12
60	CH60	MANEROMANGO SECONDARY SCHOOL	0.3543	6,12
61	CH61	KWALA SECONDARY SCHOOL	0.2712	12
62	CH62	GONJA SECONDARY SCHOOL	0.1077	12
63	CH63	DIONGOYA SECONDARY SCHOOL	0.1787	6,12
64	CH64	ITETE SECONDARY SCHOOL	0.1992	12
65	CH65	RUANGWA SECONDARY SCHOOL	0.1898	3,12
66	CH66	MIZIMBINI SECONDARY SCHOOL	0.1593	12
67	CH67	MBOPO SECONDARY SCHOOL	0.2412	6,12
68	CH68	MASAKI SECONDARY SCHOOL	0.3292	12
69	CH69	NYEBURU SECONDARY SCHOOL	0.1333	3,12
70	CH70	KITONGA SECONDARY SCHOOL	0.3578	12

Table 1: Efficiency Scores Along With Reference DMUs Sets Cont…