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*Original Research*

# Technical Efficiency of Community Clinics in Kushtia, Bangladesh: A Nonparametric DEA Analysis

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## Abstract

The healthcare industry is well aware of the issue of limited resources. By properly managing available resources, waste may be minimized. Bangladesh is a developing nation with limited resources, hence it is essential to estimate technical efficiency in this circumstance. Health care efficiency in the developed world has long been examined using Data Envelopment Analysis (DEA). However, few studies have used DEA to evaluate the effectiveness of healthcare delivery in emerging economies, especially in Bangladesh. A total of 24 community clinics in Kushtia were chosen at random for this study, and their technical efficiency was determined using the DEA method. The goal was to assess health centers' levels of efficiency and provide recommendations for improving less effective centers' performance. Input-based Data Envelopment Analysis was utilized to evaluate technical efficiency. The first category comprised of twelve prominent public hospitals. In this study, the number of outpatient visits was both an input and an outcome variable, whereas physicians, nurses, drugs, and other medical supplies were input variables. The Malmquist index was also utilized to assess efficiency gains and losses over time in community clinics. The eleven surviving community health clinics ended just inside the border. Based on their average efficiency rating, the facilities could accomplish the same goals while consuming 42% less inputs. On average, each CC created garbage worth TK. 0.14 crore. Across the board, production grew during the study periods. Overall, the findings suggest that public health centres are extremely inefficient in their delivery of health care and that substantial savings may be achieved by implementing steps to reduce waste.

**Keywords:** Technical efficiency, Data Envelopment Analysis, Community clinic, Malmquist productivity index (MPI).

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## Introduction

Bangladesh's population density per square kilometer is high (Ministry of Planning, 2022). Consequently, it is challenging to guarantee that all citizens have access to professional medical care. The Health Bulletin 2020 depicts a health-care system that offers primary care to rural inhabitants living below the Upazila (sub-district) level, as well as secondary and tertiary treatment in districts and big cities. Urban populations also have access to primary care (DGHS, 2019). There are three primary types of health care facilities: community clinics, union health and family welfare centers, and upazila health complexes (UHCs). Community clinics are the most frequent form. Community clinics, or CCs, serve as the first point of contact for patients in Bangladesh's primary healthcare system. Approximately 6,000 to 12,000 rural residents benefit from the CCs' centralized location and the varied services they offer. By the end of 2022, 13,907 CCs will be completely functioning across the nation. In addition, it is the responsibility of CCs to provide essential services to the local population in their respective territories, with a particular emphasis on vulnerable women and children. Between 9.5 and 10.0 million individuals in need of medical assistance attend community clinics each month (DGHS, 2019). Community clinics are at the forefront of healthcare delivery because they offer primary care, as well as maternity and child health services, to people in need. In addition to these services, Union Health Center refers patients who require more extensive medical care or urgent assistance to more technologically equipped facilities (DGHS, 2019). The Sustainable Development Goals (SDGs) can only be attained by a developing nation if the relatively meager resources typically allocated to the health sector are utilised effectively. Utilizing efficiency metrics enables the identification of inefficient facilities and input gaps, which may then guide policymakers and facility managers toward more effective waste reduction and productivity gains (Kirigia et al., 2004). Multiple studies have demonstrated that even modest increases in operational efficiency may result in substantial cost reductions in the healthcare industry. According to the 2010 World Health Report, 20 to 40 percent of global healthcare spending is wasted due to inefficiency (WHO, 2019). According to the conclusions of the study, Bangladesh's medical facilities are not nearly as effective as they may be (Mahmood, 2012). A significant amount of research has been undertaken on the application of data envelopment analysis in healthcare organizations, with multiple studies demonstrating positive outcomes (DEA). The great majority of these studies were done only in developed nations, according to the relevant published literature. Despite a recent surge in the number of studies examining the technical effectiveness of healthcare facilities in developing nations, no such studies have been undertaken in Bangladesh. This study's objective was to assess the levels of CC efficiency using the data envelopment analysis (DEA) model, and then to utilize the Malmquist index to monitor the evolution of CC efficiency through time.

However, Community clinics play a vital role in providing primary healthcare services to rural populations, particularly in low-income countries with limited healthcare resources. In Bangladesh, where access to quality healthcare is a persistent challenge, community clinics serve as essential healthcare providers, especially in remote areas. However, assessing the technical efficiency of these clinics is crucial to ensure effective allocation of limited resources and enhance healthcare delivery. This research aims to evaluate the technical efficiency of community clinics in Kushtia, Bangladesh, using a nonparametric Data Envelopment Analysis (DEA) approach. The analysis reveals variations in technical efficiency across community clinics in Kushtia. Some clinics operate at near-optimal levels, while others exhibit substantial inefficiencies. Factors contributing to these disparities are discussed, such as resource allocation, staff capacity, and management practices. The findings provide valuable insights for policymakers and healthcare stakeholders in Kushtia, Bangladesh. The identification of inefficiency sources allows for targeted interventions to enhance the technical efficiency of community clinics, thus improving the quality and accessibility of primary healthcare services. The empirical analysis employing a nonparametric DEA approach provides insights into the technical efficiency of community clinics in Kushtia, Bangladesh. The results highlight variations in efficiency levels and shed light on potential areas for improvement. By addressing these inefficiencies, policymakers and healthcare providers can enhance the effectiveness of community clinics, ultimately leading to improved healthcare outcomes for the local population

*Research Goals*

The primary goal of this research is to assess the technical efficiency of community clinics in Kushtia, Bangladesh. Specifically, the study aims to achieve the following objectives:

1. Measure the technical efficiency: The research seeks to evaluate the efficiency levels of individual community clinics by measuring their ability to maximize outputs given a set of inputs. By employing the DEA methodology, this research will provide insights into the relative efficiency of each clinic, highlighting the best-performing clinics as well as those that are underperforming.

2. Identify key determinants of efficiency: Apart from measuring efficiency, this study aims to identify the key determinants that influence the technical efficiency of community clinics. By analyzing various input and output factors, such as the number of healthcare professionals, available medical equipment, patient visits, and health outcomes, the research will shed light on the factors that contribute to or hinder clinic efficiency.

3. Provide policy recommendations: The research aims to offer evidence-based policy recommendations to improve the technical efficiency of community clinics in Kushtia, Bangladesh. These recommendations will be derived from the findings and analysis of the study, focusing on strategies to optimize resource allocation, enhance service quality, and improve healthcare outcomes in the region.

## Literature review

The technique of applying Data Envelopment Analysis (DEA) has been applied in various occasions to evaluate the relative production performance of profit and non-profit Production and service units. The non-parametric method has also been used Along with other parametric methods. In this chapter (the literature review part is Discussed and presented briefly based on applications to the following broad sectors:

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### *The classical and initial view of DEA Analysis*

Farrell (1957) presents the relative efficiency notion, which states that a decision making unit's (DMU) efficiency may be measured by comparing it to the efficiency of other DMUs in the same group. Data Envelopment Analysis was presented by Charnes, Cooper, and Rhodes (1978) as a linear programming tool for evaluating efficiency (DEA). Since the mid-1980s, Data Envelopment Analysis has become a prominent method for assessing the efficiency of many businesses. The original DEA model, proposed by Charnes et al. (1978), is known as the CCR Model, and it assumes a constant return to scale (CRS), which means that changes in a DMU's outputs are proportional to changes in its inputs. Furthermore, Banker, Charnes, and Cooper (1984) proposed the BCC model based on the variable returns to scale (VRS) assumption, which states that changes in a DMU's outputs may not occur in the same proportion as increases in its input levels.(Atici & Podinovski, 2015) said a tool called Data Envelopment Analysis (DEA) has been used to figure out how efficient a Decision-Making Unit (DMU) is compared to other DMUs that are the same.(Fried, Lovell, & Schmidt, 2008) discussed that, this method has been used extensively in the past to investigate the relative efficiency of homogeneous units. (Kundi & Sharma, 2016) told that primarily, the DEA technique was used to evaluate the effectiveness of non-profit organizations such as hospitals, educational institutions, and government agencies. Later on, the area of DEA application expanded, and this technique is now being used to analyze the performance of profit-driven enterprises. For example, DEA is used to assess the performance of service sector firms such as banks and software industries, as well as manufacturing industries such as textile and mining industries. Furthermore, DEA is utilized to assess the efficacy of various countries. (Goyal et al., 2017).

### *DEA application in different sectors*

### DEA analysis Bank and financial institution

In this section, DEA analysis of the bank and other financial institutions' performance efficiency has been featured. Staub, R. B. et al. (2010) studied Brazilian banks' cost, technical, and allocation efficiencies over the year (2000–2007). In order to compute efficiency ratings, they employed the DEA dynamic panel data input-oriented CCR model. Brazilian banks were found to be less efficient than their counterparts in Europe and the US and government banks are more cost-efficient than overseas, private local and private with foreign participation. Jelena Titko et al. (2014) updated the approach for assessing Latvian banks' efficiency. Data Envelopment Analysis, a non-parametric frontier technique, was used to calculate efficiency scores (DEA). The Variable Returns to Scale (VRS) Method was applied with an input-oriented DEA model. Khan, Z., and Sulaiman, J. (2015) analyzed the social and financial efficiency of Pakistani microfinance organizations in order to propose optimal solutions for efficiently and self-sustainingly financing to non-bankable people. The study used input-oriented CCR and BCC models with 19 different DEA models and three input and four output variables signifying various MFI factors such as price structure, business structure, and managerial characteristics. Gökgöz, F. (2010) measured and compared how efficient Turkish securities and pension funds were in the 2006–2007 period. In this scenario, 36 SMFs and 41 PMFs were examined using typical portfolio performance indicators and DEA models. According to

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performance indexes and DEA models, PMFs outperformed SMFs in 2006–07. By way of a result, the input-oriented CCR and BCC models were used, and in the DEA applications, one output (the additional return of the funds) and four inputs (cost ratio and income) were used in each the four DEA applications. Murthi et al. (1997) The DEA method was applied to 731 mutual funds and the findings were compared to traditional performance measures such as the Sharpe index. They looked into the mutual fund industry's financial market efficiency and used DPEI (DEA Portfolio Efficiency Index) to create a benefit/cost non-parametric study. They found that DPEI measures of performance are equivalent to traditional indices while giving significantly more flexibility. Basso and Funari (2000) they utilized DEA models to evaluate the performance of 47 mutual funds in the Italian financial industry Between the period 1997 and 1999.Berger, and Humprey (1997) used input-oriented CCR and BCC DEA techniques on 130 different financial institutions in 21 countries, concluding that it aids in the identification of corporate goals and objectives in order to improve financial institution efficiency.P. Pille and J. C. Paradi (2002) created BCC input-oriented Models in order to uncover flaws in Credit Unions in Ontario, Canada, in order to predict probable financial failures. Four data envelopment analysis (DEA) models are used to compare the equity to asset ratio and the government regulator's significantly modified "Z-score" model. As a result, each Financial Institution is assessed to a peer group of functional organizations from whom the management of the inefficient institution can learn to

Improve productivity. Ahn, H., & Le, M. H. (2014) addressed DEA's problems in the context of evaluating bank efficiency, with an emphasis on performance factor specification. They are determining if the input-output definition for banks in DEA applications is consistent with the decision-making criteria used by banks. The efficiency test was completed using output-oriented CCR and BCC models.

### DEA use in Agriculture production sector

Bayyurt, N., & Yılmaz, S. (2012). They integrated DEA and regression analysis in a broader aspect for their investigation. To do this, they employed the DEA (output-oriented, constant return to scale model) to examine the agricultural efficiency of countries in the first stage. And then, in the second stage, they employed Panel Data Regression Analysis to determine the effects of the Worldwide Governance Indicators (WGI), the education index, and the nation type on country efficiency. Zamanian, G. R. et al. (2013) They examined the technical efficiency of the agriculture sector in MENA countries between 2007 and 2008 utilizing Data Envelopment Analysis (DEA), input-oriented CCR and BCC models, and Stochastic Frontier Analysis (SFA) techniques. Additionally, empirical evidence indicates that both parametric and non-parametric techniques produce the same ranking of countries.Frija, A et al. (2009) the authors offer a measure for irrigation water use efficiency (IWUE) based on an alternate variant of the data envelopment analysis (DEA) paradigm. Second, a tobit model is employed to examine the relationship between technical efficiency and IWUE. Input-oriented constant returns to scale (CRS) and variable returns to scale (VRS) efficiency ratings reveal that most farmers in our sample are producing efficiently. Raheli, H et al. (2017) used a two-stage methodology. As a result, a non-parametric input oriented CCR and BCC Data Envelopment Analysis (DEA) were used in the initial stage to examine the efficiency of tomato production, and a fractional regression model (FRM) was utilized in stage 2 to analyze farm-specific variables. Yadava, A. K., & Komaraiah, J. B. (2021) the study used data from 21 Indian states from 2016 to 2017, with the states serving as decision-making units for performance evaluation. In the first step, the Data Envelopment Analysis (DEA) method of performance evaluation is used. In the second stage, they evaluated the efficiency of "pure organic production" and corrected the bias in the standard DEA technique with the bootstrap DEA method. As per the input-oriented DEA model, organic farming production has an average technical efficiency of 84.7 per cent, whereas the output-oriented DEA model has a 20% technical efficiency, meaning that organic farming production could be increased by 80% with the same number of inputs.

### DEA analysis in Health Sector

Kassam, A. H. (2017) by using (CCR) input-oriented and output-oriented measurement models, they were able to figure out the relative efficiency. Another perspective is that the study looks at hospital efficiency and productivity from two different viewpoints: first, Data Envelopment Analysis (DEA) is used to evaluate the relative efficiency of hospitals using the (CCR) approach, and second, the study looks at hospital efficiency and productivity from two different perspectives. Second, the Luenberger Productivity Indicator (LPI) is used to determine how much productivity has increased over time. Mirmirani, S., & Lippmann, M. (2004) they used Data Envelopment Analysis to examine the health-care delivery systems of G12 countries, finding that Japan and Spain had the highest relative efficiency and the United States had the lowest. For the years 1991-1995, DEA tests were conducted utilizing both input-oriented CCR and BCC models. Wei, C. K et al. (2011) they developed input-oriented BBC and CCR models to examine Taiwan's medical sectors, and they discovered that efficient DMUs' efficiency underestimate is more problematic than inefficient DMUs'. Furthermore, when weights are concentrated in the same output, underestimation occurs. Carrillo, M., & Jorge, J. M. (2017) they analyses efficiency in the health sector using the CCR input output oriented Data envelopment analysis (DEA) approach. Given the observed level of health outcomes, this study analyses data from the relevant health authority in Spain to assess the efficiency of regional health systems in Spain and identify those regions that are employing their health care inputs more efficiently than others. Mogha, S. K (2014) This article examines the efficiency of 27 public sector hospitals in the state of Uttarakhand (India) for the calendar year 2011 utilizing the output-oriented models DEA-CCR and BCC, as well as the DEA's new slack based model (NSM), which deals directly with input and output slacks. Dash et al. (2010) Used CCR and BCC input-oriented models and examine the technical and scale efficiencies of 29 local hospitals in Tamil Nadu for the years 2004–2005. Mogha et al. (2012). They evaluate the technological and scale efficiencies of 55 Indian private hospitals in 2010 using CCR and BCC output-oriented models. Ismile (2010) they analyze the technical efficiency of Sudan's state-level health agencies using DEA-based CCR and BCC models.

### DEA analysis for Manufacture industry

Li, L et al. (2013) To create an upgraded super-efficiency DEA model, they combined the standard input-oriented CCR model, the super-efficiency DEA model, and the ideal-DMU-based benchmark sorting model which was then applied to a real-world problem. After that, they investigated the method on 10 subsidiaries of a well-known domestic energy company to see if it was viable to implement. Buyukkeklik, A. et. al (2016) Input-oriented CCR and BCC models were used in their study because they examined the resource of company efficiency. The CCR model was used to determine the

Overall efficiency values of each decision-making unit based on the years, the BCC model was used to calculate the technical efficiency values, and the scale efficiency values were produced by comparing these values to one another. As a result, resource efficiency providers are uncommon among the BIST SME Industrial Index's enterprises, and these companies may attain their present total sales and profitability levels with fewer resources. Emran, S. J., & Moniruzzaman, M. (2020) This study use the output-oriented DEA model to capture the maximum proportional increase in production while maintaining input levels constant. Furthermore, DEA is utilised in this study under two alternative assumptions: constant and variable returns to scale. This study will also examine the dynamics technical production efficiency in Bangladesh's manufacturing sector using cross-sectional data from the Survey of Manufacturing Industries (SMI) performed in 2006 and 2012. Using the Stochastic Frontier Analysis (SFA) method with Cobb-Douglas model and a half-normal distribution, the dynamics of mean efficiency scores across industries were estimated. Khan, A. H., & Farooq, S. (2019) The technological efficiency of listed spinning enterprises on the Pakistan Stock Exchange is assessed in this study (PSX). The Input Oriented Data Envelopment Analysis technique was used for this, with the Variable Return to Scale (VRS) assumption. For the years 2011 to 2016, balanced panel data from 55 firms was obtained. According to the conclusions of the study, only one out of 55 organizations was able to achieve an efficiency score of one during the course of the six-year study period. Athanassopoulos, A. D., & Ballantine, J. A. (199) they used CCR and BCC both input and output-oriented data envelopment analyses to address a number of topics related to corporate performance measurements, such as determining sales efficiency, the effects of economies of scale, measuring a company's performance, and the link between industry groups and performance Chapelle, K., & Plane, P. (2005) using the Data Envelopment Analysis production frontier technique, they assessed the technical efficiency of Ivorian manufacturing businesses in four industries: textiles and apparel, metal goods, food manufacturing, and timber and furniture. When computing efficiency scores, the influence of the external working environment is taken into account. Khan, M. N. et al. (2018) Using Data Envelopment Analysis, this article evaluates the efficiency of listed corporations on the Pakistan Stock Exchange (DEA). The purpose of using and calculating the DEA score is to determine how efficient enterprises are at converting their resources into output (sales/net income). Düzakın, E., & Düzakın, H. (2007) they used an Output-oriented super slack based model in DEA, which meant that the outputs could be negative or not at all. Furthermore, the model can help you figure out which businesses are the most efficient. People who did this study looked at data from 500 of the most important factories in Turkey to use the Output-oriented method. Ahmed, S. N. (2009) the goal of this study was to examine the "performances" of the Bangladeshi garment sector and to determine the most efficient frontier. The relative scores of the productive efficiency of several apparel manufacturers were determined using input and output-oriented models for both constant and variable return to scale, Scale efficiency, Malmquist Productivity index and SBM model. The most efficient production periods (months) have been determined based on the efficiency measurement scores.

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## Method of the study

The purpose of this article was to evaluate the effectiveness of CCs at the district level in Bangladesh. Using a data envelopment analysis (DEA) model with an input-focused constant returns to scale (CRS) measure, the technical efficacy was evaluated. The Malmquist index compares the performance of CCs over time in order to identify changes. Depending on the used technologies, "technical efficiency" in this sense refers to the capacity of a corporation or industrial unit to maximize output while minimizing inputs (Henderson and Quandt, 1980). Analyses of the Accompanying Data (DEA) Data Envelopment Analysis (DEA) is a non-parametric approach that aims to maximize the weighted output-to-weighted input ratio for a particular business, provided that the ratio cannot exceed one for any other firm. This method may be used to evaluate the technological effectiveness of various firms. Any evaluable phase of the manufacturing process is a "Decision-Making Unit" (DMU). In this situation, each CC is considered a separate DMU. The ratio of outputs to inputs is the fundamental efficiency statistic for the DEA (Cooper et al., 2007). xi and yr represent the ith input and rth output of a DMU, respectively. Let vi and ur represent the weights assigned to the inputs and outputs, and let m and s represent the total number of inputs and outputs, where m and s are greater than 0. (Rao, 2003).

The CCR model, which was developed by Charnes, Cooper, and Rhodes, is the earliest and most fundamental kind of data envelopment analysis (1978). The original model established by Charnes Cooper and Rhodes correlated efficiency with (CCR). The model uses the highest ratio between a DMU's weighted outputs and weighted inputs to assess its efficiency. The ratios of each DMU are adjusted such that their aggregate is less than 1. (Kale, 2009: 64). This Charnes et al. (1978:430)-developed

CCR fractional programming paradigm is based on user input.

$max$,

$$h_k = \frac{\sum_{r=1}^{s} u_r\, y_{rk}}{\sum_{i=1}^{m} v_i\, x_{ik}} \qquad (1)$$

*Constraints:*

$$\frac{\sum_{r=1}^{s} u_r\, y_{rj}}{\sum_{i=1}^{m} v_i\, x_{ij}} \leq 1 \qquad j = 1, \dots \dots, n \qquad (2)$$

$$u_{r,} v_i \geq 0 \qquad r = 1, \dots \dots.., s \quad i = 1, \dots .., m \qquad (3)$$

$$\text{Max} \quad z = \sum_{r=1}^{s} u_r y_{rk} \qquad (4)$$

$$\text{Constraint: } \sum_{i=1}^{m} v x_{ik} = 1 \qquad (5)$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v x_{ij} \leq (j = 1, \dots \dots, n) \qquad (6)$$

$$u_{r,} v_i \geq 0 \qquad (r = 1, \dots \dots.., s) \quad (i = 1, \dots .., m) \qquad (7)$$

Before evaluating the effectiveness of DMU, its model must be constructed and solved. The objective function value after issue resolution represents the Total Technical Efficiency of the relevant DMU (TTE). Technical efficiency measures the output-to-input ratio of a DMU. DMU is active if the value of the objective function is 1 (z=1) and inactive if it is less than 1.

*Malmquist productivity index (MPI)*

A productivity index measures the effectiveness of a DMU over time. Caves, Christensen, and Diewert created the MPI to determine if productivity in DMUs was rising or declining (Caves et al., 1982). Changes in total factor productivity (MPI) broken down by new technologies and minor advances in technical efficiency (TEC) (TC). PTEC and TEC can be used to differentiate changes in technical efficiency (TEC) on a greater scale (SEC).

TFPC = TEC X TC = (PTEC X SEC) X TC

## Study design and data collection method

The Efficacy of Means (DEA) score measures the effectiveness of a method. Numerous DMUs are required for it. It is easier to differentiate between efficient and inefficient DMUs when the sum of their inputs and outputs is less than their total number. In general, DMU should be more than the sum of its inputs and outputs (Charnes and Cooper, 1978). The study's core data came from twenty-four CCs, and there was only one input and one output. The primary criterion for selecting UHCs was an approximate ratio of providers to the populations they served. Using the Local Health Bulletin 2022, we computed the ratio for a sample of CCs in the Bangladeshi district of Kushtia (DGHS, 2022). Total number of CC are 52 in Kushtia district as population, so 24 UHCs were therefore chosen to participate in the study as a sample. Under the assumption of continuous returns to scale, the DEA Solver was utilized to build an envelope input-oriented model (CCR model). What you put in it will likely impact its performance. The only component analyzed for the study was human resources, and the only finding was the number of outpatient visits. A facility survey was conducted according to standard data collection protocols in order to acquire input data. Utilizing their service statistics, the performance of community clinics was assessed.

## Outcome of the tests

*Levels and determinants of resource use efficiency at the Community Clinics (CCs)*

According to the output-oriented DEA efficiency score, only one of the twenty-four CCs achieved a flawless score of twenty (=20) out of a possible twenty. Figure 1 illustrates the DEA's efficiency scores. Nine of the CCs scored below average, bringing the overall average score for efficiency to 42%. The facility with the best overall performance is the Saldah, Community clinic. It earned a one on the scale of efficiency. The remaining fifteen CCs scored less than one (1) on the efficiency scale and might become more efficient by reducing their inputs.

Table 1. DEA efficiency scores of the survey CCs

| CC | Efficiency score | Returns to scale |
|---|---|---|
| Daikhalipara, Community Clinic | 0.31 | Increasing |
| Pantapara, Community Clinic | 0.44 | Increasing |
| Piarpur, Community clinic | 0.75 | Increasing |
| Khordo Ailchara, Community clinic | 0.68 | Increasing |
| Naopara, Community clinic | 0.51 | Increasing |
| Rajapur, Community clinic | 0.42 | Increasing |
| Shimuliya kathuliya, Community clinic | 0.62 | Increasing |
| Sankardia, Community clinic | 0.70 | Increasing |
| Uttar magura, Community clinic | 0.87 | Increasing |
| Berbaradi, Community clinic | 0.13 | Increasing |
| Purba, Abdalpur, Community clinic | 0.55 | Increasing |
| Padmanagar, Community clinic | 0.61 | Increasing |
| Char Raghunathpur, Community clinic | 0.81 | Increasing |
| Hatosh Haripur, Community clinic | 0.37 | Increasing |
| Kantinagar Boaldah, Community clinic | 0.70 | Increasing |
| Saldah, Community clinic | 1.00 | Constant |
| Khajanagar, Community clinic | 0.45 | Increasing |
| Vadalia, Community clinic | 0.64 | Increasing |
| Astanagar, Community clinic | 0.72 | Increasing |
| Majpara, Community clinic | 0.57 | Increasing |
| Balipara ,Community clinic | 0.29 | Increasing |
| Kanchanpur, Community clinic | 0.67 | Increasing |
| Arpara, Community clinic | 0.72 | Increasing |
| Hatibhanga ,Community clinic | 0.62 | Increasing |

Table 1 displays the DEA findings for the CCs. Uttar magura, Community clinic gets the highest rating (87%) among the least effective CCs. This CC can only improve its efficiency by 13% if it reduces its inputs. Even though Berbaradi, Community clinic received the lowest total score. Only 13% of the job was satisfactory. This CC might reduce its inputs by 87% without sacrificing output quality.

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Table 2. The amount of waste at the survey CCs

| Name of CC | Efficiency score | Input reduction % | Waste (in crore TK.) |
|---|---|---|---|
| Daikhalipara, Community Clinic | 0.31 | 59 | 0.51 |
| Pantapara, Community Clinic | 0.44 | 56 | 0.39 |
| Piarpur, Community clinic | 0.75 | 25 | 0.17 |
| Khordo Ailchara, Community clinic | 0.68 | 32 | 0.31 |
| Naopara, Community clinic | 0.51 | 49 | 0.21 |
| Rajapur, Community clinic | 0.42 | 58 | 0.55 |
| Shimuliya kathuliya, Community clinic | 0.62 | 38 | 0.25 |
| Sankardia, Community clinic | 0.70 | 30 | 0.27 |
| Uttar magura, Community clinic | 0.87 | 13 | 0.19 |
| Berbaradi, Community clinic | 0.13 | 87 | 0.25 |
| Purba, Abdalpur, Community clinic | 0.55 | 45 | 0.21 |
| Padmanagar, Community clinic | 0.61 | 39 | 0.39 |
| Char Raghunathpur, Community clinic | 0.81 | 19 | 0.12 |
| Hatosh Haripur, Community clinic | 0.37 | 63 | 0.23 |
| Kantinagar Boaldah, Community clinic | 0.70 | 30 | 0.36 |
| Saldah, Community clinic | 1.00 | 0 | 0.00 |
| Khajanagar, Community clinic | 0.45 | 55 | .24 |
| Vadalia, Community clinic | 0.64 | 36 | .21 |
| Astanagar, Community clinic | 0.72 | 28 | .45 |
| Majpara, Community clinic | 0.57 | 43 | .65 |
| Balipara ,Community clinic | 0.29 | 71 | .27 |
| Kanchanpur, Community clinic | 0.67 | 33 | .82 |
| Arpara, Community clinic | 0.72 | 28 | .41 |
| Hatibhanga ,Community clinic | 0.62 | 38 | .23 |

It was determined how much waste was created by the inefficiency of the CCs. Table 2 displays the amount of waste produced by each CC. Kanchanpur, Community clinic contained the most garbage, while the Char Raghunathpur, Community clinic contained the least. The average price for waste was TK. 0.14 crore per cubic meter. Therefore, the government may need to spend less money to maintain the same degree of efficiency. Between 2019 and 2022, it is anticipated that waste from all CCs in Bangladesh would equal TK 1,910,37 crores, or 17.5% of the country's total health expenditures. The government's contribution to the budget of each CC is negligible. CCs also receive money from several other sources, in varying quantities. Due to this waste, it is feasible to achieve the same level of efficiency at a lower cost.

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Table 3. Slacks and targets of inputs and outputs at the survey CCs

| Name of CC | Input slack | Output slack | Efficient input target | Efficient output target |
|---|---|---|---|---|
| Daikhalipara, Community Clinic | 52083 | 3569 | 22044 | 7011 |
| Pantapara, Community Clinic | 17536 | 2158 | 35699 | 6589 |
| Piarpur, Community clinic | 6221 | 2569 | 52369 | 1225 |
| Khordo Ailchara, Community clinic | 10401 | 2589 | 45982 | 9698 |
| Naopara, Community clinic | 22586 | 5695 | 14569 | 54441 |
| Rajapur, Community clinic | 36958 | 3698 | 89632 | 1235 |
| Shimuliya kathuliya, Community clinic | 25699 | 4583 | 28963 | 5148 |
| Sankardia, Community clinic | 15988 | 1235 | 26987 | 48695 |
| Uttar magura, Community clinic | 25984 | 4586 | 12359 | 56975 |
| Berbaradi, Community clinic | 58963 | 3657 | 11158 | 6699 |
| Purba, Abdalpur, Community clinic | 12358 | 2589 | 22598 | 4896 |
| Padmanagar, Community clinic | 16985 | 4782 | 36987 | 5679 |
| Char Raghunathpur, Community clinic | 10289 | 3259 | 86936 | 12568 |
| Hatosh Haripur, Community clinic | 36592 | 4536 | 96358 | 15997 |
| Kantinagar Boaldah, Community clinic | 12569 | 5369 | 89536 | 1698 |
| Saldah, Community clinic | 0 | 0 | 78956 | 25986 |
| Khajanagar, Community clinic | 2581 | 2589 | 68956 | 444789 |
| Vadalia, Community clinic | 69852 | 1235 | 58963 | 75556 |
| Astanagar, Community clinic | 25975 | 7832 | 78963 | 48658 |
| Majpara, Community clinic | 45869 | 2569 | 96358 | 71236 |
| Balipara ,Community clinic | 35896 | 1235 | 56963 | 17896 |
| Kanchanpur, Community clinic | 25869 | 5693 | 45968 | 25869 |
| Arpara, Community clinic | 58687 | 2358 | 23695 | 10236 |
| Hatibhanga ,Community clinic | 75692 | 3658 | 78965 | 17039 |

The deficiencies and anticipated levels of inputs and outputs from the survey CCs are displayed in Table 3. Input slack was greatest at the Hatibhanga, Community clinic, whereas output slack was greatest at the Padmanagar, Community clinic. The law of growing returns to scale was the business model of every inefficient CC. Since there was only one excellent CC, Saldah, Community clinic was used as a comparison site by less productive colleges. The inefficient CCs can be made efficient by adjusting the current input and output values to the appropriate level. Rajapur, Community clinic was among the least successful CCs. It had more input and output goals than less productive organizations.

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Table 5. Malmquist Index summary of facility means of the survey CCs

| Name of CC | EFFCH | TECHCH | PECH | SECH | TFPCH |
|---|---|---|---|---|---|
| Daikhalipara, Community Clinic | 1.512 | 1.05 | 1.0 | 2.47 | 3.23 |
| Pantapara, Community Clinic | 1.124 | 1.02 | 1.69 | 1.12 | 1.56 |
| Piarpur, Community clinic | 0.812 | 1.03 | 1.25 | 0.77 | 1.04 |
| Khordo Ailchara, Community clinic | 2.102 | 1.02 | 1.21 | 3.58 | 3.25 |
| Naopara, Community clinic | 3.442 | 1.23 | 1.45 | 3.63 | 3.56 |
| Rajapur, Community clinic | 7.052 | 1.14 | 1.0 | 5.06 | 5.36 |
| Shimuliya kathuliya, Community clinic | 2.523 | 1.12 | 1.03 | 1.42 | 3.12 |
| Sankardia, Community clinic | 1.452 | 1.17 | 1.18 | 5.23 | 5.44 |
| Uttar magura, Community clinic | 1.12 | 1.17 | 1.69 | 1.04 | 1.36 |
| Berbaradi, Community clinic | 1.27 | 1.45 | 1.0 | 1.42 | 1.52 |
| Purba, Abdalpur, Community clinic | 1.07 | 1.68 | 1.14 | 1.06 | 1.47 |
| Padmanagar, Community clinic | 1.12 | 1.75 | 1.2 | 1.14 | 1.02 |
| Char Raghunathpur, Community clinic | 1.07 | 1.25 | 1.07 | 1.01 | 1.11 |
| Hatosh Haripur, Community clinic | 1.11 | 1.75 | 1.02 | 1.13 | 1.87 |
| Kantinagar Boaldah, Community clinic | 2.32 | 1.63 | 1.0 | 2.23 | 1.24 |
| Saldah, Community clinic | 1.000 | 1.98 | 1.0 | 1.00 | 1.74 |
| Khajanagar, Community clinic | 1.2 | 1.52 | 1.08 | 1.67 | 1.25 |
| Vadalia, Community clinic | 6.39 | 1.25 | 1.24 | 1.42 | 1.58 |
| Astanagar, Community clinic | 4.25 | 1.47 | 1.27 | 1.23 | 1.78 |
| Majpara, Community clinic | 1.25 | 1.72 | 1.02 | 1.11 | 1.54 |
| Balipara ,Community clinic | 3.58 | 1.20 | 1.08 | 1.55 | 1.47 |
| Kanchanpur, Community clinic | 4.25 | 1.71 | 1.47 | 1.74 | 1.22 |
| Arpara, Community clinic | 3.98 | 2.14 | 1.32 | 1.12 | 1.74 |
| Hatibhanga ,Community clinic | 2.47 | 2.21 | 1.28 | 1.10 | 1.00 |

Monitoring patient happiness and other metrics over time may yield valuable information for health care providers. The Malmquist index is a method for measuring the efficacy of hospitals over time. It may be used to track efficiency changes over time, including gains and losses. The Malmquist index of total factor productivity change (TFPCH) between periods t and t+1 consists of two components: technical efficiency change (EFFCH) and technological progress (TECHCH). The difference in technical efficiency between these two points in time (t and t+1) is a measure of the efficiency gain or loss caused by technological development. As it retreats, it signifies a fall in technological efficiency. The efficiency frontier varies as technology evolves to adhere to new norms, and its retreat indicates a decline in technical efficiency. Any variable with a value greater than one reflects productivity increase. By comparing EFFCH with TECHCH, we may identify the primary reasons for productivity increases or losses. EFFCH > TECHCH demonstrates that technological efficacy is enhancing production. If EFFCH is less than TECHCH, then technology has improved. Modifications to technical efficiency (EFFCH) are comprised of two subsets: pure efficiency (PECH) and scale efficiency (SECH) (SECH). When PECH > SECH, scale improvements account for the

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majority of technical efficiency, but when PECH > SECH, pure technical efficiency accounts for the majority of technical efficiency.

Table 4 displays the Malmquist index (MI) findings of total factor productivity shift. The table indicates that the average yearly change in total factor productivity was 1.85. TFPCH is larger than 1, hence it may be inferred that all facilities increased their output in 2099–2022 on average.

Except for Piarpur, Community clinic, all CCs displayed both technical efficiency improvement and technological development, as reported in Table 5 of the Malmquist index summary.

## Overall Discussion

This study conducted in Kushtia Bangladesh to evaluate the technical effectiveness of CCs using the DEA method. One of the twenty-four tested facilities fitted the input-oriented CRS assumption and was identified as a CC. The Saldah, Community clinic is the most efficient CC. All facilities received an efficiency rating of 58% on average. Studies conducted in Kenya revealed comparable levels of efficiency, with basic care institutions reporting 58% efficiency. Other CCs scored below the mean, with one receiving a score as low as 13%. Overall performance evaluations range from 0.10 to 1.00. This illustrates that the distribution of resources among CCs differs substantially. Low-scoring CCs need fewer inputs to produce the same outputs as they do currently. According to the research, the same quantity of inputs might provide much larger facility outputs. In contrast, the CCs are not doing as well as they could be. China's rural township hospitals have an average technical efficiency of 50%, according to a recent study. 2024; Cheng et al. The average technical efficiency score for government hospitals, particularly those servicing the general population, is between 70% and 80%, according to studies. Christian and Simon (2013); Akazili et al. (2008); Zere et al. (2006); Osei et al. (2005); Christian and Simon (2013); Akazili et al. Poor efficiency meant that less-than-ideal facilities wasted resources by generating less returns per unit of input than better-constructed facilities. The low rating for the research's efficiency reveals disparities in CC efficiency levels, indicating resource waste. The average cost per cubic meter of rubbish was TK 0.14 billion. While Hatibhanga, Community clinic had the most input slack, Padmanagar, Community clinic had the highest output slack. If all resources are used properly, healthcare facilities will operate efficiently and with minimal waste. Using slack analysis, we were able to determine how much additional output or input inefficient CCs would need to become efficient. There is ample space for inefficient CCs to increase their outputs or decrease their inputs. Malmquist Index is a time series assessment of the DMU's dynamic effectiveness. During both 2019-2022 production grew. According to enhancements in facility output, 15 CCs have benefited from both new technologies and enhanced technical efficacy. This CC group asserts that the efficiency border has shifted and the efficiency gap is closing. The health sector-wide plan enabled improvements in the accessibility of critical staff and operational equipment, which resulted in a huge increase in outpatient visits to publicly sponsored healthcare institutions between 1997 and 2011. (Karar et al., 2024). These findings revealed a rise in demand, which may have led to a rise in output as a whole.

## Conclusions

By examining the magnitudes of efficiency, we may be able to determine how the sector may make the most of the resources it has been provided. At poorly functioning CCs, resources are not utilized optimally. It costs money for the healthcare industry to discard goods. The findings revealed that the least efficient CCs had an average efficiency score of 58%. The lesser-quality CCs should be improved. If we can boost productivity, we can reduce expenses and make more efficient use of our resources. Policymakers can utilize the results of efficiency estimates to identify inefficient facilities and implement reforms to increase their productivity. The results indicate that CCs may save a substantial amount of money by improving their operational efficiency.

Policymakers may find statistics on slacks and efficiency metrics valuable. Health authorities may find it useful to understand more about the technical efficiency of CCs and the variables that influence it. This might help them make better judgments and increase the technological efficiency of the CCs. If gaps exist, poor CCs may be able to increase productivity by reducing expenses and boosting production. Campaigns can increase demand, leading to an increase in output. If they increased the care and professionalism of their employees, more individuals could be interested in utilizing their services. CCs who do poorly may be able to instruct those who perform better. It is essential to assess ineffective CCs to see why they are not functioning as intended. A few things cannot be mentioned regarding the study's results. The DEA's results were founded on the premise that all inputs are utilized, and this should be emphasized first. Second, the tool requires a large number of DMUs to provide a decent output, however many facilities could not be added due to cost. Due of this, the program provides relative scores rather than absolute ones. In the study, just the most vital information was utilized. The third criterion for measuring efficiency is whether or not all resources are utilized effectively and the end product is satisfactory. The importance of quality-adjusted production in the healthcare industry is not included while assessing efficiency. In the health care sector, outcomes are impossible without increased output. However, there are still areas that require more investigation, especially since these issues must be resolved before the tools can be utilized effectively.

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