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Impact of Information and Communication Technology on the Secondary Schools' Efficiency in Barisal Division of Bangladesh: Teachers' Preference and Perceptions

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Abstract: This study assess the efficiency and identify the factors causing responsible for school inefficiency of Barisal division in Bangladesh using stochastic frontier analysis. Multiple regression analysis was used to investigate the impact of teachers' preference and use of ICT on their knowledge and motivated factors in teaching and learning. The determinants of factors affecting to secondary school efficiency were investigated by Tobit regression analysis. Through the likelihood-ratio test, Translog model was found an appropriate than Cobb-Douglas model. The number of students, the number of class rooms and teaching ability of the teachers had a positive and significant contribution to improve the efficiency. The ICT lab, teacher's preference of ICT tools like multimedia projector used played a contributor role in increasing the school efficiency. The urban secondary schools performed better than the rural secondary schools. Barisal district was found comparatively better for urban secondary schools and Jhalokhati district was for rural secondary schools. Both medium and high level ICT teaching ability have positive and significant influence on the secondary school efficiency. Government should take necessary steps to improve the teaching and learning system in Barisal division by improving the teacher-student ratio, rural school and conventional teaching method in secondary school.

Keywords: Efficiency of secondary schools, ICT, Stochastic frontier analysis, Tobit regression analysis, Bangladesh

Introduction

Effective teaching and learning in education relies on the performance and teaching-learning methodological development of the teachers and students. Quality education, teaching, learning achievement and reduction of dropout in Bangladesh has not yet made breakthrough. Information Communication Technology (ICT) has the latent to transform the teachers' design work, the roles of students and teachers in the learning process and learning environment etc. Studying the issues and challenges incidental to to ICT use in teaching and learning can help teachers in overcoming the impediment of ICT integration in schools. The value of quality education at the secondary level is a vital implement for the facilitated economic development Bangladesh. In setting the students for the digital epoch, teachers are the primal participant in using ICT in the classrooms. Schools in the countries like Netherland, United Kingdom and Malta acknowledged the value of technical aid to assist teachers to usage ICT in the classroom (Yang & Wang, 2012). Lack of adequate ICT equipment and internet entree is the fundamental question that schools narrowly in rural areas are lining now. Former researches established that use of ICT in teaching will intensify the learning process and maximizes the students' quality in learning (Finger & Trinidad, 2002; Jorge et al., 2003; Young, 2003; Jamieson-Procter et al., 2013).

Teachers' preparedness and acquisition in using ICT are acting indispensable role in the use of ICT in education. According to Winzenried, Dalgarno and Tinkler (2010) teachers went through ICT course that is more effectual in teaching as opposing to those that have no knowledge in ICT. A school in Ireland reported that teachers who did not create adequate assurance using ICT. Related case occurred in Canada, a few teachers admitted they were loath ICT users because they disquieted they might acquire abashed that the students knew more about the ICT than they did (Hennessy et al., 2005).

According to Warwick and Kershner (2008) the importance and benefits of ICT should be best-known by teachers to deal a substantive pedagogy through ICT. ICT assists students to create new intelligent acquisitions which may transfer to various situations which may necessitate investigation and understanding accomplishment, and accordingly captious acquisition improvement (Al Hudhaifi & Al Dughaim, 2005), exploration and identification of the barriers that affected the implementation of ICT in the Bangladesh education system (Khan et al., 2012; Mou, 2016). This is a need for this study to look into the role of ICT in advancing a synergistic learning state of affairs. In a Bangladesh circumstance there has been a fast alteration in the function of the teacher in new years. There is another new modification and situation that teachers face, and are needed to accommodate to. However, there is a little research which focuses on the role of ICT in creating and boosting an synergistic educational situation, as the part of teaching and learning.

The efficiency of schools studies have been conducted by many researchers. A good school plan of action can result the cognitive acquisition of students, can change productiveness, social quality and the legal status rights in the society. Hence the increasing involvement in measuring the efficiency of acquisition of the students, of the acquisition acquired and of the knowledge of ICT use in everyday life (Hanushek & Woessmann, 2010). The study by Sengupta and Sfeir (1986) made an beginning point for the survey of frontier efficiency measuring method in education. Sengupta (1987) ended that the frontier method seemed to be more better than non-frontier method, particularly in case of inputs variation. Chakraborty (2009) calculated the efficiency of public school education using a stochastic frontier analysis (SFA) and an inefficiency effect function that controls the socio-economic and environmental factors. Again, Scippacerola and D'ambra (2014) utilized a SFA in Campania to measure the school relative efficiency and a Tobit regression model was utilized to evaluate the factors affecting efficiency.

Due to lack of study on secondary school educational efficiency by ICT integration in Bangladesh, it is supposed to develop a suitable stochastic frontier secondary schools efficiency model by ICT intervention and to find the responsible factors for secondary school inefficiency in Barisal division that could be the essential facts for the educationist of Bangladesh. This type of unresolved problem in ICT integration in secondary schools may fill up the current gap between teachers and students. So, it is essential to analyze the impact of ICT and measure how teachers comprehend ICT innovation and its effectiveness in teaching-learning process.

Method

Study Areas

The quantitative data were collected from both urban and rural secondary schools selected from six districts namely Barisal, Bhola, Patuakhali, Pirojpur, Barguna and Jhalokati under Barisal division in Bangladesh through structured questionnaire on the use of ICT and preference, teachers' qualification, teachers' knowledge of ICT, experience regarding the ICT application etc.

The study sites of this study are as follows: Barishal is a administrative division which is the south-central part of Bangladesh, it has an area of 13,644.85 km^2 (5,268.31 sq mi), located in between 21°48' and 22°29' north latitudes and in between 89°52' and 90°22' east longitudes. In particular, it is delimited by Gopalganj, Madaripur, and Shariatpur districts on the north, Bay of Bengal on the south, Lakshampur and Noakhali districts on the east, Bagerhat district on the west, and a population of 8,325,666 at the 2011 Census. It lies in the Padma river delta on an offshoot of the Arial khan river. Barisal division is criss-crossed by many rivers that attained it the nickname *Dhan-Nodi-Khal, Ei tin-e Borishal* (rice, river and canal built Barishal). This study covered the six districts under Barishal division presented in Figure 1.

Sampling Design for Quantitative Component

Six districts namely Barisal, Bhola, Patuakhali, Pirojpur, Barguna and Jhalokati were selected under Barisal division in Bangladesh. Both urban and rural secondary schools were selected from the selected districts of Barisal division. The questionnaire in size of 240 were distributed to different stakeholders like non-trained teachers, trained teachers, head teachers and students over the 12 secondary schools. The secondary schools were selected based on both urban and rural context, and the questionnaires apportioned are not equal in numbers where teachers from urban secondary schools predominate the total population as compared to teachers from rural secondary schools.

Figure 1. Description of the study areas (Barisal, Bhola, Patuakhali, Pirojpur, Barguna and Jhalokati districts) in Barisal division.

Table 1.Variable names and the description of the variables

Variables	Symbol / Variable description
Dependent variable	
Percentage of the students passed in SSC	Y
Input variables	
Number of teachers	X_1
Number of students	X_2
Number of class rooms	X_3
Teaching ability of the teachers	X_4
Explanatory variables	
Teacher-student ratio	ϕ_1
Teaching experience	Teaching experience defined into different categories: 0-2 years (Ref.), 2-5 years (Φ_2), 5-10 years (Φ_3), and 10 years above (Φ_4)
School type	Secondary schools are three types: Government (Ref.), Non-government (Φ_5), and MPO (Φ_6)
School location	Location of the school are semi-urban (Ref.) and rural (Φ_7)
Preference of teaching methods	Teaching methods are modern (Ref.) and conventional (Φ_8)
ICT teaching ability	Teaching ability in ICT are three types: Low (Ref.), medium (Φ_9), and high (Φ_{10})
ICT variables	
ICT lab of the secondary schools	Z_1
Online class of the secondary schools	Z_2
Multimedia project used always in the secondary schools	Z_3
Multimedia project used often in the secondary schools	Z_4
Multimedia project used sometimes in the secondary schools	Z_5
Multimedia project used rarely in the secondary schools	Z_6
Multimedia project used never in the secondary schools	Z_7

Data Sources and Variable Description

The data on non-trained teachers, trained teachers, head teachers and students were obtained from the secondary schools of Barisal division in Bangladesh through the structured questionnaire in the year of 2021. This data collection is carried out on teachers and students of secondary schools in the selected study area. The data collection has been done reference point to fitting the objectives using a questionnaire. The questionnaire admit segments on (i) background characteristics of the teachers and students of secondary schools (ii) Teacher's preference of ICT use in teaching and learning (iii) Effectiveness of ICT integration for student's learning (iv) Challenges for Teacher in using ICT in teaching and learning. The associated both teacher's and student's data set are described in Table 1.

Empirical Cobb-Douglas Stochastic Frontier Secondary School Model

The empirical specification of Cobb-Douglas stochastic frontier secondary school model for Barisal division can be expressed as follows:

$$lnY_i = \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + V_i - U_i \qquad (1)$$

where, ln = Natural logarithm; Y_i = the percentage of the students passed in SSC in i-th secondary school; X_{1i}= the number of teachers in i-th secondary school; X_{2i}= the number of students in i-th secondary school; X_{3i} = the number of class rooms in i-th secondary school; X_{4i} = teaching ability of the teachers in i-th secondary school; β_i =The unknown parameters (i=1,2,3,4) to be estimated. The systematic error component V_i, which is assumed to be independently and identically distributed as $V_i \sim NID(0, \sigma_v^2)$ independent of U_i which measure the technical efficiency relative to the stochastic frontier.

Empirical Translog Stochastic Frontier Secondary School Model

The specification of Translog stochastic frontier secondary school model for Barisal division is given by

$$\begin{aligned}\ln(Y_i) &= \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) \\ &+ \frac{1}{2}[\beta_{11} \ln(X_{1i}^{\,2}) + \beta_{22} \ln(X_{2i}^{\,2}) + \beta_{33} \ln(X_{3i}^{\,2}) + \beta_{44} \ln(X_{4i}^{\,2})] \\ &+ \beta_{12} \ln(X_{1i}) * \ln(X_{2i}) + \beta_{13} \ln(X_{1i}) * \ln(X_{3i}) + \beta_{14} \ln(X_{1i}) * \ln(X_{4i}) \\ &+ \beta_{23} \ln(X_{2i}) * \ln(X_{3i}) + \beta_{24} \ln(X_{2i}) * \ln(X_{4i}) + \beta_{34} \ln(X_{3i}) * \ln(X_{4i}) + V_i - U_i \qquad (2)\end{aligned}$$

where Y_i = the percentage of the students passed in SSC; X_1= the number of teachers; X_2= the number of students; X_3 = the number of class rooms; X_4 = teaching ability of the teachers; β_i (i = 1,2,3,4), β_{ij} $(i < j)$ =the unknown parameters to be estimated.

Empirical Technical Inefficiency Effect Model

The specification of the technical inefficiency effects model U_i for Barisal division is defined as

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} + W_i \qquad (3)$$

where U_i's are the technical inefficiency effect for the i-th secondary schools, assumed non-negative random variables and independently distributed, U_i, were estimated by truncation of normal distribution with mean zero and variance, σ_i^2 such that Z_{1i} = the ICT lab in the i-th secondary school; Z_{2i} = the online class in the i-th secondary school; Z_{3i}= the multimedia project used always i-th secondary school; Z_{4i}= the multimedia project used often i-th secondary school; Z_{5i}= the multimedia project used sometimes i-th secondary school; Z_{6i}= the

multimedia project used rarely i-th secondary school; Z_{7i}= the multimedia project used never i-th secondary school, $\delta_0, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5, \delta_6, and\ \delta_7$ are parameters to be estimated. W_i are the disturbance terms, assumed independently distributed, estimated by truncation of normal distribution with mean zero and variance, σ_i^2. The variances are stated in terms of $\sigma^2 = \sigma_v^2 + \sigma_u^2$, $\gamma = \frac{\sigma_u^2}{\sigma^2}$, γ is the ratio of variance of education output efficiency to the total variance of output and bounded by zero and one. All parameters of the inefficiency effects model were calculated by using the Maximum Likelihood (ML) method.

Likelihood Ratio Test for an Appropriate Model for Barisal Division

The likelihood ratio test helps us to determine whether Cobb-Douglas or Translog production function is better or not. It is measured as follows:

$$\lambda = -2\{\ln[L(H_0)/L(H_1)]\} = -2\{\ln[L(H_0)] - \ln[L(H_1)]\}. \quad (4)$$

where $L(H_0)$and $L(H_1)$ are the values of the likelihood function under the null and alternative hypothesis (note that this statistic has a mixed chi-square distribution). The null hypothesis is rejected when $\lambda_{LR} > \chi_c^2$.

Empirical Tobit Regression Model

The specification of the Tobit regression model for Barisal division is defined as

$$E_i = \phi_0 + \phi_1 TSR_i + \phi_2 TE(2-5)_i + \phi_3 TE(5-10)_i + \phi_4 TE(10+)_i + \phi_5 STNG_i + \phi_6 STMPO_i + \phi_7 SLR_i + \phi_8 PTMC_i + \phi_9 ICTTAM_i + \phi_{10} ICTTAH_i + \xi_i. \quad (5)$$

where E_i is defined the efficiencies based on Stochastic frontier Cobb-douglas, Translog with Battese and Coelli (1992,1995) in the i-th secondary schools; TSR_i is the teacher-student ratio of the i-th secondary school; TE_i is the teaching experience (0-2 years, 2-5 years, 5-10 years, and 10 years above) of the i-th secondary school; ST_i is the school type (government, non-government, MPO) of the i-th secondary school; SL_i is the school location (semi-urban, rural) of the i-th secondary school; PTM_i is the preference of teaching methods (modern, conventional) of the i-th secondary school; ICT-TA_i is the ICT teaching ability (low, medium, high) of the i-th secondary school. ξ_i is the error term.

Results and Discussion

Results of the Secondary Schools for Barisal Division in Bangladesh

Results on Frequency Distribution of the Secondary Schools in Barisal Division

The frequency distribution of the secondary schools of Barisal division is represented by the Table 2 and it is observed from the data set that teaching experience of the teachers those who have more than 1 to 5 years is found highest, the second highest is 6 to 10 years (30.51%), the teaching experiences for those who have less than 1 year and above 10 years are recorded almost similar in Barisal division. According to sample data set, the number of MPO type schools are found highest (71.23%), second highest is Non-government type schools (21.92%) and government type schools are found lowest (6.65%). The data set covered both urban and rural school where the 64.38% of urban schools and 35.62% of rural schools. From the sample data set it is found that 79.45% of teachers who have preference of teaching style is ‘modern’ and the 20.55% teachers still prefer conventional method for their teaching to the students in the class.
The highest number of teachers those who have education level is found ‘HSC’ (45.21%) and second highest is noticed ‘Graduation’ (27.40%) while the ‘SSC’ is 16.44% and the ‘Post-graduation’ is found lowest (10.96%).

The teaching ability of the teachers in ICT is recorded 'high' (72.60%), 'medium' (12.33%), and 'low' (15.07%) respectively. The secondary school having ICT lab in is satisfactory (91.78%) and 8.22% of the secondary school don't have ICT lab in Barisal division.

Table 2. Frequency distribution of the secondary schools in Barisal division

Variables		Frequency	Percentage
Teaching Experience	<1 Year	6	8.22
	1-5 Years	33	45.21
	6-10 Years	23	31.51
	>10 Years	8	10.96
School Type	Government	5	6.85
	Non-government	16	21.92
	MPO	52	71.23
School location	Urban	47	64.38
	Rural	26	35.62
Preference of teaching style	Modern	58	79.45
	Conventional	15	20.55
Education	SSC	12	16.44
	HSC	33	45.21
	Graduation	20	27.40
	Post-graduation	8	10.96
ICT in teaching ability	Low	11	15.07
	Medium	9	12.33
	High	53	72.60
ICT lab	Yes	67	91.78
	No	6	8.22

Table 3. Maximum Likelihood Estimates (MLE) of Cobb Douglas frontier secondary school model with Battese & Coelli (1992) for Barisal Division

Variables	Parameters	Estimate	Std. Error	Z value	Pr(>|z|)
Intercept	β_0	4.152688	0.212962	19.4997	<2.20E-16***
X_1	β_1	0.374649	0.088486	4.234	2.30E-05***
X_2	β_2	-0.06649	0.045357	-1.4659	0.14267
X_3	β_3	-0.07369	0.048143	-1.5307	0.12585
X_4	β_4	0.080255	0.032969	2.4342	0.01492
		Variance Parameters			
sigmaSq	σ^2	0.040178	0.008798	4.567	4.95E-06***
gamma	γ	0.957263	0.038677	24.7499	<2.20E-16***

*, **, *** Significance level at 1, 5, and 10%, respectively, @ indicates insignificant.

Results of Secondary School Efficiency with Cobb-Douglas Model based on Battese & Coelli (1992) for Barisal Division

The estimated parameters of secondary school efficiency model were presented in the Table 3. In this model, a positive coefficient shows the advance of efficiency and vice-versa. The variables like the number of teachers and teaching ability have straight causation to gain the efficiency where the number of teachers played a role to improve the secondary school efficiency significantly. Both the number of students and the number of class rooms have influence to decrease the level of efficiency.

The negative coefficient of the number of students and the number of class rooms were indicated that these might be the cause of decreasing secondary school efficiency. The value of γ was positive and significant indicating that 95.72 percent of random variation around in secondary school outcome due to inefficiency. The estimated value of σ was found different from zero and significant, indicated a good fit.

Results of Cobb-Douglas Secondary School Inefficiency Effects Model with Battese & Coelli (1995) for Barisal Division

The estimated parameters of secondary school inefficiency effects model based on Battese & Coelli (1995) were reported in Table 4. The number of teachers and teaching ability have straightforward determinant to change the efficiency while both the number of students and the number of class rooms are the cause of decreasing secondary school efficiency. In inefficiency effects model, a positive coefficient points the decrement of efficiency and vice-versa. Both the coefficient of ICT lab and online class had no direct influence to improve secondary school efficiency. Both ICT lab and online class in secondary school were found increasing the level of inefficiency. The coefficients of ICT tools that is multimedia projector used always, often, sometimes, rarely, and never in teaching and learning were found negative which indicated that multimedia projector use play positive role in decreasing the school inefficiency. The estimated value of σ was found other than zero, point a fit. The value of γ (1.00) was positive and significant, interpreted that 100% random fluctuation in secondary school outcomes due to inefficiency.

Table 4. MLE of Cobb Douglas frontier secondary school inefficiency effects model with Battese & Coelli (1995) for Barisal division

Variables	Parameters	Estimate	Std. Error	Z value	Pr(>|z|)
Intercept	β_0	4.39E+00	1.48E-01	29.6459	<2.20E-16***
X_1	β_1	3.80E-01	6.89E-02	5.5172	3.44E-08
X_2	β_2	-1.09E-01	3.06E-02	-3.5459	0.000391
X_3	β_3	-8.14E-02	3.77E-02	-2.1604	0.030738
X_4	β_4	6.15E-02	2.65E-02	2.3199	0.020345
		Estimation of Inefficiency Effects Model			
Z_1	δ_1	4.50E+01	1.07E+02	0.423	0.672317
Z_2	δ_2	2.21E+01	5.10E+01	0.4328	0.665159
Z_3	δ_3	-7.48E+02	1.78E+03	-0.4203	0.674247
Z_4	δ_4	-2.54E+02	5.96E+02	-0.4261	0.670057
Z_5	δ_5	-2.06E+02	4.88E+02	-0.4223	0.672809
Z_6	δ_6	-4.94E+02	1.18E+03	-0.4194	0.674941
Z_7	δ_7	-1.95E+02	4.59E+02	-0.4253	0.670635
		Variance Parameters			
sigmaSq	σ^2	1.19E+01	2.81E+01	0.4247	0.67104
gamma	γ	1.00E+00	8.30E-04	1203.82	<2.20E-16***

*, **, *** Significance level at 1, 5, and 10%, respectively, @ indicates insignificant.

Table 5. MLE of translog stochastic frontier secondary school model based on Battese & Coelli (1992) for Barisal division

Variables	Parameters	Estimate	Std. Error	Z value	Pr(>|z|)
Intercept	β_0	-0.06377	0.96663	-0.066	0.947405
X_1	β_1	-3.0000	0.945688	-3.1723	0.001512**
X_2	β_2	1.139749	0.565578	2.0152	0.043884*
X_3	β_3	3.383784	0.937686	3.6087	0.000308***
X_4	β_4	0.913261	0.982752	0.9293	0.352739
X_1^2	β_1^2	-0.03711	0.928759	-0.04	0.968126
X_2^2	β_2^2	-0.10959	0.179147	-0.6117	0.540735
X_3^2	β_3^2	0.468403	0.845511	0.554	0.579587
X_4^2	β_4^2	0.517098	0.911567	0.5673	0.570535
$X_1 X_2$	$\beta_1\beta_2$	0.498826	0.35566	1.4025	0.160755
$X_1 X_3$	$\beta_1\beta_3$	0.055493	0.670956	0.0827	0.934084
$X_1 X_4$	$\beta_1\beta_4$	0.155277	0.947201	0.1639	0.869784
$X_2 X_3$	$\beta_2\beta_3$	-0.69512	0.309235	-2.2479	0.024585*
$X_2 X_4$	$\beta_2\beta_4$	-0.1178	0.467457	-0.252	0.801034
$X_3 X_4$	$\beta_3\beta_4$	-0.27961	0.941009	-0.2971	0.766365
		Variance Parameters			
sigmaSq	σ^2	0.029747	0.072586	0.4098	0.681943
gamma	γ	0.979259	0.961305	1.0187	0.308357

*, **, *** Significance level at 1, 5, and 10%, respectively, @ indicates insignificant.

Results of Secondary School Efficiency with Translog Model based on Battese & Coelli (1992) for Barisal Division

MLE of the parameters was reported in the context of secondary school efficiency in Barisal division of Bangladesh followed by Translog stochastic frontier model presented in Table 5. The coefficients of students, class rooms and teaching ability of the teachers in secondary school have had a positive and significant contribution to improve the school efficiency. Again, the coefficient of the number of teachers was observed negative and significant. Both the square effects of the number of class rooms and teaching ability have had positive effect in increasing secondary school efficiency while both the square effects of the number teachers and the number of students have had negative effect in decreasing secondary school efficiency of Barisal division in Bangladesh. The interaction effects of the number of teachers along with the number of students, number of class rooms and teaching ability were found positive in improving the school efficiency. The interaction effects of the number of students along with the number of class rooms and teaching ability of the teachers played role to decrease the school efficiency. These two interaction effects have reversely effect on secondary school efficiency of Barisal division in Bangladesh. The estimated value of σ was different from zero, indicate a good fit. The value of γ was positive and it showed that 97.9 percent of random variation around in secondary school outcomes due to inefficiency.

Table 6. MLE of translog stochastic frontier secondary school inefficiency effects model based on Battese & Coelli (1995) for Barisal division

Variables	Parameters	Estimate	Std. Error	Z value	Pr(>|z|)
Intercept	β_0	-0.24606	0.941141	-0.2615	0.793744
X_1	β_1	-3.37322	0.743082	-4.5395	5.64E-06***
X_2	β_2	1.220791	0.400539	3.0479	0.002305**
X_3	β_3	3.860197	0.824975	4.6792	2.88E-06***
X_4	β_4	0.501341	0.646967	0.7749	0.438393
X_1^2	β_1^2	-0.05703	0.823535	-0.0692	0.944793
X_2^2	β_2^2	-0.10718	0.101187	-1.0592	0.289517
X_3^2	β_3^2	-0.2258	0.36076	-0.6259	0.531382
X_4^2	β_4^2	0.002993	0.282557	0.0106	0.991549
$X_1 X_2$	$\beta_1\beta_2$	0.434356	0.161262	2.6935	0.007071**
$X_1 X_3$	$\beta_1\beta_3$	0.559359	0.420545	1.3301	0.183492
$X_1 X_4$	$\beta_1\beta_4$	-0.4973	0.299074	-1.6628	0.09635.
$X_2 X_3$	$\beta_2\beta_3$	-0.72682	0.138808	-5.2362	1.64E-07***
$X_2 X_4$	$\beta_2\beta_4$	0.058787	0.203106	0.2894	0.772245
$X_3 X_4$	$\beta_3\beta_4$	0.162539	0.335548	0.4844	0.628104
Estimation of Inefficiency Effects Model					
Z_1	δ_1	-0.0896	0.12539	-0.7146	0.474862
Z_2	δ_2	0.276774	0.177718	1.5574	0.11938
Z_3	δ_3	-0.34244	0.552236	-0.6201	0.5352
Z_4	δ_4	-0.14233	0.360711	-0.3946	0.693146
Z_5	δ_5	-0.13125	0.406127	-0.3232	0.746556
Z_6	δ_6	-0.38576	0.378693	-1.0187	0.308368
Z_7	δ_7	-0.21849	0.477283	-0.4578	0.647108
Variance Parameters					
sigmaSq	σ^2	0.019072	0.01131	1.6862	0.091754
gamma	γ	0.997001	0.03559	28.0133	<2.20E-16***

*, **, *** Significance level at 1, 5, and 10%, respectively, @ indicates insignificant.

Results of Secondary School with Translog Inefficiency Effects Model based on Battese & Coelli (1995)

MLE of the parameters was reported in the context of Translog stochastic frontier secondary school efficiency model with Battese & Coelli (1995) for Barisal division in Bangladesh presented in Table 6. The coefficient of the number of students, class rooms and teaching ability were found to be positive values where the number of students and class rooms were recorded significant. It implies that these have had direct impact to improve efficiency of secondary school. The square effects of the number of teachers, the number of students, class rooms have had reversely effect on secondary school efficiency of Barisal division in Bangladesh. The coefficient of squared effect of teaching ability of the teachers has positive effect in the secondary school efficiency. The interaction effects of the number of teachers and the number of students was recorded positively significant. The interaction effects of the number of teachers and class rooms, the number of students and

teaching ability of the teachers, and class rooms and teaching ability of the teachers have had positively impact to increase the secondary school efficiency. The interaction effects of the number of teachers and teaching ability of the teachers, and the number of students and the number of class rooms have had reversely effect on secondary school efficiency of Barisal division in Bangladesh. The coefficients of all explanatory variables except online class variable were recorded negative, indicated that the ICT lab, teacher's preference ICT tools for example multimedia projector used variables have direct influence to decrease secondary school inefficiency. The explanatory variables those were found negative hence decreasing the level of inefficiency. The online class in school was found increasing the level of inefficiency. The technical efficiency level tended increasing due to the cause of effect on multimedia projector used in teaching and learning in secondary school. The value of γ was positive and significant, interpreted that 99.7 percent of random variation exists in secondary school through inefficiency. The estimate of sigma was found significant and positive, indicated that the estimated factors are perfectly fitted to this model.

Results on the Choice of Appropriate Model for Barisal Division with Battese & Coelli (1992, 1995)

The results of likelihood ratio test for an appropriate model for Barisal division with Battese & Coelli (1992, 1995) is represented in Table 7. The likelihood values of Translog and Cobb-Douglas models with Battese & Coelli (1992) were found 65.604 and 53.813 respectively. The chi-square value was recorded 23.582 and significant. Based on the likelihood values that Translog model is an appropriate than Cobb-Douglas model. Again, the likelihood values of Translog and Cobb-Douglas models were found 80.648 and 63.924 respectively. The chi-square value was recorded 33.45 and significant. So it can be concluded that Translog model is an appropriate than Cobb-Douglas model in case of Battese & Coelli (1995).

Table 7. Results of likelihood ratio test for an appropriate model for Battese & Coelli (1992, 1995)

Model	Log Likelihood Value	Degrees of freedom	Chisq	Pr(>Chisq)
Trans_Barisal_92	65.604	17		
CD_Barisal_92	53.813	7	23.582	0.00879**
Trans_Barisal_95	80.648	24		
CD_Barisal_95	63.924	14	33.45	0.000229***

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

District-Wise Efficiency Results of Secondary Schools (Urban & Rural) in Barisal Division

From the results, it was presented in Table 8 that both Cobb-Douglas and Translog stochastic frontier models (Battese & Coelli, 1995) performed better compare to (Battese & Coelli, 1992) models in determining the district-wise average efficiency of both urban and rural secondary schools in Barisal division. Again, Translog frontier model (Battese & Coelli, 1995) performed better than Cobb-Douglas frontier model (Battese & Coelli, 1992) in measuring the average efficiency of urban secondary schools. Again, Cobb-Douglas frontier model (Battese & Coelli, 1995) performed better than Cobb-Douglas frontier model (Battese & Coelli, 1992) in determining the average efficiency of rural secondary schools in Barisal division.

Table 8. District-wise average efficiency score of secondary schools (Urban & Rural) in Barisal division

District	Urban				Rural			
	TL 92	TL 95	CD 92	CD 95	TL 92	TL 95	CD 92	CD 95
Barisal	0.92246	0.96612	0.90188	0.95611	0.84205	0.85087	0.85529	0.89739
Bhola	0.92245	0.92463	0.93282	0.96648	0.88854	0.90805	0.85807	0.90569
Patuakhali	0.82694	0.93716	0.88998	0.96424	0.84990	0.86368	0.84384	0.90132
Pirojpur	0.92201	0.93173	0.89914	0.94846	0.81180	0.80506	0.75050	0.76773
Barguna	0.86461	0.86771	0.85663	0.91503	0.86952	0.89374	0.86016	0.91144
Jhalokati	0.80201	0.89834	0.87175	0.97924	0.92298	0.91792	0.93090	0.95431
Overall Mean	0.87675	0.92094	0.89203	0.95492	0.86413	0.87322	0.84979	0.88964

The overall urban mean efficiency was observed 92.09% while it was recorded 87.32% for rural secondary schools in case of Translog (1995) model. Again, for Cobb-Douglas (1995) model, the overall mean efficiency of urban secondary schools was found 95.49% while it was observed 88.96% for rural secondary schools. These showed that the urban secondary schools performed better than the rural secondary schools in Barisal division. On an average the urban secondary schools of Bhola district are comparatively better than other districts when Cobb-Douglas stochastic frontier (1995) model were used and on an average the urban secondary schools of

Barisal district are found comparatively better than other districts when Translog stochastic frontier (1995) model were used. Again, on an average the rural secondary schools of Jhalokhati district are comparatively better than other districts in case of both Cobb-Douglas and Translog stochastic frontier models (1995).

Results of Tobit Regression Model with Secondary School Efficiency for Barisal Division

Table 9 represents the results of the factors affecting to secondary school efficiency derived from both stochastic Cobb-Douglas and Translog frontier models for Barisal division. As regards the explanatory variables, by Tobit regression with inefficiency, in case of Translog model with (Battese & Coelli,1992, 1995) the teacher student ratio was found negative and significant, implying that the teacher-student ratio had a negative impact on the secondary school efficiency. In case of Translog model with (Battese & Coelli,1992, 1995) the teaching experiences those who have 6 to 10 years was observed negative and highly significant implying that has negative influence on the secondary school efficiency. Non-government school type, and school location (rural) were notice negative but significant and these had a negative influence on the secondary school efficiency. Again, both medium and high level ICT teaching ability were recorded positive and significant for both Cobb-Douglas and Translog models indicating that this had a positive influence to increase the secondary school efficiency.

Table 9. Determinants of factors affecting to secondary school efficiency of Barisal division

Variables		Parameters	Tobit Regression Model			
			TL_1992	TL_1995	CD_1992	CD_1995
Intercept		ϕ_0	0.966***	0.908***	0.845***	0.857***
Teacher Student Ratio		ϕ_1	-0.003**	-0.0009	0.001	0.0004
Teaching	< 1 Years					
Experience	1-5 Years	ϕ_2	-0.006	-0.058	-0.061*	0.002
	6-10 Years	ϕ_3	-0.062	-0.118***	-0.095***	-0.101***
	> 10 Years	ϕ_4	-0.006	0.016	0.040	0.025
School Type	Government					
	Non-government	ϕ_5	-0.008	-0.071***	-0.077***	-0.037
	MPO	ϕ_6	0.049*	0.008	-0.013	0.021
School Location	Urban					
	Rural	ϕ_7	-0.065***	-0.019	-0.011	-0.047**
Preference of	Modern					
Teaching Methods	Conventional	ϕ_8	-0.032	-0.014	0.002	-0.018
ICT Teaching	Low					
Ability	Medium	ϕ_9	0.062***	0.069***	0.047**	0.085***
	High	ϕ_{10}	0.134***	0.152***	0.115***	0.186***
Log likelihood	58.994					
Sigma	0.038					

*, ** . *** means significant at 10%, 5% and 1% level

Conclusion

This study developed an appropriate model to estimate the secondary school efficiency and in this context Translog stochastic frontier model was found an appropriate than Cobb-Douglas model for Barisal division in Bangladesh. The Stochastic frontier models were applied to estimate secondary school efficiency of Barisal division and Tobit regression was utilized to look into the grounds of secondary school efficiency. The study is contrary from the earlier as it adopted a two-stage (Tobit) regression to analyze the effects of the secondary school efficiency of Barisal division in Bangladesh.

In measuring the average efficiency of urban secondary schools for Barisal division, Translog model (Battese & Coelli, 1995) performed better than Cobb-Douglas (Battese & Coelli, 1992). While Cobb-Douglas model (Battese & Coelli, 1995) performed better than Cobb-Douglas model (Battese & Coelli, 1992) in case of rural secondary school's efficiency. The number of students, the number of class rooms, the teaching ability of the teachers were found positive and significant which indicated that these have straight determinant to gain the secondary school efficiency. The interaction effects of the number of teachers with the number of students, number of class rooms and teaching ability were found positive which implied that these have positive impacts to increase the secondary school efficiency of Barisal division.

The explanatory variables such as ICT lab, and teacher's preference ICT tools like multimedia projector were found positive indicated that these played significantly contributor role in increasing the secondary school efficiency. The urban secondary schools performed better than the rural secondary schools. In specific, on an average the rural secondary schools of Jhalokhati district was found comparatively better than other districts of Barisal division. In case of Tobit regression, both medium and high ICT teaching ability of the teachers were recorded positive and significant which implied that these variables had a positive influence towards the secondary school efficiency of Barisal division in Bangladesh.

Scientific Ethics Declaration

The authors declare that they are responsible for the scientific, ethical, and legal aspects of the paper published in EPSTEM.

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