Research Article

A Systematic Review of Determining the Input and Output Variables To Measure The School Efficiency By Data Envelope Analysis Method

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ABSTRACT:
In an attempt to support maximize utilization of public funds towards education; this study distilled existing literature to shed light on schools' efficiency, while focusing on the input and output variables along with data envelopment analysis (DEA). A systematic search of the existing literature was conducted through the relevant scientific databases of 'Google Scholar', 'Scopus', and 'Web of Science', using the keywords: 'Education Efficiency', as well as 'School Performance', 'Input and Output variables'. The search resulted in 1550 articles published between the years 2010 and 2020. Following a pre-determined inclusion criteria and a thematic analysis, the findings revealed that school-related factors, student-related characteristics, and external environmental factors aligned to the input variables are the major determinants to drive the most important indicator of education efficiency that is academic performance (output variable). Results gathered from this study are hoped to generate significant insights and benefits for the major stakeholders of public primary education. Apart from enriching the current literature on education efficiency, this study could guide the ongoing educational reforms that are taking place across the globe in a significant and timely manner.

Keywords: education efficiency, school performance, input output variables, DEA, systematic review

1. INTRODUCTION

Education plays a vital role in transmitting values and the accumulated knowledge of a society (Britannica, 2019). Educational effectiveness, on the other hand explores the key determinants of academic achievements (Aparicio et al., 2018). More specifically, school efficiency emerged as a well-recognized, widely studied and measured area by researchers worldwide using both non-statistical and statistical approaches including Data Envelopment Analysis (DEA), Corrected Ordinary Least Squares regression, and Stochastic Frontier Analysis (Huguenin, 2015). Researchers stressed on maximizing education efficiency, which translates that education system should focus on the delivery of decent quality education with minimum usage of resources (Johnes, Portela, & Thanassoulis, 2017; Tsakiridou & Stergiou, 2013). Perhaps it why last few decades have seen worldwide implementation of diverse national policies as well as assessment programs for improving student outcomes.

In the context of education in the school setting, educational efficiency refers to relationship between inputs and investments that occurs in the educational system of the schools and the outputs or outcomes that are attained from the utilization of the input resources (Lopez-Martin & Gaviria, 2016). Governments invest heavily in education so that it can be managed in an efficient manner translating that utilization of limited invested funds in education should result in maximum impact (Yang, 2014). According to Aparicio et al. (2018), the existing constraints of resources across most countries coupled with the significant amount of national income devoted to education makes assessing the efficiency of schools a seriously increasing concern for researchers and policy makers. It is thus not surprising that the analysis of Organization for Economic Cooperation and Development (OECD) recommended that improving efficiency in compulsory education is one of four reforms required to raise education outcomes (Huguenin, 2015).

Research revealed education quality has not kept up pace with its expansion (Queiroz, Sampaio, & Sampaio, 2020). Unfortunately, the evaluation of education institutes' efficiency and performance remain greatly challenged by lack of comprehensive data. Most school related literature centered on how

spending impacts students performance, largely ignoring how efficiently that spending takes place (Shero & Hart, 2020). Moreover, measuring school efficiency is not easy, thanks to the multiple inputs and outputs involved (Huguenin, 2015). In a recent study Lee, Worthington, and Wilson (2019) stressed that understanding how to improve primary school performance is a key challenge for governments of most developed and developing countries as the principal operators and funders of primary school education along with other stakeholders. Furthermore reducing the gap between students of public education system reflects one of the current challenge (Chakraborty & Harper, 2017). Based on the above, the objective of this study is therefore to filter the relevant literature and shed light on the input and out variables along with use of DEA method for measuring schools' effectiveness in its role of providing quality education to the students.

2. LITERATURE REVIEW

2.1. **Education Efficiency**

Education translates as the process of acquiring knowledge and skills including value, attitudes, and habits among individuals with the intention of helping the individuals to become useful member of the society. In a relatively recent study, Maigida (2018) explained that education refers to the totality of experiences made available to individuals so they may be able to progress with a wholesome personality and become valuable to themselves and the society. On the other hand, Emrouznejad and Cabanda (2010) explained that efficiency relates to the capability to produce an outcome using a minimum amount of resources. According to Koontz and Weihrich (2012), efficiency is the attainment of an objective or a goal by using the minimum quantity of resources. It could be deduced that an organization is technically efficient if it can maintain its productivity using few inputs or resources wherein inputs reflect resources which are quantifiable and compulsory for the task to be completed. In the context of education Nauzeer, Jaunky and Ramesh (2018) defined efficiency as the total weighted output and total weighted input ratio. The resources usage efficiency implies that the observed output from education are the outcome generated from the utilization of the lowest level of resources while resources usage effectiveness reflects the multitude of outcomes from the use of resources in education as demanded by society are attained.

The concept of education efficiency gained significance from the fact that education has generally become more expensive than other commodities. Although the effects of education have been clearly identified as beneficial to the society and the economic development of the country (Johnes et al., 2017), governments need to allocate substantial proportion of their budgets for education development (Ortiz-Ospina & Roser, 2019), which leads to the significant implications of educational efficiency. Previous studies stressed that education efficiency should be given more emphasis (Johnes et al., 2017). In an earlier study, Tsakiridou and Stergiou (2013) stated that an education system should focus on the delivery of decent quality education with minimum usage of resources. A strong education system indicated by high efficiency implied that without the use of additional inputs (resources), the outputs can be increased (Johnes et.al. 2017). Based on the above, it is evident that determining the efficiency of education and identifying its sources becomes important as economic prosperity is closely reliant on good education (Tsakiridou & Stergiou, 2013). Moreover, since a substantial research effort show that gaining a nuanced understanding regarding the potential role of schools can improve students' learning outcomes; hence following Masci et al. (2018), we focus on analyzing school efficiency specifically, which could be perceived as the ability to transform inputs (resources) into outputs (test scores).

2.2. **Measuring School Efficiency and the DEA**

Education Efficiency is mainly measured by the relative ability of schools to generate educational products using the minimum levels of inputs, including the innate ability of students as one of the school resources (Queiroz et al., 2020). The extant literature is typically found to use data envelopment analysis (DEA) or Corrected Ordinary Least Squares regression (OLS), as well as Stochastic frontier analysis (SFA) to measure school performance in the form of efficiency, which could be coined as the ability to maximize (minimise) outputs (inputs) for a given set of inputs (outputs) (Lee at el., 2019; Huguenin, 2015; De Witte & López-Torres, 2017). Specifically the DEA, as a non-parametric approach can evaluate the performance of homogenous units, employing multiple inputs to yield multiple outputs. The DEA

model could be referred as a mathematical programming that is employed to observational data to gather the empirical estimates of relations between inputs and outputs in the measurement of performance. This method is quite commonly used in the assessment of primary school education efficiency and performance (Tsakiridou & Stergiou, 2014; Raposo, Menezes, Cavalcanti & Maia, 2011; Essid et al., 2010; Sarrico et al., 2010). According to Thanassoulis and Silva (2018), DEA is a method enabling the comparisons where units use multiple incommensurate resources ('inputs') to deliver multiple incommensurate outcomes ('outputs'), to obtain one solo measure of overall performance.

The DEA compares each decision-making unit (DMU) with all other DMUs in a set of DMUs, and then makes a calculation of an aggregate performance measure using the output-input ratio. The DEA model identifies the observed frontier of performance, using the units with 100 percent performance to indicate that all those units performing better relative to all other DMU in the set of units. The analysis envelopes the observation data so that the best-practice DMU's location can be identified and the frontier is then used to estimate productivity index measures for each DMU. The efficiency of any DMU is determined through the maximization of the weighted outputs to weighted inputs ratio but subjected to the constraints that the comparable ratios for every DMU will be smaller or equal to one. Efficient DMU has a ratio of one and inefficient DMU has a ratio of between 0 and 1 (Salleh, 2012). The ratio of input and output should not be more than one for every decision-making unit. The objective is to maximize the DMUs to an optimal value of one. Mathematically, non-negativity constraints are not sufficient for the fractional terms in subject to constraints equation to have a positive value.

Most studies on efficiency used the two-stage model of DEA whereby, in the first stage, the DEA's efficiency estimates is produced. In the second stage, these estimates undergo regression with other exogenous variables using a parametric model, either censored tobit or ordinary least squares models. For the two-stage model, the DEA makes the estimation by construction serially correlated and this causes a problem in analysis. Therefore, bootstrapping scheme is used to eliminate inconsistency bias and correct the serial correlation problem. The two-stage approach aims to find which environmental characteristics including those that are not within the control of the school to explain educational efficiency. It is not about finding which variables give an explanation about efficiency but to shows the ranking of schools that are determined only by the features that are under the control of the school, independent of other variables beyond the school's control. Therefore, the variables that affect the school efficiency but is not within the control of the school should be accounted for in a first stage OLS regression and its residuals are applied as output variable in the second DEA.

2.3. **Determinants and Consequences of Education Efficiency**

This study coins Education Efficiency as Technical efficiency, which refers to the employment of resources to facilitate the educational processes in a technologically efficient way (Lopez-Marin & Gaviria, 2016). Technical efficiency combines both the ability and the capacity to yield economic unit to an output at a maximum level of the amount of inputs and technology. The inputs and output variables thus can be chosen from an array of selection in designing a framework to investigate schools' education efficiency. The inputs can be factors relating to student, factors relating to family, factors relating to education institution and community. It is perceived that inputs are one of the most important variables in the education efficiency model.

The input-factors relating to school are about school resources that are mobilized to enable the implementation of education for the students in the school. This includes the students-teacher ratio (Kornfeld, 2010), students-classroom ratio (Atta, Jamil, Ayaz, Shah & Shah, 2011; Bruhwiler & Blatchford, 2011), teachers' academic qualification, teachers' professional training, teachers' experience and school facilities availability (Vandiver, 2011). Student related factors include elements relating to the students' past achievement (Carvalho & Abreu, 2018), study habit (Rabia, Mubarak, Tallat & Nasir, 2017; Kaur & Pathania, 2015; Kumari & Chamudeswari, 2015) and taking extra tuition (Suleman & Hussain, 2014; Baily, 2012; Kilonzo, 2014). Family factors relate to the socio-economic level of the parents (Bae & Wickrama, 2014; Chen, Kong, Gao & Mo, 2018). Outputs, on the other hand are the outcomes that are expected from the investment and utilization of various resources in education. The theory of production based on an economic perspective provides the model that relates the inputs to the

outputs. The formal relationship of the inputs with the outputs identify the best practice based on the comparison of different units of inputs that are transformed to outputs where all unites are measured relative to that of optimum. From this economic model, school effectiveness can be defined as the process of transforming inputs into outputs.

2.4. **Input and Output Variables**

There are numerous educational inputs that can be considered to explain and measure efficiency. Generally, inputs have two main categories: the endogenous (discretionary) inputs which can be under the control of the schools, and the exogenous (non-discretionary) inputs which are beyond the control of the schools. Human and school resources are the main endogenous inputs. This includes the operating expenses and teaching staff, school management in terms of good leadership, staff participation and appropriate rewards (Hussain, Abbas, Lei, Haider & Akram, 2017). Other inputs include effective monitoring like regular assessment of teacher efficiency, assessment of student performance, and evaluation of overall school performance. Good classroom management is also another form of input that includes lessons that are efficient, purposes and contents in the lesson that are clear. In addition, input in the form of pedagogic qualities includes active participation from students, effective teaching, making full use of learning time etc. Other factors such as socio-economic, student previous attainment, gender, ethnicity and free school meals can also produce variation in student academic achievement (Banerjee, 2016).

In Badri et al. (2014), average cost/student, average cost/teacher; teacher load average unit, class capacity average and student/teacher ratio was found as determinants of school efficiency. In a separate study ratio of student/teacher, ratio of classroom/student, ratio the cost to increase learning process/student ratio, cost/student ratio, welfare/student ratio, ratio of increase in extracurricular guidance cost/student, ratio the profession coaching cost/student, cost of maintenance and replacement of facilities and infrastructure/student, ratio of household school costs/student, ratio of monitoring, ratio of non-education/student, ratio of computer/student, along with supervision and reporting/students were highlighted as factors of efficient education (Mahmudi, Ismail, Ananda & Khusaini, 2014). The same study confirmed that input contributing to reduce the maximum efficiency scores include monitoring, supervision and reporting per student, training cost, number of computers per student, household costs per student, and the amount of non-educational personnel per student (Mahmudi et al., 2014). An earlier review by De Witte and Lopez-Torres (2017) further showed that the inputs on efficiency measurement in past studies remain divided into four categories based on the levels: students, family-related variables, education institution and community variables.

In terms of output variables, Academic performance is known to be the most important output in the evaluation of efficiency measurement. The most supported variable in existing literature examining education quality was found to be students' academic performance, which refers to the proportion of students passing an examination coupled with marks obtained for specific subjects (De Witt & López-Torres, 2017; Farooq, Chaudhry, Syafiq & Berhanu, 2011). Badri et al. (2014), who carried out a study on the measurement of efficiency across public schools used data envelopment analysis (DEA) with the outputs depicting the English, Math, Science and Arabic (EMSA) average scores, the 12th grade average exit exam results, and the Common Educational Proficiency Assessment (CEPA) average score. The results of the study further showed that cost per students and cost per teacher were the inputs with the highest impact while students' assessment tests at the national level were the outputs with the highest impact. In a separate study by Mahmudi et al. (2014), the outputs included the graduation/student ratio, the academic achievement/student ratio and the non-drop out/student ratio.

In a separate study of relative efficiency measurement of the educational schools a total of nine inputs were compared to two outputs. The inputs comprise of the numbers of battalion pupils, students enrolled, teachers, women professors, Master graduates in technological institutes, workers, students in need, students teaching assistants, and operating subsidies. The outputs comprised of the success rate of students who received a good rating above average in education certificate along with the students transferring to the first year secondary, who obtained the average of 10 or above. Tyagi, Yadav and Singh

(2009) included elementary schools to determine the technical efficiency and efficiency differences. The study used DEA based on eight input variables and three output variables. These inputs were divided into two categories, which were school resources and the home environment of the students. School resources included teaching, teachers' qualities, and physical and ancillary facilities, while the home environment of the students is divided into parents' education and occupation. Outputs were the school-wise average marks in mathematics, environment studies, and language.

In a research report prepared by the Mastercard Foundation (2018) on the efficiency of secondary education the inputs were schools' background characteristics, headteacher background, school finances, teachers' qualification, computer to student and teacher ratio, teacher recruitment and allocation and cost. Huguenin (2015) studied the primary schools' efficiency o as a means of determining primary school performance. The study employed a two-stage DEA method whereby in the first stage of the model, the individual efficiency of each of the schools was calculated while in the second stage, the efficiency was regressed on school characteristics and environmental variables. Liouaeddine, Elatrachi and Karam (2018) conducted a study on the efficiency of primary schools to provide the measurement of the efficiency of the primary schools. The study showed that socio-economic environment of the student impacted on the efficiency of the schools in a significant manner.

Borge and Naper (2005) evaluated the efficiency potential and efficiency variation of lower secondary schools and showed that by using DEA analysis, the efficiency potential was at 14 percent with grades in core subjects, adjusted for student features and background of the family. Low educational efficiency was related to high municipal revenue level, high party fragmentation degree and high socialists share on the local councils. The technical efficiency of high schools was explored by Halkiotis, Konteles and Brinia (2018) focusing on the factors pertaining to the technical efficiency. Another study was carried out by Tsakiridou and Stergiou (2013) on primary schools that used DEA with the aim of maximizing education attainment of the students under a budget constraint. The second stage analysis in their study used linear regression and the Ordinary Least Squares (OLS) to explain the reasons for any inefficiency and to examine the effect of students' parental educational level, family socio-economic status, school area, school size, and school innovations on school efficiency. Findings showed that students' family socio-economic status, school area and school innovations are positively related to efficiency. The high level of father's academic qualification increased the efficiency of the schools. Low education level of the mother however, lead to negative impact on school efficiency. Further to that, the school size was also significantly but negatively related to school efficiency.

Wanke, Blackburn and Barros (2016) also employed DEA to determine the efficiency drivers in public schools. They used the two-stage procedures to determine the cost and learning efficiency level. Apart from the aforesaid, De Witte and Lopez-Torres (2017) wrote a broad overview of the literature that described educational efficiency by summarizing the inputs, outputs and contextual variables that were applied along with the use of sources of data in previous studies. Their systematic review had identified numerous studies at school and high school levels (Agasisti, 2013; Aristovnik & Obadic, 2014; Blackburn et al., 2014; Bradley et al., 2010; Brennan et al., 2014; Burney et al., 2013; Carpenter & Noller, 2010; Essid et al., 2010, 2013; Gronberg et al., 2012; Haelermans & Blank, 2012; Haelermans & De Witte, 2012; Haelermans & Ruggiero, 2013; Haelermans et al., 2012; Johnes et al., 2012; Kirjavainen, 2012; Mancebón et al., 2012; Misra et al., 2012; Mongan et al., 2011; Portela et al., 2012) and at student level studies (Cordero-Ferrera et al., 2011; Crespo-Cebada et al., 2014; De Witte & Kortelainen, 2013; Deutsch et al., 2013; Montoneri et al., 2012; Perelman & Santín, 2011; Podinovski et al., 2014; Portela et al., 2013; Thieme et al., 2012).

3. METHODS

For the purpose of present study, school efficiency inputs comprised of three variables: school-related factors, student-related characteristics, and external environmental influence. These inputs reflected the predictors of the output, technical efficiency in terms of student achievement in science, mathematics; English and Arabic language studies. This study used the systematic review approach with the research objective of identifying, analyzing, and discussing the determinants and consequences of schools' education efficiency. Hence, 'School Performance', 'Education Efficiency', and 'Input Output variables'

were the identified key terms used to search the relevant literature within selected databases of 'Google Scholar', 'Scopus' and the 'Web of Science'.

3.1. **Inclusion Criteria**

Before initiating the literature search, the following inclusion filters were applied. Firstly, to ensure content relevancy, it was decided that only publications that examined the determinants (input variables) and consequences (output variables) should be consulted. Secondly, the years of publication for the literature search were limited to 2010-2020 to get an overview of recent (and adequate) research. Finally, in terms of language, only publications in English language were included in the search criteria.

3.2. **Search Strategy**

To develop a suitable search strategy that would complement the objective of this review, different possible search terms were enlisted. After careful consideration, 'School Performance', 'Education Efficiency', and 'Input Output variables' were identified as the most effective keywords for this study. The search terms were searched for in the titles, abstracts, and keywords in order of articles to target the most appropriate publications, as suggested by Elisabeth et al. (2009), and Marvel, Davis, & Sproul (2016).

3.3. **Identification of Relevant Literature**

The literature search was comprehensive within the scientific databases of Google Scholar, Scopus, and Web of Science (including Social Sciences Citation Index, Science Citation Index, Emerging Sources Citation Index, and Arts & Humanities Citation Index). Consistent with previous reviews (Marvel et al., 2016), books, book sections, editorials, teaching cases, teaching case notes, and commentaries were ignored so that the data would contain only reviews, meta-analysis, other research articles, and conference proceedings. Before the final analysis, the downloaded literature was checked and duplicate articles were removed.

3.4. **Coding and Analysis**

When examining the literature, special attention was paid to articles that suggested the possible components of an analytical framework to guide the category and comparative aggregation analyses. Following previous systematic reviews (e.g. Ke, 2016; Marvel et al., 2016), articles were coded and analyzed based on their focus or research objective, theories, constructs, research methods, analyses, and significant findings relevant to the present study. At this stage, the articles were carefully read and a critical analysis was carried out using self-devised review of the literature based on the description and evaluation of the key search words found in the publications. Initially, the abstracts of the selected publications were screened thoroughly for significance. If the abstract could not provide adequate information, the full content was read to decide if the publication met the predetermined criteria for final synthesis.

Table 1: Summary of Included Studies

Variables	Studies Included
Students	Mainardes et al. (2014), Perelman and Santín (2011); Cordero-Ferrera et al. (2011), Crespo-Cebada et al. (2014), Grosskopf et al. (2014), Mongan et al. (2011), Perelman and Santín (2011); Grosskopf and Moutray (2001); Cordero-Ferrera et al. (2015), De Witte et al. (2010), Johnes (2013), Khalili et al. (2010), Kong and Fu (2012), Kuah and Wong (2011), Perelman and Santín (2011), Portela and Camanho (2010), Portela et al. (2013), Sarrico et al. (2010), Podinovski et al. (2014); Conroy and Arguea (2008), Kuah and Wong (2011); Perelman and Santín (2011), Thieme et al. (2013).Kong and Fu (2012), Mongan et al. (2011), Kirjavainen (2012), Mancebón et al. (2012); Perelman and Santín (2011), Mancebón et al. (2012); Kong and Fu (2012).

Family	Mongan et al. (2011); Sarrico et al. (2010); Kirjavainen (2012), Perelman and Santín (2011); Aparicio et al. (2018), Cordero-Ferrera et al. (2011), Khalili et al. (2010), Kirjavainen (2012), Kong and Fu (2012), Mancebón et al. (2012), Mongan et al. (2011), Perelman and Santín (2011), Sarrico et al. (2010); Thieme et al. (2013); Aristovnik (2013), Deutsch et al. (2013), Mancebón et al. (2012), Mongan et al. (2011), Perelman and Santín (2011), Thieme et al. (2013); Aparicio et al. (2018), Agasisti (2013), Cordero-Ferrera et al. (2011), Chakraborty and Harper, 2017; Crespo-Cebada et al. (2014), Kirjavainen (2012), Mancebón et al. (2012), Perelman and Santín (2011a), Podinovski et al. (2014), Thieme et al. (2013); Lee at el. (2019); Cordero et al. (2017);
Education institutions	Agasisti (2011), Thieme et al. (2013); Mongan et al. (2011), Perelman and Santín (2011). Mancebón et al. (2012); Aparicio et al. (2018), Agasisti (2013), Agasisti and Pérez- Agasisti et al. (2012), Cordero-Ferrera et al. (2011) (2015), Crespo-Cebada et al. (2014)Esparrells (2010), Essid et al. (2010), Haelermans and Blank (2012), Haelermans and Ruggiero (2013), Lee (2011), Mongan et al. (2011), Perelman and Santín (2011), Mancebón et al. (2012), Misra et al. (2012), Thieme et al. (2013), Zoghbi et al. (2013); Cordero et al. (2017); Alexander et al. (2010), Aristovnik and Obadic (2014), Davutyan et al. (2010), Gronberg et al. (2012), Johnes (2014), Johnes et al. (2012), Katharaki and Katharakis (2010), Khalili et al. (2010), Mayston (2014), Misra et al. (2012), Rayeni and Saljooghi (2010); Agasisti (2014), Agasisti and Johnes (2015), Alexander et al. (2010), Aristovnik (2013), Aristovnik and Obadic (2014), Blackburn et al. (2014), Brennan et al. (2014), Carpenter and Noller (2010), Duh et al. (2014), Essid et al. (2014), Gronberg et al. (2012), Haelermans and Blank (2012), Haelermans and De Witte (2012), Haelermans and Ruggiero (2013), Haelermans et al. (2012), Houck et al. (2010), Johnes (2013), Johnes and Schwarzenberger (2011), Johnson and Ruggiero (2014), Katharaki and Katharakis (2010), Kempkes and Pohl (2010), Kirjavainen (2012), Kounetas et al. (2011), Kuah and Wong (2011), Lee (2011), Lu and Chen (2013), Mayston (2014)Mongan et al. (2011), Misra et al. (2012), Ouellette and Vierstraete (2010), Sexton et al. (2012), Thanassoulis et al. (2011), Zoghbi et al. (2013); Ouellette and Vierstraete (2010); Misra et al. (2012); Conroy and Arguea (2008); Agasisti and Johnes (2015), Carpenter and Noller (2010), Kantabutra and Tang (2010), Kirjavainen (2012), Perelman and Santín (2011), Thieme et al. (2013) Agasisti et al. (2012), Agasisti and Pérez-Esparrells (2010), Alexander et al. (2010), Bradley et al. (2010), Brennan et al. (2014), Burney et al. (2013), Davutyan et al. (2010), Deutsch et al. (2013), Duh et al. (2014), Essid et al. (2014), Haelermans et al. (2012), Haelermans and Blank (2012), Haelermans and Ruggiero (2013), Johnes et al. (2012), Katharaki and Katharakis (2010), Kempkes and Pohl (2010), Kounetas et al. (2011), Kuah and Wong (2011), Lee (2011), Mayston (2014)Ouellette and Vierstraete (2010), Rayeni and Saljooghi (2010), Thieme et al. (2012), Wolszczak-Derlacz and Parteka (2011), Huguenin (2015), Kempkes and Pohl (2010), Wolszczak-Derlacz and Parteka (2011). Agasisti and PérezEsparrells (2010), Bradley et al. (2010), Burney et al. (2013), Crespo-Cebada et al. (2014), Essid et al. (2014), Haelermans and Blank (2012), Kirjavainen (2012), Kounetas et al. (2011), Kuah and Wong (2011), Mancebón et al. (2012), Perelman and Santín (2011), Podinovski et al. (2014), Wolszczak-Derlacz and Parteka (2011), Aparicio et al. (2018); Agasisti (2014), Cherchye et al. (2010), Cordero-Ferrera et al. (2015), Chakraborty and Harper, 2017; Crespo-Cebada et al. (2014), Johnes (2013), Kirjavainen (2012), Misra et al. (2012), Naper (2010), Perelman and Santín

	(2011), Sarrico et al. (2010), Zoghbi et al. (2013); Heshmati and Kumbhakar (1997); Misra et al. (2012); Bradley et al. (2010), Agasisti et al. (2012), Kuah and Wong (2011), Misra et al. (2012), Sarrico et al. (2010), Thieme et al. (2012) Bayraktar et al. (2013), Carpenter and Noller (2010), Cherchye et al. (2010), De Witte and Kortelainen (2013), Dehnokhalaji et al. (2010), Deutsch et al. (2013), Haelermans and Blank (2012), Johnes (2013), Montoneri et al. (2012), Nazarko and Saparauskas (2014), Sarrico et al. (2010), Zoghbi et al. (2013) Eff et al. (2012), Gronberg et al. (2012), Haelermans and Blank (2012), Johnson and Ruggiero (2014); Chakraborty and Harper, 2017; Masci et al. (2018); Kim, J. (2018)
Community	Perelman and Santín (2011), Nazarko and Saparauskas (2014). Grosskopf et al. (2014). Kantabutra and Tang (2010), Kirjavainen (2012)
Student Achievement	Agasisti (2014), Agasisti and Johnes (2015), Kuah and Wong (2011), Alexander et al. (2010), Aristovnik (2013), Bayraktar et al. (2013), Blackburn et al. (2014), Brennan et al. (2014), Carpenter and Noller (2010), Cherchye et al. (2010), Crespo-Cebada et al. (2014), Davutyan et al. (2010), De Witte and Kortelainen (2013), De Witte et al. (2013), Deutsch et al. (2013), Eff et al. (2012), Essid et al. (2013), Gronberg et al. (2012), Haelermans and Blank (2012), Haelermans et al. (2012), Haelermans and De Witte (2012), Haelermans and Ruggiero (2013), Johnes (2013), Johnes et al. (2012), Johnson and Ruggiero (2014), Houck et al. (2010), Kirjavainen (2012), Khalili et al. (2010), Mancebón et al. (2012), Misra et al. (2012), Mongan et al. (2011), Montoneri et al. (2012), Naper (2010), Perelman and Santín (2011), Podinovski et al. (2014), Portela et al. (2013), Portela and Camanho (2010), Sarrico et al. (2010), Sexton et al. (2012), Thieme et al. (2013), Zoghbi et al. (2013), Huguenin (2015), Masci et al. (2018)
Educational outcomes	Alexander et al. (2010); Agasisti and Johnes (2010), Aristovnik (2013), Aristovnik and Obadic (2014), Bayraktar et al. (2013), Brennan et al. (2014), Burney et al. (2013), Davutyan et al. (2010), Eff et al. (2012), Essid et al. (2014), Johnes (2014), Johnes and Schwarzenberger (2011), Lee (2011), Lu and Chen (2013), Ouellette and Vierstraete (2010), Podinovski et al. (2014).

4. **DISCUSSION**

Education is now considered as a fundamental right, implying that everyone is entitled to receive education. In most countries, education reform is currently ongoing to make education contribute effectively towards local, national, and international levels. Interesting, even with significant allocation of public funds towards education, students are performing lesser than the anticipated level. Students' knowledge and skills are considered as a significant predictor of the future wealth of the country and social outcome. In this regards Badri, Mohaidat and Moudad (2014) argued that performance-based school reforms deserves significant consideration. Hence this study explored existing literature to shed light on the input output variables along with the DEA methods that could be exploited for schools' effectiveness, thereby facilitating its role of providing quality education to the students.

The findings revealed that school-related factors, Student-Related Characteristics, and External Environmental Factors aligned to the input variables act as the major determinants to drive academic performance (output variable) and ensure attainment of educational goals. Specifically, the school-related factors including the ratio of student and teacher, the ratio of student and classroom, teacher academic qualification, teacher professional training, teacher experience, and school facility availability should be prioritized to enhance education efficiency across schools. The ratio of student and teacher refers to the mean number of students per teacher at a specific level of education in a given school year. The key aim is to determine the human resources input level based on teachers in relation to the size of the student population in a given school. A high ratio indicates that every teacher has a greater responsibility to a

larger number of students and there is a relatively lower access of the students to the teachers. The assumption is that a smaller student-teacher ratio is preferable as the teacher can pay more attention to individual students, and this in turn will lead to greater performance of the students.

Student and classroom ratio is the other important consideration of the students' academic performance. A ratio of student and classroom refers to the number of students in a classroom at a particular level of education in an academic year. A high ratio indicates that the classroom has more students, and this would provide more challenges to the teacher to teach the class and pay individual attention to the student. The teachers' qualification could also be taken into consideration as an input to explain efficiency. It is perceived that students taught by higher qualified teachers gain greater benefits compared to those tutored by teachers with inadequate qualifications. Along with qualifications, a teachers' professional training is also an important consideration that relates to students' performance.

Apart from qualifications and training, Teachers' experience is also related to students' academic achievement. In terms of School Facility Availability, the physical facilities in the school are an important factor of students' academic performance. School facilities could include the school hall, classroom furniture, libraries, recreational equipment, canteen, staff rooms, toilets, playgrounds, instructional materials, science laboratories, and other school buildings. The accessibility and adequacy of physical facilities in the school like modern laboratories, classrooms, library and others are associated with the education quality in the school. Hence it could be contended that students in schools with adequate and accessible facilities perform better academically, translating that a school's internal efficiency is reliant on the school facilities' ease of access, sufficiency and applicability.

In terms of student-related characteristics, we found the three main factors to be students' past achievement, study habit, and taking extra tuition. Students' past achievement is considered as a student characteristic related to their future achievement. Students with good track of performance and interest behavior at school are expected to behave in a consistent manner in the present and leads to higher expectations. Secondly, study habit of students, refers to the dedicated scheduled and uninterrupted time that a student allocates for the task of learning. Study habit is the adopted manner of a learner or a student during his or her private time after school to gain mastery of a particular subject. Good habits of study are identified by diverse skills like time management, self-focus and concentration, discipline, memorization, organization and effort, which could strongly correlate to how students perform academically. Finally, as agreed by many researchers taking private or home tuition after school is important to strengthen and improve students' academic achievement. As for External Environmental Factors, Family comes first. Family related factors refers to the size and structure of the family, social classes , parents' educational level, occupation, economic status, and influencing factors relating to family and students' immediate external environment. The socio-economic status of a student is ascertained and based on the combination of the parents' scholastic levels, professions, and income level. Family upbringing is crucial to students' personal and academic lives as it can influence their learning in a meaningful way. Additionally, Educational level and economic status of parents relates in a positive manner to their children's academic performance.

5. **CONCLUSION**

This study primarily enriched the existing literature on education efficiency forwarding insights that could lead to a nuanced understanding of the subject matter. Results gathered from this study are hoped to generate insights and benefits towards main stakeholders of public primary education, which includes the school heads and other educational stakeholders at the grassroots level in mobilizing appropriate resources so that greater student performance is attained. The findings could further be beneficial for curriculum developers, the Ministry of Education in order to identify efficiency inputs and outputs that are critical in getting the best outcomes from students. The insights gained can be used in fine tuning the school quality inspection framework so that schools are not only producing high performing students, but they are doing it with efficiency in terms of resource usage. Based on the review, it is recommended that a major reform in the school education curriculum with more focus on enriching the mind of the students need to be executed that ensure that students are equipped with numerous skills, instilled with virtuous

values, have national identity, innovative, creative and can apply critical thinking skills (c.f. Dukmak & Ishtaiwa, 2015).

The review revealed that methodologies in most past studies have been based on the assessment of the input-output ratio with ordinary least squares (OLS) regression analysis (Nauzeer et al., 2018). It is know that only the average of expected outcome can be computed using a regression model but in the case of maximum achievable outcome, this cannot be possibly done. Furthermore, the production function of input/output in a regression model may pose some issues as majority of the regression models employs a sole output production function, thereby in the context of school performance, it seems unrealistic. Based on the limitations, it is recommended that future researchers could exploit non-parametric approaches, such as DEA to evaluate the performance of homogenous units, employing multiple inputs to yield multiple outputs. This method could be beneficial particularly for future empirical explorations, as several previous studies used it in the assessment of primary school education efficiency and performance.

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