Measuring Inter-District Variation of Efficiency of Elementary Schools using Data Envelopment Analysis: Evidence from Rajasthan, India

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Abstract: Data envelopment analysis has been used for measuring the efficiency of Schools, Universities, Hospitals, Banks, and other institutions. This paper analyses the technical efficiency of elementary schools in all 33 districts of Rajasthan, India from 2014 to 2016. Assuming variable-returns-to-scale and utilizing data envelopment analysis (DEA) for obtaining the technical efficiency scores. We used data from National University of Educational Planning and Administration (NUEPA), and District Information System for Education (DISE). The results of the paper show that average technical efficiency was high in 2016 compared to the other two years. In 2016, twenty districts were listed as efficient districts, whereas, in 2014 and 2015, the number of efficient districts was 13 and 12 respectively. After comparing literacy rate and technical efficiency score of the districts, some evidence of high literacy rate but low technical efficiency score were found which reveal that high literacy rate does not necessarily imply that districts are technically efficient.

Keywords: Data Envelopment Analysis, Technical Efficiency, Elementary Schools

I. Introduction

Education as a vehicle for economic growth can boost the economy of a country in several ways. In today's world, Countries heavily invest in education to promote innovations, creativity, skilled labor, etc. India as a member of G20 countries and one of the highest growing economy has been invested heavily in infrastructure, Education and other aspects of the economy since 1947. Literacy rate jumped from 18.33 Percent in 1951 to 73 percent in 2011[1]. Many schools, universities and other educational institutions have been established to improve access to education in all States of India. Rajasthan is one of the largest State of India with a population of around 74 million who live in 33 different districts of the state[2]. Literacy rate rose to 66.1 percent from 8.5 percent in the Period 1951-2011[3]. All the 33 districts are not the same in area, Population, literacy level, and other aspects. There are differences in population, illiteracy level, and other aspects but we do not take those differences into account. The main questions are: (i) "Do all the schools perform efficiently? (ii) "Do all the districts use the given resources effectively?

People have different views about the efficiency of schools. Some might call those schools as efficient schools which operate with low cost. Some might define those schools as efficient which provide good quality education irrespective of charges, but some might think the other way round. One of the objectives of this paper is to measure the efficiency of elementary schools by using a commonly accepted method which is called Data Envelopment Analysis (DEA). DEA analysis is a method used for measuring the efficiency of Schools, Banks, hospitals, universities and other institutions. It is a linear program based on input and output variables. It takes several variables as inputs and outputs to measure the efficiency score of a particular institution. Selection of inputs and outputs is a critical issue because different inputs and outputs can be used for measuring the efficiency of any institution. For example, to measure the efficiency of schools, we can take (class size, number of teachers, number of students and many other variables) as inputs and (achievement of the student, overall enrollment, girls' enrollment, boys' enrollment, and other factors) as outputs. In this paper, we have taken overall enrollment in schools, the percentage of girls in total enrollment, and drop-out rate as output variables. And pupil-teacher ratio, student-classroom ratio, number of schools per lakh population, and percentage of the teachers with graduate or above graduate degree as input variables. Elementary schools consist of both Primary and Upper primary levels in this paper. Structure of primary and upper primary levels differs from state to state in India. In Gujarat and some other states, Grades 1-4 are called as primary, and Grades 5-8 are called as upper primary but in Rajasthan and some other states, Grades 1-5 are named as primary, and Grades 6-8 are called as upper primary level[4]. We have gathered the data of primary and upper primary levels for all districts, and after that, the DEA Solver software is run for obtaining the technical efficiency scores. The remaining four sections of the paper are organized as follows: The second section is a review of the literature on efficiency measurement. The third section presents the objectives of the paper. The methodology of the paper is presented in the fourth section. And the final section deals with results and conclusion.

II. Review of literature

Several studies have been done across the world on measuring the efficiency of schools, universities, hospital, banks and other institutions. Fatimah and Mahmudah (2014-2015) attempted to explore the efficiency of elementary schools in Indonesia. The techniques of DEA has been applied for obtaining efficiency score for 34 provinces. Assuming constant returns to scale, it has been observed that out of 34 provinces, 12 had an efficient elementary schools. At the same time, assuming variable returns to scale, it has been found that 17 provinces had efficient elementary schools compared to 12 provinces in constant returns to scale case.

Badri and Mourad (2012) examined the efficiency of secondary public schools in Abu Dubai. They constructed different models with different inputs and output variables. The results show that using (cost per teacher, cost per student and class size) as input variables and (G12 & E12 math test) as outputs, only 4% of the secondary public schools were listed as efficient schools.

Tyagi et al. (2009) applied DEA to evaluate technical efficiency of elementary schools in the Uttar Pradesh state of India. Four different models were utilized to obtain the efficiency score of districts. They found that the average technical efficiency was 0.7058 using all inputs and outputs variables (model 4). Sixty-seven schools were listed as efficient schools which account for 19.25 percent of the sample. Lian- Zhang (2010) analyzed the efficiency of schools in Taipei, Taiwan. Two-stage DEA approach was applied for obtaining efficiency scores. Their paper covered 140 elementary schools in Taipei, Taiwan. The result of the research indicates that there is no significant difference in CRS and VRS efficiency scores in both stages. In their paper, schools with 37-48 and 49-60 classes had the highest improvement rate. They suggested that inefficient schools can become cost efficient; if they reduce most inputs by 8 – 9 percent.

Maragos and Despotis (2000-2001) explored the efficiency of high schools in Greece. They clustered 59 municipalities of Greater Athens Area (GAA) of Greece in the period 2000-2001. The paper concluded that schools which are located in the non-privileged area are more efficient than those which are located in the privileged area. In their research, they provided recommendations for improving the efficiency of the inefficient area. Alejendra et al. (2000) examined the efficiency of schools in Chile. DEA analysis and the stochastic production frontier techniques have been applied for obtaining efficiency score of 2000 schools (private fee-paying, private subsidized, public schools). The results show that both the methods give almost the same result. Using the stochastic production frontier method, the average efficiency score was 0.93 ranging from 0.73 to 0.98. While using DEA analysis method, the average efficiency score was 0.95 ranging from 0.53 to 1. The paper further found that private fee-paying schools were the most efficient schools in Chile. Ghosh and Bhanja (2011) evaluated the inter-district variations of the efficiency of elementary schools in West Bengal. DEA analysis with variable returns to scale was applied for obtaining technical efficiency score for all 20 districts. The result shows that all the districts were not efficient in primary and upper primary level. They further found that high literacy rate and high educational development index (EDI) do not reflect efficiency always. They conclude that there are some districts which have a high literacy rate and EDI but still their technical efficiency score is low. Also, there is some evidence which reflects high-efficiency rate for the districts which have low literacy and EDI index.

Raposo et al. (2007) applied both one – stage and two - stages DEA analysis for obtaining the efficiency score of schools in north-east of Brazil. Twenty-five variables as inputs and average math's score of 4th grade as output variable were used for measuring the efficiency of the schools. They concluded that ranking of the schools based on their performance is difficult to obtain if we remove the environmental variables. In one – stage DEA method the result was homogeneous as they removed the environmental variables in the model. Lauro et al. (2016) analyzed the efficiency of municipal schools in Rio de Janeiro of Brazil. Their paper covered 465 elementary schools. Two-stage Data Envelopment analysis was applied to obtain the efficiency score for all the elementary schools. The result shows that some activities like student's discipline-related, long schooling days, and community cleanup are correlated with low efficiency. The paper further found that higher student socioeconomic level does not lead to higher efficiency score.

Xu and Liu (2017) applied DEA to evaluate the efficiency of education and technology and its implications on national development. The paper covered 53 countries across the world using the panel – Data from the educational and technology sectors of the countries. For obtaining the efficiency of education, total public expenditure on education and total public expenditure on education per capita were taken as input variables while enrollment in secondary schools and higher education achievements as output variables. Similarly, for obtaining an effect of technology, total expenditures on R&D and total R&D personnel nationwide were taken as input variables while scientific articles, patent applications, and patent grants were taken as outputs. They found that countries with high educational and technological efficiency scores are located in East Asia. They further evaluate the effect of educational and technological efficiency scores on the national development of the country. The result shows that efficiency in education has a significant positive role in the balanced national development of a country.

III. Objectives

1. To obtain the technical efficiency score for all 33 districts of Rajasthan state for three academic years 2013/2014 - 2015/2016 – 2016/2017.
2. To compare the efficiency score of all districts and rank the districts based on the efficiency of elementary schools.
3. To compare the literacy rate and technical efficiency score of the districts for exploring the impacts of literacy rate on the efficiency of elementary schools.

IV. Methodology and Data

"There are two components of efficiency: technical efficiency (TE) and allocative efficiency (AE). TE shows the ability of a Decision-making Unit (DMU) to obtain maximum output from a given set of inputs and technology. , on the other hand, allocative efficiency reflects the ability of a DMU to use the inputs in optimal proportions, given their respective prices. Technical efficiency of a DMU can be measured either by (I) output-oriented or by (II) input-oriented approach. ***Input-oriented*** TE measure represents the maximum amount of input quantities, which can be proportionately reduced without changing quantities produced as output. ***Output oriented*** technical efficiency measure, on the other hand, represents the maximum output quantities that can be proportionately increased without altering input quantities. In case of output-oriented measure, the TE of a DMU can be computed by comparing its actual output with the maximum producible quantity from its observed inputs i.e.by how much can output quantities be proportionally expanded without altering the inputs quantities used. In input-oriented measure, the TE of a DMU can be measured by comparing its actual input in use with the minimum input that would produce the targeted output level, i.e., by how much can input quantities be proportionally reduced without changing the actual output bundle" (Ghose & Bhanja, 2014, P5). In this paper, we will only measure the technical efficiency of Decision-making units.

Methodology for Output-Oriented Technical Efficiency Score:

Suppose we have 'n' number of decision-making units which use 'q' number of inputs for producing 'f' number of outputs.

J = 1, 2, 3 ……………n Number of Decision-making units

I = 1, 2, 3…………….q Number of Inputs

R = 1, 2, 3……………f Number of Outputs

Let K^{th} Decision-making unit uses X bundle of inputs (x_{1k}, x_{2k}, x_{3k}……… x_{qk}) for producing Y bundle of outputs (y_{1k}, y_{2k}, y_{3k}…………..y_{fk}). To find the output-oriented technical efficiency score for the K^{th} DMU, we need to solve the following linear problem:

$$\max \theta_k$$

Subject to the constraints

$$\sum_{j=1}^{n} \gamma j\, xij \quad \leq \quad xik$$

$$\sum_{j=1}^{n} \gamma j\, yrj \quad \geq \quad \theta k\, yrk$$

$$\sum_{j=1}^{n} \gamma j = 1$$

After solving the above linear program, we will get the maximum output bundle y^* which can be produced from the given bundle of inputs. (Banker et al. 1984)

Specification of input and output variables

We have covered three academic years for measuring the efficiency of elementary schools in the Rajasthan state of India. Selection of output and input variables is a critical issue; several variables can be taken as inputs and outputs. In this paper, we have chosen three output variables and four output variables for measuring the efficiency scores of decision-making units. Inputs and outputs variables are as follow:

Table 1: Definition of Input and Output Variables used in Technical Efficiency Measurement

No.	**Input variables**
1	Pupil-Teacher ratio
2	Student - Classroom ratio
3	Number of schools per lakh population
4	Percentage of teachers with Graduate or above Graduate Degree
	Output Variables
1	Total enrollment in schools
2	Percentage of girls in total enrollment
3	Drop-Out rate (Undesirable variable)*

Source: Author's elaboration

Input variables: Student - Classroom ratio is taken for the purpose to see the impact of class capacity and number of students on the efficiency of schools. More teachers are required for a large number of students for a better outcome. We have taken the pupil-teacher ratio as an input variable to show how the number of teachers and students influence the efficiency of schools. The number

*Note: Efficiency measurement in Data Envelopment Analysis (DEA) is usually based on the assumption that inputs have to be minimized and outputs have to be maximized. In some situations, undesirable (bad) inputs and outputs may be presented in the production process. In order to improve the performance of an inefficient Decision Making Unit (DMU) the undesirable outputs and desirable (good) inputs should be decreased while the desirable outputs and undesirable inputs should be increased. (Jahanshahloo et al. (2005). For example, CO2 emission is an undesirable output for industries which they try to reduce it to the possible extent. Whereas, recycle of inputs is undesirable input which companies try to maximize it because with more recycling company can produce additional outputs.

of schools per lakh population is taken to see the impacts of population on the efficiency of elementary schools in districts. The percentage of teachers with Graduate or above Graduate degree is made to examine the effects of teachers' qualification on the efficiency of elementary schools in districts.

Output variables: Total enrollment in schools and Percentage of girls in total enrollment are taken as two outputs variables for the chosen four inputs variables. The drop-out rate is third undesirable output variable.

Source of Data

This paper called measuring the efficiency of elementary schools by using Data Envelopment Analysis is based on secondary Data which are collected from two sources namely National University of Educational Planning and Administration (NUEPA), and District Information System for Education (DISE).

Sample of Districts

Sample of Districts which are chosen consist of 33 districts namely: Ajmer, Alwar, Banswara, Baran, Barmer, Bharautpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dausa, Dhilpur, Dungarpur, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Paratapgarh, Rajsamand, SawaiMadhopur, Sikar, Sironi, Sri Ganganagar, Tonk , Udaipur.

V. Empirical Results

In this section, the empirical results of the paper are presented. We assume variable returns-to-scale for obtaining the technical efficiency scores of the all decision-making units. We attempted to separate all the districts into three categories. In Category Ⅰ, all the districts have been included which have attained the technical efficiency score less than the average score of the sample. This category is the most inefficient districts compared to the other two categories. Those districts have been included in category II, which have attained the technical efficiency score above the average score of the sample. This category's districts are marginally inefficient, with a little improvement in resource utilization they can achieve the status of efficient districts. The final category is all the districts which are the fully efficient districts among all 33 districts.

The average technical efficiency scores of 2014 along with standard deviation and the number of efficient and inefficient districts are presented in Table 2.

Table 2: Average Technical Efficiency Along with Standard Deviation and Number of Efficient & Inefficient Districts 2014/2015.

Category I (Below Average)	Category II (Above Average)	Category III (Most Efficient)
Sirohi (33)	Bhundi (21)	Udaipur (1)
Jalor (32)	Sikar (20)	Dungarpur (2)
Jodhpur (31)	Banswara (19)	Pratabgarh (3)
Baharatpur (30)	Jahalawar (18)	Dausa (4)
Barmer (29)	Chittaurga (17)	Rajsamand (5)
Karauli (28)	Baran (16)	Hanumangarh (6)
Sawai (27)	Nagaur (15)	Ganganagar (7)
Bikaner (26)	Churu (14)	Tonk (8)
Ajmer (25)		Kota (9)
Pali (24)		Jhunjhunun (10)
Bilwara (23)		Jaisalmer (11)
Alwar (22)		Jaipur (12)
		Dhulpur (13)
Number of Efficient Districts = 13		
Number of inefficient Districts = 20		
Average technical efficiency score = 0.9859		
Standard Deviation = 0.0218		

Source: Author's Calculation

The results in table 2 indicate that the average technical efficiency score is 0.9859 in 2014 ranging from 0.8949 for the inefficient district (Sirohi) to 1 for efficient districts (Udaipur). In 2014, 13 districts were listed as efficient districts while 20 districts were listed as inefficient districts. Districts with below the average level of technical efficiency score are Sirohi (33), Pali (24), Sawai (27), Karauli (28), Jodhpur (31), Jalor (32), Bikaner (26), Bharatpur (30), Barmer (29), Alwar (22), Ajmer (25), and Bilwara (23). These 12 districts appear in the category of most inefficient districts which need more attention compared to other districts.

Districts with above the average level of technical efficiency score are Sikar (20), Nagaur (15), Jahalawar (18), Churu (14), Chittaurgarh (17), Baran (16), Banswara (19) and Bundi (21). These eight districts have the potential to attain the status of efficient districts with a little Improvement in the resources utilization. The remaining 13 districts are listed as most efficient districts among all 33 districts of Rajasthan state. These are the districts which attained technical efficiency score equal to one. As all districts achieved efficiency score equal to one in category III, it makes ranking difficult. To address this issue, we have applied the super efficient method to compare technical efficiency score of all efficient district and rank them based on their super efficiency score. After applying super efficiency method, top three ranks were attained by Udaipur (1), Dungarpur (2), and Pratbagarh (3) while districts with low rank among the efficient districts were Dhulpur, Jaipur, and Jaisalmer respectively.

Table 3 presents the results for 2015/16 academic year along with the average technical efficiency score and standard deviation.

Table 3: Average Technical Efficiency Along with Standard Deviation and Number of Efficient & Inefficient Districts 2015/2016.

Category I (Below Average)	Category II (Above Average)	Category III (Most Efficient)
Jaislamer (33)	Chittaurga (13)	Jaipur (1)
Sirohi (32)	Nagaur (14)	Sikar (2)
Jalor (31)	Pali (15)	Dausa (3)
Barmer (30)	Ajmer (16)	Dungarpur (4)
Jodhpur (29)	Bhundi (17)	Ganganagar (5)
Sawai Madhopur (28)	Bhilawarah (18)	Churu (6)
Bharatpur (27)	pratbagar (18)	Tonk (7)
Udaipur (26)	Banwara (20)	Rajsamand (8)
	Baran (21)	Kota (9)
	Jhalawar (21)	Jhunjhunun (10)
	Alwar (21)	Hanumangarh (11)
	Bikaner (24)	Dhulpur (12)
	Karauli (25)	
Number of Efficient Districts = 12		
Number of Inefficient Districts = 21		
Average Technical Efficiency Score = 0.9828		
Standard Deviation = 0.0245		

Source: Author's Calculation

Table 3 shows that the average technical efficiency score is 0.9828 in 2015 which is low compared to the technical efficiency score of 2014. The table also shows that the number of efficient districts dropped to 12 districts in 2015 from 13 districts in 2014. Similarly, the number of inefficient districts rose to 21 districts in 2015 compared to 20 districts in 2014. Districts with below the average level of technical efficiency are Udaipur (26), Barmer (30), Bharatpur (27), Jodhpur (29), Sawai Madhopur (28), Sirohi (32), Jaisalmer (33), and Jalor (31). The number of districts which attained efficiency score below the average level of technical efficiency score come down to 8 districts compared to 12 districts in 2014. One district (Jaisalmer) was listed as the most efficient district in 2014, but it attained the status of most inefficient districts in 2015.

Districts with above the average level of technical efficiency are Ajmer (16), Banswara (20), Baran (21), Chittaurgarh (13), Jhalawar (21), Karauli (25), Nagaur (14), Pali (15), Pratabgarh (18), Alwar (21), Bhilwara (18), Bikaner (24), and Bundi (17). The number of Districts with an above average level of technical efficiency rose to 13 districts compared to 8 districts in 2014. Districts like

Ajmer, Alwar, Bhilwara, Bikaner, Karauli, and Pali were listed as the most inefficient in 2014, but with little improvement, they shifted to category II in 2015. The remaining 12 were listed as the most efficient districts in 2015. Super efficiency method was applied for ranking the most efficient districts; top three places were taken by new districts like Sikar (3), Dausa (2), and Jaipur (1) while the top three from the bottom were taken by Dhulpur, Hanumangarh, and Jhunjhunun districts. If we see the results of 2014 and 2015, there is clear evidence of a shift from one category to another. Some districts attained the status of most efficient districts while some districts lost the status of most efficient districts and were listed as most inefficient districts. The results also indicate that if any of the districts use resources optimally and make improvements in other related variables, it can shift from most inefficient status to most efficient status. Results for the year 2016/2017 are presented in table no.4. Variation in the technical efficiency of the districts is evident.

Table 4: Average Technical Efficiency Along with Standard Deviation and Number of Efficient & Inefficient Districts 2016/2017.

Category I(Below Average)	**Category II (Above Average)**	**Category III (Most Efficient)**	
Sawai Madhopur (25)	Jhalawar (24)	Jaipur (1)	Tonk (12)
Karauli (26)	Chittaurgarh (23)	Nagaur (2)	Dhulpur (13)
Banswara (27)	Udaipur (22)	Jodhpur (3)	Churu (14)
Bhilwara (28)	Sirohi (21)	Rajsamand (4)	Ganganagar (15)
Alwar (29)		Dausa (5)	Bundi (16)
Bharatpur (30)		Sikar (6)	AJMER (17)
Baran (31)		Bikaner (7)	Jaisalmer (18)
Barmer (32)		Hanumangarh (8)	Kota (19)
Jalor (33)		Pali (9)	Jhunjhunun (20)
		Dungarpur (10)	
		Pratabgarh (11)	
Number of Efficient Districts = 20			
Number of Inefficient Districts = 13			
Average Technical Efficiency Score = 0.9940			
Standard Deviation = 0.0110			

Source: Author's Calculation

The average technical efficiency score is 0.9940 which is the highest score in all three years. Average efficiency score ranges from 0.9485 for the inefficient district (Jalor) to 1 for efficient districts (Jaipur). The number of efficient districts rose to 20 districts from 12 districts in 2015. Only four districts namely Chittaurgarh (23), Jhalawar (24), Sirohi (21), and Udaipur (22) attained score above the average level of technical efficiency while nine districts are listed in the first category. Districts like Ajmer, Baran, Bikaner, Bundi, Karauli, Nagaur, Pali, Pratabgarh, Sirohi, Sawai, Jodhpur, and Jaisalmer were listed in Category I or category II in the previous year, but they attained the status of most efficient districts in 2016.

Trends in the status of districts during 2014-2015

: As we described the results for all the three years in the section above. Changes in the status of the districts were evident as some of the districts attained the statue of the most efficient districts, but some lost the efficient status. We have attempted to explain the changes in a better way and see the changes in the status of all the districts. Changes are presented in the table (5) below:

Table no.4 indicates variation in the technical efficiency score of the districts during 2014-2016. Some districts consistently performed well with attaining the status of most efficient districts over the period 2014-2016, But some of the districts were listed as the most efficient districts in the same period.

Tonk, Kota, Jhunjhunun, Jaisalmer, Jaipur, Hanumangarh, Ganganagar, Dhaulpur, and Dausa are the districts which consistently performed well over the period 2014-2016. These nine districts are the top districts among 33 districts of Rajasthan; these districts were listed as most efficient districts (category III) during 2014-2016.

Churu, Bundi, Jaisalmer, Nagaur, Pratapgarh, Sikar, and Udaipur are the districts which performed well after the top 9 most efficient districts. These districts were listed either in category II or category III over the period 2014-2016. Most of these districts were listed in category III in the years 2015 and 2016.

Table 5: Trends in the Status of Districts during 2014-2016

Districts	2014	2015	2016
Ajmer	Category I	Category II	Category III
Alwar	Category I	Category II	Category I
Banswara	Category II	Category II	Category I
Baran	Category II	Category II	Category III
Barmer	Category I	Category I	Category I
Bharatpur	Category I	Category I	Category I
Bhilwara	Category I	Category II	Category I
Bikaner	Category I	Category II	Category III
Bundi	Category II	Category II	Category III
Chittaurgarh	Category II	Category II	Category II
Churu	Category II	Category III	Category III
Dausa	Category III	Category III	Category III
Dhaulpur	Category III	Category III	Category III
Dungarpur	Category III	Category III	Category III
Ganganagar	Category III	Category III	Category III
Hanumangarh	Category III	Category III	Category III
Jaipur	Category III	Category III	Category III
Jaisalmer	Category III	Category I	Category III
Jalor	Category I	Category I	Category I
Jhalawar	Category II	Category II	Category II
Jhunjhunun	Category III	Category III	Category III
jodhpur	Category I	Category I	Category III
Karauli	Category I	Category III	Category I
Kota	Category III	Category III	Category III
Nagaur	Category II	Category II	Category III
Pali	Category I	Category II	Category III
Pratapgarh	Category III	Category II	Category III
Rajsamand	Category III	Category III	Category III
Sawai Madhopur	Category I	Category I	Category I
Sikar	Category II	Category III	Category III
Sirohi	Category I	Category II	Category II
Tonk	Category III	Category III	Category III
Udaipur	Category III	Category III	Category II

Source: Author's Calculation

The remaining two groups are the districts which need more attention compared to the above two groups of districts. These groups of districts did not perform well and can be taken as "target districts." Policy makers or the authority of the state have to pay more attention to the elementary schools of these groups of districts. The first group consists the districts which were not fully inefficient (they attained the status of most efficient or category II once) during 2014-2015 namely: Karauli, Ajmer, Bikaner, Jodhpur, Pali, Alwar, Banswara, Bhilwara, Jhalawar, and Sirohi. These ten districts attained the status of most efficient or were listed in category II at least once over the given period. Second group: the districts which had worse performance during the period 2014-2016. This group of districts is the "target districts" which need more attention compared to other groups of districts. Districts which did not perform well and were listed as the most inefficient districts over the period 2014-2016 are Barmer, Bharatpur, Jalor, and Sawai Madhopur.

Comparing Technical Efficiency Score with Literacy rate:

In this section, we attempted to check whether the literacy rate of the districts has effects on the technical efficiency of elementary schools or not. Table no.6 presents the literacy rate of different districts of Rajasthan for the year 2014.

Table 6: Literacy Rate and Technical Efficiency Score of the districts (2014)

Districts	Literacy rate (2014)	Technical efficiency score (2014)
AJMER	70.46	0.9834
Alwar	71.68	0.9856
Banswara	57.2	0.9884
Baran	67.38	0.9903
Barmer	57.49	0.9747
Bharatpur	71.16	0.9718
Bhilwara	62.71	0.9854
Bikaner	65.92	0.9816
Bundi	62.31	0.9861
chittaurgarh	62.51	0.9901
Churu	67.46	0.9975
Dhulpur	69.17	1
Dungarpur	70.14	1
Dausa	60.78	1
Ganganagar	70.25	1
Hanumangarh	68.37	1
Jaipur	76.44	1
Jaisalmer	58.04	1
Jalor	55.58	0.9294
Jhalawar	62.13	0.9898
Jhunjhunun	74.72	1
Jodhpur	67.09	0.966
Karauli	67.34	0.9758
Kota	77.48	1
Nagaur	64.08	0.9944
Pali	63.23	0.9852
Pratabgarh	56.3	1
Rajsamand	63.93	1
Sawai Madhopur	66.19	0.978
Sikar	72.98	0.9865
Sirohi	56.02	0.8949
Tonk	62.46	1
Udaipur	62.74	1
Average literacy rate = 65.50 %		
Average technical efficiency score = 0.9859		

Source: Calculation from DISE data (2014).

The table shows that the average literacy rate is 65.50 percent. Districts which are above the average level of literacy rate are Ajmer, Alwar, Baran, Bharatpur, Churu, and some other districts while districts with below the average level of literacy rate are: Sikar, Sirohi, Rajsamand, Pali, and some other districts. Data in table no.6 reveals that there is clear evidence of high literacy rate but low-efficiency score.

Similarly, some evidence of low literacy rate but higher technical efficiency score are also revealed in the table. Districts with above the average level of literacy rate but below the technical efficiency score are Bharatpur, Bikaner, Jodhpur, Sawai, and Karauli. These are the districts which have a higher literacy rate, but still, the efficiency score is below the average level which reveals that higher literacy rate does not imply higher technical efficiency scores.

On the other hand, some districts have a literacy rate below the average level but the technical efficiency score above the average level. These Districts are Banswara, Bundi, Chittaurgarh, Dungarpur, Dausa, Jaisalmer, Nagaur, Pratabgarh, Rajsmand, Tonk, and

Udaipur. It indicates that neither a higher rate of literacy nor the lower rate of literacy indicates higher or level technical inefficiency. We have clear evidence of high literacy rate but low technical efficiency score and vice versa. It reveals that efficiency of the elementary schools in a district is not dependent on literacy rate, but it is dependent on some other variables like the qualification of teachers, number of students per teacher, number of schools, etc.

Conclusion

The objective of this paper was to analyze the technical efficiency of elementary schools in all 33 districts of Rajasthan, India throughout 2014 - 2016. Also, comparison of literacy rate and technical efficiency scores of the districts was sought. It is relatively easy to measure the technical efficiency score using data envelopment analysis (DEA), but the interpretation and implications of technical efficiency score are hard and very significant. The score has to be interpreted carefully. Also, the implications of the score have to be precisely clarified. Our results have shown that some districts like Barmer, Bharatpur, Jalor, and Sawai Madhopur performed very poor during 2014-2016 but some other districts like Udaipur, Tonk, Kota, Jhunjhunun, Jaisalmer, Jaipur, Hanumangarh, Ganganagar, Dhaulpur, and Dausa maintained the status of most efficient districts during 2014-2016. Also, changes in the status of districts were evident as some most inefficient districts attained the status of most efficient districts in 2016. It raises the question as to why some districts remained inefficient. Policy-makers of the state and administration of the districts can relook at the allocation of resources to these inefficient districts. Also, available teaching, physical, and ancillary facilities influence the efficiency of elementary schools in districts. Most inefficient districts can be brought to the efficient list by revising the available facilities and resources of these districts. Results from literacy rate and technical efficiency scores have indicated that high literacy rate of the districts do not always imply that the districts are technically efficient. It reveals that not only literacy rate has bearings on technical efficiency of districts, but it is also impacted by other variables such as commitment and qualification of teachers, available facilities, infrastructural variables, environment-related variables, and parent's education.

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Appendixes

Table 7: Technical and Super Efficiency Score of the Districts Along with ranking (2014/2015)

No.	District	Technical Efficiency Score	Super Efficiency Score	Rank
1	AJMER	0.9834	0.983445996	25
2	Alwar	0.9856	0.985628743	22
3	Banswara	0.9884	0.988375533	19
4	Baran	0.9903	0.990270677	16
5	Barmer	0.9747	0.974750246	29
6	Bharatpur	0.9718	0.971789204	30
7	Bhilwara	0.9854	0.985444146	23
8	Bikaner	0.9816	0.981619248	26
9	Bundi	0.9861	0.98614967	21
10	Chittaurgarh	0.9901	0.990085378	17
11	Churu	0.9975	0.997521198	14
12	Dhulpur	1	1	8
13	Dungarpur	1	1.026875197	2
14	Dausa	1	1.012753976	4
15	Ganganagar	1	1.001719065	7
16	Hanumangarh	1	1.004100743	6
17	Jaipur	1	1	8
18	Jaisalmer	1	1	8
19	Jalor	0.9294	0.929363513	32
20	Jhalawar	0.9898	0.989854055	18
21	Jhunjhunun	1	1	8
22	Jodhpur	0.966	0.965990447	31
23	Karauli	0.9758	0.975772248	28
24	Kota	1	1	8
25	Nagaur	0.9944	0.994426751	15
26	Pali	0.9852	0.985179652	24
27	Pratabgarh	1	1.014470863	3
28	Rajsamand	1	1.006492768	5
29	Sawai Madhopur	0.978	0.978105354	27
30	Sikar	0.9865	0.986509825	20
31	Sirohi	0.8949	0.894896743	33
32	Tonk	1	1	8
33	Udaipur	1	1.403739163	1

Source: Author's Calculation, DEA Solver

Table 8: Technical and Super Efficiency Score of the Districts Along with ranking (2015/2016)

No.	District	Technical Efficiency Score	Super Efficiency Score	Rank
1	AJMER	0.9903	0.9903327	16
2	Alwar	0.9843	0.984260231	23
3	Banswara	0.9846	0.984582315	20
4	Baran	0.9843	0.984310502	21
5	Barmer	0.9501	0.950085904	30
6	Bharatpur	0.978	0.97800176	27
7	Bhilwara	0.9848	0.984820933	19
8	Bikaner	0.9833	0.983336358	24
9	Bundi	0.9857	0.985721935	17
10	Chittaurgarh	0.9961	0.996121216	13
11	Churu	1	1.000392777	6
12	Dhulpur	1	1	7
13	Dungarpur	1	1.008570554	4
14	Dausa	1	1.012184428	3
15	Ganganagar	1	1.003454004	5
16	Hanumangarh	1	1	7
17	Jaipur	1	3.042530255	1
18	Jaisalmer	0.8983	0.898305085	33
19	Jalor	0.9456	0.945580262	31
20	Jhalawar	0.9843	0.98429061	22
21	Jhunjhunun	1	1	7
22	Jodhpur	0.9592	0.959186318	29
23	Karauli	0.9832	0.983240018	25
24	Kota	1	1	7
25	Nagaur	0.9953	0.995356497	14
26	Pali	0.9907	0.99070699	15
27	Pratabgarh	0.9848	0.984840276	18
28	Rajsamand	1	1	7
29	Sawai Madhopur	0.9774	0.977390358	28
30	Sikar	1	1.309869972	2
31	Sirohi	0.9124	0.91243614	32
32	Tonk	1	1	7
33	Udaipur	0.9798	0.97977783	26

Source: Author's Calculation, DEA Solver

Table 9: Technical and Super Efficiency Score of the Districts Along with ranking (2016/2017)

No.	District	Technical Efficiency Score	Super Efficiency Score	Rank
1	AJMER	1	1	12
2	Alwar	0.9821	0.98206	29
3	Banswara	0.9864	0.986444	27
4	Baran	0.9807	0.98071	31
5	Barmer	0.9753	0.975278	32
6	Bharatpur	0.9816	0.981654	30
7	Bhilwara	0.9858	0.985773	28
8	Bikaner	1	1.01241	7
9	Bundi	1	1	12
10	Chittaurgarh	0.9958	0.99585	23
11	Churu	1	1	12
12	Dhulpur	1	1	12
13	Dungarpur	1	1.006478	10
14	Dausa	1	1.01871	5
15	Ganganagar	1	1	12
16	Hanumangarh	1	1.011429	8
17	Jaipur	1	3.264594	1
18	Jaisalmer	1	1	12
19	Jalor	0.9485	0.948483	33
20	Jhalawar	0.9944	0.994453	24
21	Jhunjhunun	1	1	12
22	Jodhpur	1	1.051838	3
23	Karauli	0.9872	0.987191	26
24	Kota	1	1	12
25	Nagaur	1	1.09911	2
26	Pali	1	1.009368	9
27	Pratabgarh	1	1.00407	11
28	Rajsamand	1	1.032782	4
29	Sawai Madhopur	0.9874	0.987391	25
30	Sikar	1	1.015269	6
31	Sirohi	0.9998	1	12
32	Tonk	1	1	12
33	Udaipur	0.9971	0.997116	22

Source: Author's Calculation, DEA Solver

[1] Census of India (2011)
[2] DISE (2014)
[3] Census of India (2011)
[4] DISE (2017)