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Measuring Efficiency and Effectiveness of Workers' Performance and Information Flow System in Technical Universities in Ghana

Appiah Ruth[1*], Liu Shizhu[2], Ayamba Emmanuel Caesar[3] and Fang Moping[4]
[1,2,3] *School of Management, Jiangsu University, Zhenjiang 212013, P. R., China*
[4]*School of Finance and Economics, Jiangsu University, Zhenjiang 212013, P. R., China*
Tell: +86 18552453253,
**Corresponding Author: Appiah Ruth,*

Liu Shizhuin 2004 Liu obtained his Master's degree in Social Medicine and Health Management at Peking Union Medical University, China. He is presently an Associate Professor at the Jiangsu University, School of Management. He was the dean of the Department of Public Utilities at the School of Management, Jiangsu University, China and is engaged in health care and public administration research.

Appiah Ruth attainedher Bachelor of Business Administration - Human Resource Management 2012, Ghana and presently a Master's candidate in Jiangsu University, School of Management, China. She is also aSenior Administrator at the school of Business Studies, Takoradi Technical University, Ghana and is engaged in human resource and public administration research.

Ayamba Emmanuel Caesar attainedhis Master's degree in Business Planning and Microfinance Management in 2015 and presently a Doctoral candidate in Jiangsu University, School of Finance and Economics, China. He is also aLecturer at the school of Business Studies, Bolgatanga Polytechnic, Ghana and is engaged in international trade and industrial economic research.

Fang Moping is a graduate student of School of Public Administration, Jiangsu University. His research direction is medical insurance and health management.

ABSTRACT:
This study observes the relationship between effective information flow system and worker's performance in the Technical Universities in Ghana. DEA was adapted for this study because it maximizes the output measure of the various DMU without making any assumptions on the form of inputs to output. DEA has the capability of modelling model multi-input and multioutput relationships without a priori underlying functional form and thus has been used in various fields of operation. Data from the 10 technical universities in Ghana was used covering the period between 2013 and 2017. The findings indicated that these institutions, ATU, KuTU and KTU came out with the best overall efficiency score which means they had the best scores and are blending their inputs and output variables rightly.

Keywords:**I**nformation flow system; Worker's performance; Efficiency; Effectiveness; Technical Universities

I. INTRODUCTION

All institutions, either public or private entities depend on some form of correspondence to send their messages crosswise over to their intended interest group or inform their intended interest group of the mission and vision of their organisation. Workers mostly perform better at the work place when effective flow of information is at its uttermost. For example, there is employee satisfaction and higher productivity if there is an optimum flow of information about the techniques and strategies of an organization (Akarika, Ekanem, & Ukpe; Neves & Eisenberger, 2012).

An organization's hierarchical arrangement to its technique depends to a great extent on administration's capacity to obtain information to settle on choices and to make informed decisions. Basically, without access to the correct information, the members cannot operate to maximum satisfaction. Consequently, the stream of information will undoubtedly happen in each member where information is passed on from one individual (sender) to the next (receiver); using either verbal or non-verbal means of information flow, or even both.

Thought has been given to the investigation of organisational correspondence in authoritative conduct of research because of the criticalness of this variable to organisational efficacy. For example, it has been discovered that compelling correspondence enhances work fulfilment (Femi, 2014; Gesogwe, 2013) and which thus enhances efficiency. Research has likewise demonstrated that effective flow of information enhances

employee work execution (Alsayed, Motaghi, & Osman, 2000; Ramirez, 2012), whereas poor flow of information brings about low worker duty to the organisation(Vander Elst, Baillien, De Cuyper, & De Witte, 2010).

Information flow is an important factor for employees in every organization. Hence, it is the key variable indicator for quality organizational functioning. The necessary features of good information flow are relevance, timeliness, and clarity. Information flow create a vital role in an organization from the one delivering to the receiver. The various departments in an organizations are in harmony through effective information flow system.

Also, workers' productivity is regarded as the amount of goods and services that a worker produces in a given period of time. In light of this, it would be very prudent to adopt a generalized and acceptable pattern with which we can check the flow of information in order to achieve a maximum output and near perfect flow of information from the topmost hierarchy to the bottom low. This obviously enhances organizational outcomes since information is disseminated through appropriate channels. According to Paarlberg and Lavigna(Paarlberg & Lavigna, 2010), workers perform undertakings out of distinguishing proof with the supervisors or with the organization's targets and roles. This relationship brings about the specialists' basic concurrence with the standards to which they are required to perform. Hence, the stream of information flow can make distinguishing proof with specialists disguising alluring qualities, as in regards to an organization's objectives and targets.

Nonetheless, better execution can be accomplished just when there is a sensible level of desire fit and when the social trade amongst administrators and workers is reasonable and equal, (Pansap & Vithayarat, 2016). Inside the point of view of human asset administration, it has regularly been conjectured that workers' knowledge, capacities and abilities will empower them to be great executioners when they are employed. In such manner, the administrators must direct its policies and goals such that specialists execute their work and do their allotted undertakings. We live in an era where information flow systems are changing rapidly which is paramount for the success and growth of an organization and is by and large perpetually called upon to assume a more noteworthy part in the journey for monetary and political security. Viable work environment execution is the key component in the accomplishment of an organisation and the potency of the workers enlisted will decide exactly how fruitful the organisation will be. Effective flow of information amongst employees and supervisors is indispensable on the grounds that, employees should comprehend what is anticipated from them, management should give a reasonable expected set of responsibilities to each worker which would influence workers to have moment access to the essential apparatuses to finish every task given to them. Dissemination of information covers all exercises that the administration does to improve workers performance.

Despite the above stated benefits of effective information flow, businesses everywhere throughout the present reality is exceptionally active. To remain beneficial in the exceptionally difficult and focused worldwide market economy, all components of production, i.e. men, machine, technique, market, cash and materials, ought to be fittingly overseen. Among the components of production, the human asset constitutes the greatest test on the grounds that not at all like other inputs, worker administration requests skillful treatment of contemplations, sentiments and feelings to get most elevated profitability. Effective flow of information in an organisation plays an important role in this task. Powerlessness of heads or administrators of any organisation to organize an impeccable and smooth flow of information collaboration among workers and outside business environment may certainly make and encourage low efficiency among workers. In any case, individuals comprehend and decipher messages in various ways. In correspondence, there are numerous undesirable obstructions that can twist a message and remain dependably a potential danger to effective information, since it can meddle with the exactness of a message being conveyed (Dali, 2010).

Additionally, TU's in Ghana have been challenged with a variety of issues that appear to be a hindrance to the development of any institutions. For example, embezzlement of funds and assets, poor initiative aptitudes, low level of genuine salary, and poor infrastructural facilities, among others. It is in this setting that this study will analyse the relationship between effective information flow on workers and their productivity using six Technical Universities as an empirical study.

II. THEORETICAL CONSIDERATIONS

2.1. Concept of Efficiency

The idea of efficiency generally deals with how well resources are used in the production process to attain desired outputs. Simply put efficiency can be defined as the ratio of output to the input. The ideology of efficiency could be applied and noticed in different concepts such as technical efficiency, allocative efficiency, and overall efficiency. Technical efficiency explains how the maximum possible output could be attained at the lowest cost possible (Worthington & Dollery, 2000). Whereas, Allocative efficiency is defined as the utilization of societal resources without necessarily causing harm to its inhabitants (Choi & Jung, 2017).Furthermore, in more technical terms OECD Manual (2001) explains overall or full efficiency as a production process has

achieved the maximum amount of output that is physically achievable with current technology, and given a fixed amount of inputs.

The concept of efficiency expressed in allocative, technical, and overall efficiencies was defined by Banker, Janakiraman, and Natarajan (2004) in geometric and mathematical forms. Figure1 below represents an efficiency graph indicating varying levels of inputs with same levels of output.

Insert Figure 1 here

Where: Ya and Yb represent isoquants of same levels of output

A – D represents different levels of inputs

First, the input mix for achieving allocative efficiency (AE) is defined as a set that minimizes production costs or a set that maximizes the level of output under "a fixed money outlay". To compute the allocative efficiency (AE), the relative price of the input factor is required. In Figure 1, AE is measured as OD/OB and allocative inefficiency is 1−OD/OB. Second, technical efficiency (TE) is defined as when an authority produces the same level of output with a lower level of input compared with others. Since the ability to create the difference in efficiency is regarded as a technique that can reduce the level of input, this efficiency is called technical efficiency. For example, in Figure 1, authority A uses a lower level of input than authority B; thus, authority A is appraised as technically more efficient than authority B, given the same levels of output (Ya and Yb). TE is OB/OA and inefficiency is measured as 1−OB/OA. Third, overall efficiency is the product of AE and TE, which is defined as OD/OA (p. 75). In sum, allocative efficiency (AE)=OD/OB, technical efficiency (TE) = OB/OA, overall efficiency (OE) = AE * TE = OD/OA.

2.2. Concept of Effectiveness

Effectiveness is generally the level of results from the actions of employees and managers (Miksen, 2018). Various researchers have tried to explain effectiveness in the following context: goal attainment, system resource, reputation, and multidimensional approaches (Choi & Jung, 2017). The first and earliest approach to effectiveness is the goal approach which measures the degree to which an organization has achieved its goals (Eydi, 2015). This approach is achieved by measuring how successful an organization is in attaining its goals. This approach is however confronted with some challenges. First, an organization normally has numerous targets to accomplish which may be conflicting and intertwined. Also, the environment is dynamic and therefore will require a continuous modification of organizational goals. This makes the attainable goals unstable and at times unclear making the use of this goal oriented approach to measure effectiveness not very appropriate, (Cavadel, Kauff, Anderson, McConnell, & Derr, 2016; Goldenberg & Glueck, 2009). The second approach adopted for measuring effectiveness is the system resource. It measures the ability of the organization, in either absolute or relative terms, to exploit its environment in the acquisition of scarce and valued resources, (Josan, 2013). The main idea of this approach view effectiveness as how well an organization is capable of attaining and sustaining the needed resources for the running of its activities without any harm to the natural environment. For example, a university would be considered effective if it can attract a large number of students to enrol and/or recruit highly qualified faculty members. This can be achieved if only the university has the required resource to admit and employ more students and faculty members respectively. Therefor it is assumed that the greater the resources are the greater the organizational effectiveness would be to attain organizational goals, (Oghojafor, Muo, & Aduloju, 2012). The third approach is the internal process approach. With this approach organizations that can offer a harmonious and efficient internal environment are viewed as effective operations, (Eydi, 2015). The practice of this approach is weakened because it is seen as a inclined only the internal processes at the expense of output and client satisfaction, (Eydi, 2015). Another effectiveness approach is strategic constituencies approach. This approach encourages more on the development of human resources. That is seeking the inputs of main stakeholders as apex interest or aim, (Martz, 2008). In other words, the multiple-constituency model according to Gocevski and Nikolov (2018) and Hossein, Ramezanineghad, Yosefi, and Sajjadi (2011), is based on, a view of organizational effectiveness in which several (potentially, many) different effectiveness statements can be made about the focal organization, reflecting the criterion sets of different individuals and groups we shall refer to as constituencies. This approach is considered as appropriate for both the profit and non-profit oriented organizations by researches (Eydi, 2015; Gocevski & Nikolov, 2018). As time evolves, various effectiveness approaches are adopted to meet the changing environment. Some of these may include but not limited to competing values approach, reputation approach, the safety-critical approach, the social function model, multidimensional approaches etc.

2.3. Relation between Efficiency and Effectiveness

This relationship talks about the connectivity between effectiveness and efficiency. However, before this connection could be established, there should be productivity or performance. Productivity used in this context refers to employees ensuring that the preferred output or results are attained with the right resources.

According to Drucker (2012) getting the right thing done is effectiveness while efficiency is getting things done in the right manner. This implies that effectiveness is based on ensuring results are achieved whereas efficiency is an input, continuous and time based. Hence, the relationship will indicate how the inputs are used by employees to achieve required results within a stipulated time period. According to Schaubroeck, Shaw, Duffy, and Mitra (2008) there is no need to lower your expectations to meet your performance, raise your performance level to meet your expectations. In this context, they expressed expectation to mean both effectiveness and efficiency. They say efficiency and effectiveness depends on productivity or performance. Mandl, Dierx, and Ilzkovitz (2008) used an input-output-outcome approach to elaborate the relationship between efficiency and effectiveness (see Figure 2). The authors state, "effectiveness is more difficult to assess than efficiency, since the outcome is influenced political choice" which implies the impact of environmental factors is more crucial on effectiveness than on efficiency.

Insert Figure 2 here

For example, according to {Guyon, 2003 #615} they indicated in a 2 by 2 matrix as shown in table 1 the values demonstrate how some states in America could attain both effectiveness and efficiency at the same time whereas other states could not, thereby either attaining one of the two or none at all. They however concluded that the main priority of any government or institution is to attain its prime objective by ensuring that its outputs reach its goals which surely is a great way to ascertaining effectiveness. Therefore, when the government or institution establishes its outputs with the least possible costs or expenditure, it is referred to as an efficient government or institution. Hence, the best practice happens when the effectiveness accompanies the efficiency; the second-best practice indicates when an organization achieves goals effectively but is less efficient than others; the third best practice means less effective but more efficient results, and the worst practice occurs when a government fails both values.

Insert Table 1 here

Based on the review of the theoretical literature and the conceptual framework, it could be assumed that both efficiency and effectiveness are interrelated. Previous empirical research have indicated how to measure the two values, how the values are conceptualized in the process of input-output-outcome. On the other hand, there are little studies that have investigated the link between these values. Thus, it is important and interesting to investigate whether and how efficiency and effectiveness are related.

III. METHODOLOGY

To achieve employee efficiency, the research methodology to be adopted will be the use of Data Envelopment Analysis (DEA). Before the DEA model is looked at, we will consider efficiency and effectiveness models.

3.1 Model Formulation and Framework

The evaluation of technical efficiency is normally done using either Stochastic Frontier Analysis (SFA) or Data Envelopment Analysis (DEA)(Jacobs, 2001). SFA deals with the usage of parametric techniques whereas DEA uses non-parametric techniques. The underlying principle of the two concept is how efficient the production process will be in generating or producing maximum output from the inputs from the various decision-making units (DMU).

For the purpose of this study, we will apply technique of DEA to analyse the technical efficiency of information flow systems in the TU's. In short, the principle concept of DEA is that it optimizes each individual observation with the objective of calculating a discrete piecewise frontier using a linear programming problem to identify the best practice. It calculates a relative efficiency ratio based on differences between observed and best

practice units for a DMU being evaluated (Charnes, Cooper, Lewin, & Seiford, 1994; Charnes, Cooper, & Rhodes, 1978). DEA was adapted for this study because it maximizes the output measure of the various DMU without making any assumptions on the form of inputs to output. Also, different measures could be used for different DMUs. DEA has the capability of modelling model multi-input and multioutput relationships without a priori underlying functional form and thus has been used in various fields of operation.

3.2Measuring Efficiency: Data Envelopment Analysis Approach

The concept of DEA is better explained in the figure below (see Figure 4-1). Barrow and Wagstaff (1989) distinguished concepts of productivity and efficiency. Adopting his approach, we suppose that Figure 4-1 has about five DMU for which they generate a single output (X) with two inputs Y_1 and Y_2. From Figure 4-1, with all other things held constant it could be said that points B, C and F are technically efficient because DMU B uses more of input Y_2 and less of Y_1. Whereas DMUs C and F use more of input Y_1 and less of Y_2. On the

contrary, it could be said that DMU E is technically inefficient because it uses more of both inputs than DMU C and yet produces no more output.

Insert Figure 3 here

DEA is very purposeful because of its comparison feature. It enables efficiency levels of each DMU to be compared. As was realized from figure 1 DEA ensures efficiency levels of DMU under the same production line of the same kind of output are measured, (Choi & Jung, 2017). As seen in Figure 1, which assumes one output with two inputs, five DMUs have efficient bundles of input among seven DMUs. Since the isoquant line envelops the inefficient DMUs A and E, it is called "data envelopment analysis" (Choi & Jung, 2017). DEA could be expressed in a function of:

$$Max\ \theta = \frac{\sum_{r=1}^{n} u_r\, y_r}{\sum_{i=1}^{m} v_i\, x_i} \qquad (1)$$

Where; $y_{r\ is}$ quantity of output r;
u_r is weight attached to output r;
$x_{i\ is}$ quantity of input i;
$v_{i\ is}$ weight attached to input i;

We used DEA in the analysis to identify variations in the efficiency scores of information flow systems in TTU. A panel data of 4years was used for the analysis. The input and output variables could be seen in table 2.

IV. RESULTS AND DISCUSSIONS

Insert Table 2 here
Insert Table 3 here

Table 3 presents the descriptive statistics of the input and output variables' data resultsas follows: (A) Information Systems Investment (ISI) From 2013 to 2017 the mean is (5400) in investment of information systems. 2017 has the highest amount of ISI for the study period with (6000) in investment, while 2013 and 2014 had the smallest amount of investment in ISI with 5000 each. (B) Number of workers (Nws): the mean number of workers is 568.8. 2014 has the highest Nws with 577, while 2015 has the lowest Nws with 562 for the study period. (C) Number of computers (NC): the mean score is 116.8. The highest NC is in 2017 with 123 and the lowest in 2013 with 109. (D) Number of computers with Internet connection (NCI): the mean NCI is 91.2. The highest NCI is in 2017 with 96 and the lowest is in 2013 and 2014 with 87 each. (E) Total number of training courses between 2013 and 2017 (NTC): the mean score for NTC is 9.4. The highest NTC is in 2017 with 12 and the lowest is in 2015 7. (F) Total number of information system's training courses in 2013 and 2017 (NISTC): the mean value for NISTC is 5.2. The highest number is in 2017 with 7 and the lowest are in 2013, 2014 and 2016 with 5 each. (G) Total number of workers who attended ICT training courses in 2013 and 2017 (NwsFICIT): the mean value for NwsFICIT is 32.8. The highest NwsFICIT is 41 which was in 2014 and the lowest is 29 which was in 2016. (H) Total number of workers with ICT skills (NweICTS): the mean value for NweICTS is 48.6. The highest NweICTS is in 2017 with 57 and the lowest is in2013 with 35. (I) Student enrolment resulting from information system usage between 2013 and 2017 (SE): the mean value for SE is 8364.6. The highest SE value for the study period is in 2017 with 8941 and the lowest for the study period is in 2013 with 7541.

Insert Table 4 here

It can be seen from Table (4) that majority of both the input and output indexes have significant positive correlation, which satisfies the requirement of the model. Therefore, the input-output index of this paper is logical, and the sample data is reasonable, which can be the basis of this study.

Insert Table 5 here

Table 5 depicts the abridged form of the efficiency report, where efficiency scores of the Polytechnics in Ghana and their years are reported. The results show an average overall score efficiency of 0.97 or 97% over the 5-year period. The eight-input and one-output model from Table 3 indicate that overall only three (ATU, KuTU and KTU) out of the ten Technical Universities (Tus) are efficient. From the overall scores of each TU, TTU, STU, CTU, HTU, TaTU, Bpoly and Wpoly were inefficient even though they were efficient in some of the years. In addition, the mean/average observation from the various years suggest that all the years (2013 to 2017) were not efficient. However, the general performance of all the TUs clearly show how prudent they are when it comes to their inputs and output resources respective.

4.1. Discussions

~In this section, the input-oriented efficiency scores attained from the CCR have been discussed. This paper tries to measure the efficiency and effectiveness of workers performance and information flow systems in Technical Universities in Ghana.It is important to note that input-oriented efficiency measures address the question: 'what amount of input quantities can be uniformly reduced without changing the output quantities produced?'

~Table 5 presents efficiency scores of the 8 Technical universities and the two Polytechnics along with their ranks. The results indicate that the technical universities in Ghana has been characterized with immense asymmetry between institutions as regards to overall technical efficiency that ranges between 1 and 0.695. The average of technical efficiency scores of the 10 institutions for the study period turned out to be 0.964 (see Table 5). This indicates that an average institution, if producing its outputs on the efficient frontier instead of its virtual position, would only need 96.4% of the inputs currently being used. This indicates that, by applying best managerial practices, Technical universities in Ghana can, on an average, decrease their inputs by at least 3.6% and still produce at the same level of outputs.Nonetheless, the likely decrease in inputs from implementing best managerial practices differs from institution to institution. On the other hand, Technical universities have the prospect producing 1.04 times (1/0.964) as much as output from the same level of inputs used. As earlier indicated that an institution with technical efficiency score equal to 1 is efficient and the institution with technical efficiency score less than 1 is inefficient. Results from the 10 institutions illustrate that, only a few institutions (3) were seen to be efficient for various years (see Table 5). However, results from their total averages for the various years indicates that all the institutions were not technically efficient since none of them attained an efficiency score of 1. The resource utilization process in these institutions is not effective, meaning that the production process of these institutions is characterized by some amounts of waste of inputs. The results, thus, suggests a presence of serious deviations of the technical universities from the best managerial practices. These institutions can improve their efficiency by decreasing their inputs. Overall technical efficiency scores (1 to 0.901) among the institutions can potentially decrease their current inputs levels by 0% and 0.01%, respectively while leaving their output levels unaffected.

~Considering the ranks of the institutions, ATU, KuTU and KTU came out with the best overall efficiency score of 1 whiles the rest did not. This means that the three institutions with the best score are blending their inputs and output variables rightly. The other inefficient institutions could adopt the efficient institutions even though they may have different environment which could also be considered.

V. CONCLUSIONS

The paper tries to measure theefficiency and effectiveness of workers' performance and information flow system in Technical Universities in Ghanafrom 2013 to 2017 using data envelopment analysis (DEA) model. The paper further on analyzed the data from the 10 Technical universities by looking at the overall technical efficiency and their ranks. The results showed that for the whole research period (2013 – 2017) the overall technical efficiency was relatively high even though only three institutions where seen to be efficient. According to the results, those institutions that were not efficient need at least an average of 3.6% decrease in inputs to become efficient.

It is suggested that, firstly, the enterprises should identify the main factors that affect the efficiency of their institutions, adjust the size of input-output to augment the structure of resource allocation and take note of the collection of favorable resources in all aspects to improve their efficiency.

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Figure 1: Graph for efficiency concept

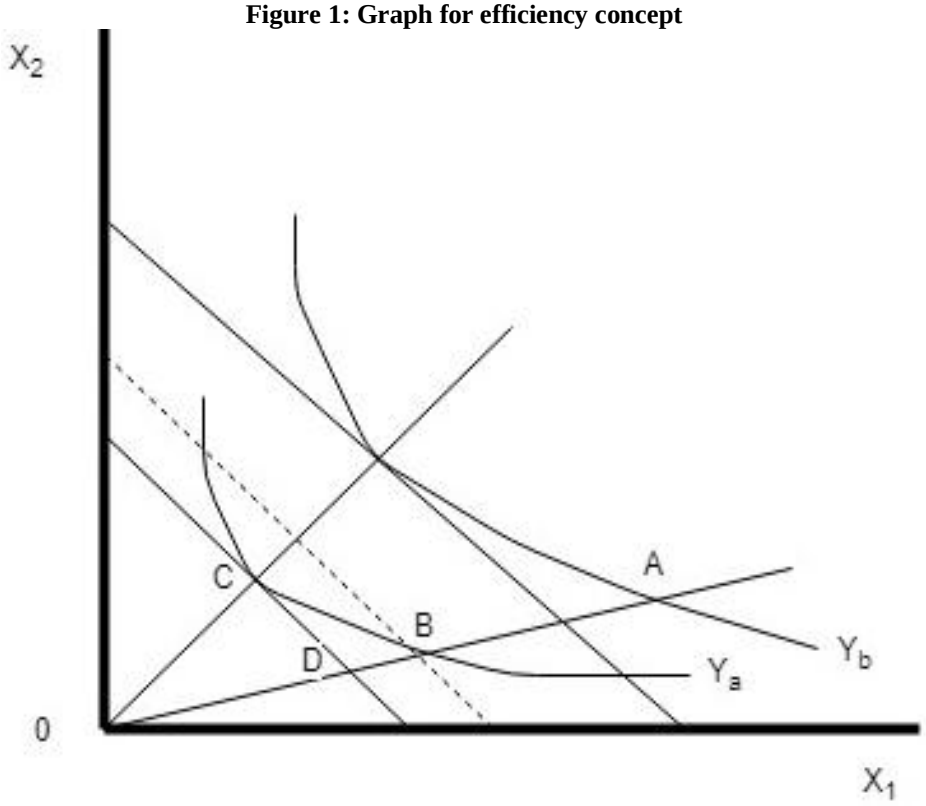
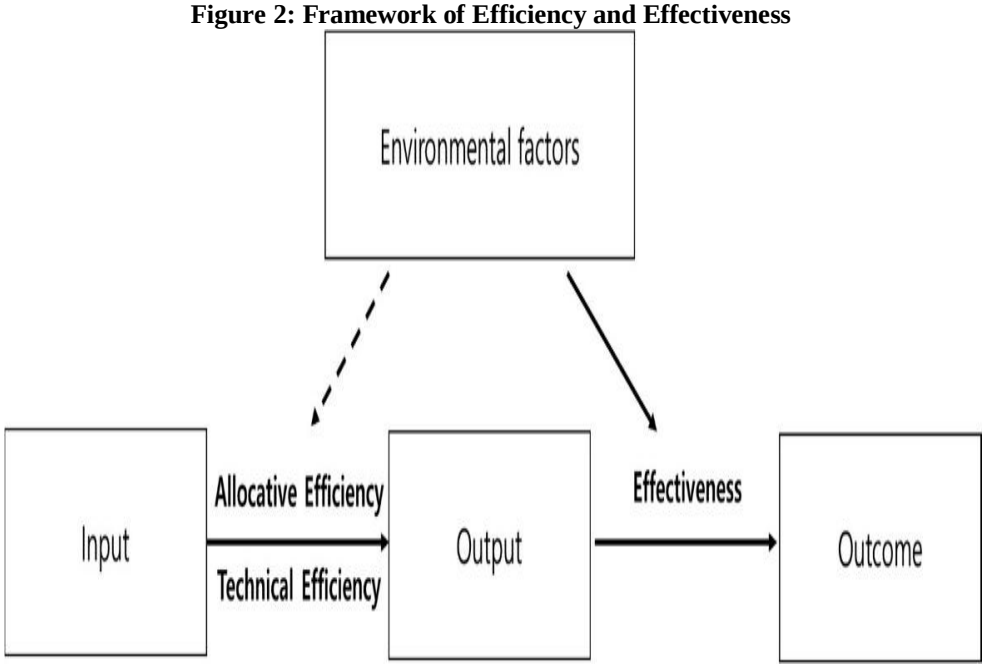


Figure 2: Framework of Efficiency and Effectiveness



Source:Adapted from Choi and Jung (2017)

Table 1. Matrix of Effectiveness and Efficiency.

	Ineffective	Effective
Efficient	3rd best practice	Best practice
Inefficient	Worst practice	2nd best practice

Figure 3: Graph for data envelopment analysis (DEA)

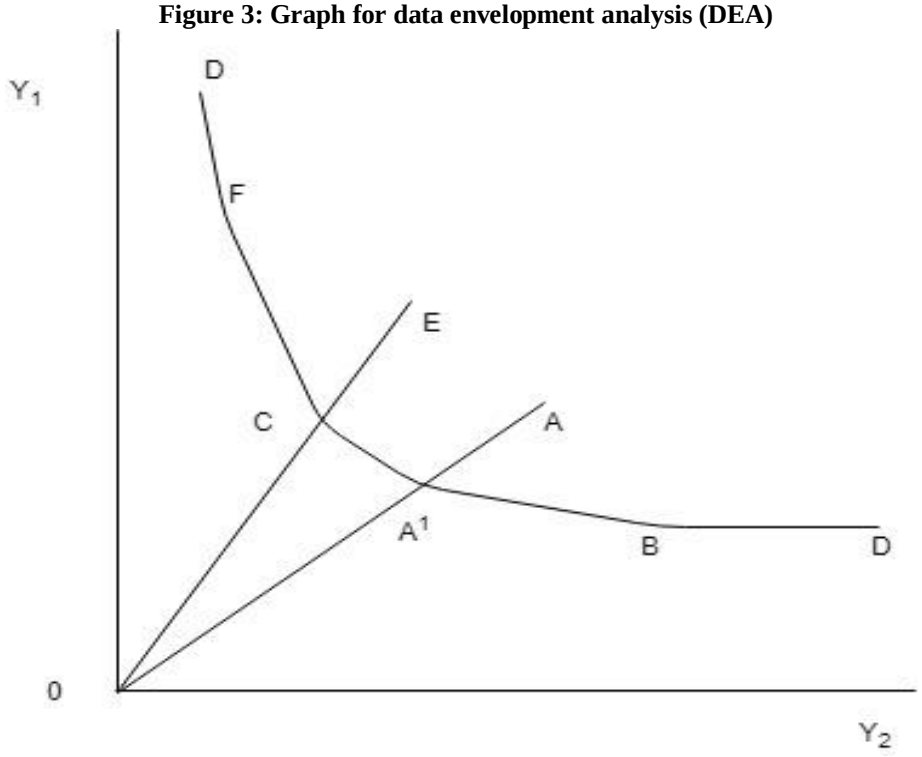


Table 2. Input and Output factors for DEA

Input and Output Factors		Description	Data Source
Input	ISI	Information Systems Investment	TTU statistics 2013 – 2017
	Nws	Number of workers	
	NC	Number of computers	
	NCI	Number of computers with Internet connection	
	NTC	Total number of training courses between 2013 and 2017	
	NISTC	Total number of information system's training courses in 2013 and 2017	
	NwsFICTT	Total number of workers who attended ICT training courses in 2013 and 2017	
	NwsICTS	Total number of workers with ICT skills	
Output	SE	Student enrolment resulting from information system usage between 2013 and 2017	TTU statistics 2013 – 2017

Table 3. Statistics on input/output data

	Max	Min	Mean	SD
ISI	6000	5000	5400	374.1657
Nws	577	562	568.8	5.418487
NC	123	109	116.8	4.749737
NCI	96	87	91.2	3.815757
NTC	12	7	9.4	1.854724
NISTC	7	4	5.2	0.979796
NwsFICIT	41	29	32.8	4.308132
NwsICTS	57	35	48.6	7.735632
SE	8941	7541	8364.6	509.9904

Source: adapted from Barrow and Wagstaff (1989)

Table 4. Correlation

	ISI	Nws	NC	NCI	NTC	NISTC	NwsFICIT	NwsICTS	SE
ISI	1								
Nps	-0.0099	1							
NC	0.8890	0.3248	1						
NCI	0.9245	0.0310	0.9071	1					
NTC	0.2017	0.7841	0.2588	0.0735	1				
NISTC	0.6001	0.4973	0.5243	0.5243	0.8364	1			
NpsFICIT	-0.6328	0.6751	-0.3929	-0.7032	0.5106	-0.0379	1		
NpsICTS	0.8154	0.3703	0.9885	0.8700	0.2063	0.4328	-0.3385	1	
SE	0.8854	0.2087	0.9874	0.9365	0.1101	0.4244	-0.5029	0.9829	1

Table 5. Results of Polytechnics in Ghana from 2013 to 2017

DMUs/ Years	ATU	KuTU	TTU	STU	CTU	HTU	KTU	TaTU	Bpoly	W Poly	Average
2013	1.000	1.000	1.000	1.000	0.841	0.920	1.000	1.000	1.000	0.822	0.958
2014	1.000	1.000	0.859	1.000	1.000	1.000	1.000	1.000	1.000	0.695	0.955
2015	1.000	1.000	1.000	0.968	0.835	1.000	1.000	0.879	1.000	1.000	0.968
2016	1.000	1.000	0.974	1.000	0.831	0.953	1.000	0.902	0.868	1.000	0.953
2017	1.000	1.000	1.000	1.000	1.000	0.952	1.000	0.930	0.997	1.000	0.988
Overall	1.000	1.000	0.967	0.994	0.901	0.965	1.000	0.942	0.973	0.903	0.964
Rank	1st	1st	6th	4th	10th	7th	1st	8th	5th	9th	

Note: Accra Technical University (ATU), Kumasi Technical University (KuTU), Takoradi Technical University (TTU), Sunyani Technical University (STU), Cape Coast Technical University (CTU), Ho Technical University (HTU), Koforidua Technical University (KTU), Tamale Technical University (TaTu), Bolgatanga Polytechnic (Bpoly), Wa Polytechnic (Wpoly)

Corresponding Author: Appiah Ruth,
[2]School of Management, Jiangsu University, Zhenjiang 212013, P. R., China