Technical Efficiency of Handloom Industry in Bangladesh: A Study

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Abstract

The handloom textile industry is one of Bangladesh's major labor contributing endeavors that provides income and employment opportunities for a sizable section of rural labor. However, in recent years, the handloom textile industry has been experiencing severe competition with the power loom textile industries in terms of technical efficiency, wage discrimination, and profit margin. This study aims to measure the technical efficiency of the handloom textile industry in handloom rich areas of Bangladesh. This study used multistage sampling techniques to collect data from 50 handloom textile industries in the Sirajganj district. The Stochastic Frontier Analysis (SFA) technique was used to assess technical inefficiency and production efficiency. In contrast, the Benefit-Cost Ratio was used to determine the profit margin for handloom textile industries. The results show that the sample means technical efficiency is 79 percent, ranging from 38 to 100 percent. The SFA regression model also indicates that 6 percent of handloom industries have a 0.75–1.00 efficiency score, while 6 percent of the firms operate below 50 percent of technical efficiency. The Benefit-Cost Ratio analysis shows that handloom products are not highly profitable. The study also found that the existing handloom textile industries face high prices of colors and fabrics, lower adoption of technical knowledge, and obstacles to access to credit, all of which affect the production efficiency of handloom industries. With the foremost prospect of this industry, government policies should address the above problems to ensure favorable textile production in the study area.

Keywords: Handloom Industry, Technical Efficiency, Stochastic Frontier Analysis, Benefit-Cost Ratio, Cobb-Douglas

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1. Introduction

The handloom textile industry is one of Bangladesh's major labor-contributing industries. This is a major non-farm sector in Bangladesh that continuously helps to reduce rural poverty by employing a large share of rural men and women (Ahmed, 1999) The weaving business employs 1.5 million weavers, dyers, hand spinners, embroiderers, and affiliated craftspeople (BHB, 2012). The BHB report also shows that 0.30 million active looms produce 620 million meters of clothing a year, meeting 40 percent of local demand in Bangladesh. The industry weaves around 173.7 million yards of fabric per two months. This industry adds around BDT. 10 billion to the national exchequer annually (BHB, 2012).

The industry has a rich and glorious history. The Dhakai muslin and Jamdani sarees were renowned all over the world for their distinctive method of construction as well as their fabric (BBS, 2018).One of the most significant weaving industries in the country, contributing to supplying domestic fabric demands. In the distant past, it has continued to be an economically viable and important cottage industry in Bangladesh, playing a crucial role in providing rural people with a means of subsistence and encouraging the economic progress of the nation. It is Bangladesh's second-largest employer of people in rural areas, following agriculture. In this industry along with men, women are also able to contribute to the production process while keeping their daily domestic responsibilities without difficulty or discrimination. Moreover, the lack of non-agricultural employment in rural Bangladesh, the handloom sector employs a total of 0.85 million rural residents. This industry accounts for 48.04 percent of cottage industry employment and 49.50 percent of the cottage industry output in Bangladesh (Islam & Hossain, 2012).

Despite the bright prospects of the handloom industry, the country's handloom has started declining at a significant rate. For instance, the most recent Handloom Census shows that the total number of handloom units in Bangladesh is 116006, which is a decrease of 36.79 percent from the number of handloom units recorded in the 2003 census and a decrease of 45.39 percent from the number of handloom units recorded in the 1990 census. The figure below shows the total number of handloom units in the past three handloom censuses in Bangladesh.

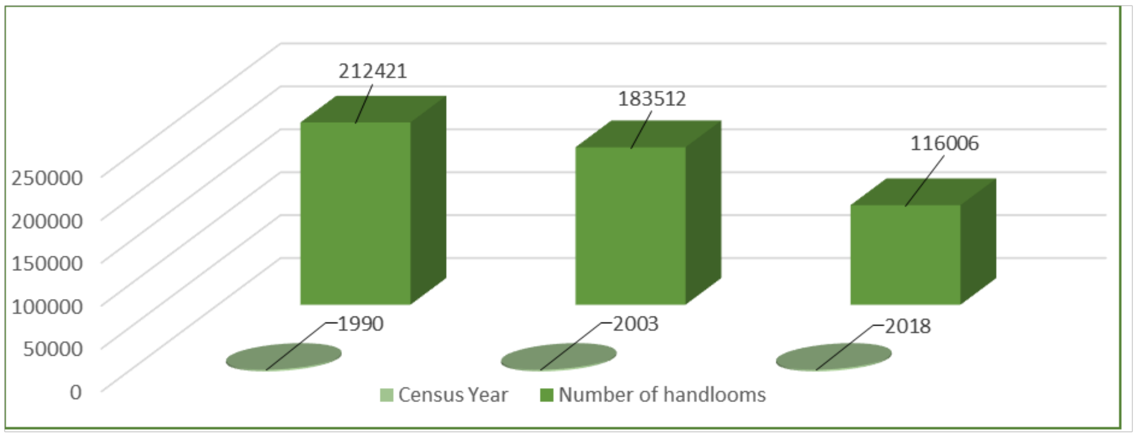

Figure 1: Handloom Units in the last three Handloom Census
Source: BBS (Handloom Census), 2018

The lack of insufficient capital is one of the main reasons for this decline in the number of handlooms throughout time. Moreover, an excessive increase in the cost of fabric and color is another major cause of the decline in this sector. In addition, Most of the looms are being replaced with power looms. However, some products that can only be woven by handloom are not possible to produce in power loom. But even so, not all weavers have the financial capability to convert their looms into power looms. So they are being forced to close their weaving business. Besides, low-profit margins lack of capital and problems related to marketing were accused of this rapid decline of the handloom industry in Bangladesh (BBS, 2018).

The handloom owner who is still running their weaving industry is not able to run their business efficiently because they do not have enough knowledge and ideas about the handloom business. Even if they can't adapt to technology that's why they are not able to convert their handloom to a power loom.

Moreover, the handloom sector lags behind the power loom sector in competition and its market share decreases along with the profit margin. Consequently, there has been a downward trend in the handloom industry for the past three decades. Poor infrastructure for product marketing and insufficient government policy for sector development are the current issues facing the sector (Rahman & Noman, 2019).

Though the handloom owners can't capable to adapt with technological changes, this textile industry is currently experiencing several difficulties. Where production inefficiency is the major problem i.e., handloom units cannot produce at full capacity due to inefficiency. This results in low handloom unit productivity. Consequently, the units cannot generate additional income (Islam & Hossain, 2015).

In such a situation these questions are raised. The purpose of this investigation is to discover the answer to the following questions:

- Whether the handloom industry efficient or not? and
- How much are the costs and returns of the handloom industries in the study area?

Against this backdrop, this study is an attempt to measure the technical efficiency of the handloom industry units in the Sirajganj district of Bangladesh. So that the unpacked potential can be utilized.

The paper is structured as follows: The background of the research problem is stated in section 1. Section 2 describes the related literature reviews. Section 3 provides the methodology of the study in detail. Section 4 shows the empirical results and interpretations of those results, and finally, Section 5 gives the conclusion of the study.

2. Literature Review

There has been sample literature to examine the technical efficiency of the handloom industry. But a few studies are found the technical efficiency of the handloom industry in Bangladesh. This section provides a summary of findings from the previous literature and also some related findings from other countries will be included here.

Islam & Hossain (2018) investigated the factors that influence the profitability of handloom weaving units in Kumarkhali Upazilas of Kushtia district in Bangladesh. They used the multi-stage random sampling technique and collect 120 handloom unit data. This study calculated these handloom units' net profit and profitability using conventional statistical methods. The Cobb-Douglas production function model is used to examine the variables that influence the profitability of the handloom units. The factors that affect profitability are identified by estimating a log-linear regression model, which confirms that sales revenue and the inputs of labor, capital, and yarn have a positive impact on the profitability of the units. They found that the annual average net profit of the Handloom units is BDT.274.3 thousand, which is 46.75% in terms of average yearly profitability.

Islam & Hossain (2015) traced the factors that led to the technical inefficiency of handloom weaving units located in the Kumarkhali Upazila in Kushtia, Bangladesh. The study is mainly based on primary data from people who particularly own handloom units in the study area. Structured questionnaires were used to collect the data. A total of 57 handloom units are chosen for the study. They used a Cobb-Douglas production function model to compute the technical inefficiency index produced from the acquired efficiency values for handloom units. They also used the Tobit Model. It is possible to uncover inefficiencies in handloom weaving units. They analyzed that handloom units in the study area had an average inefficiency of 0.245 percent. Their finding from this study is factors such as the owner's education, experience, team size, and age all have a role in handloom weaving's inefficiency.

Banarjee et al., (2014) examined a case study on handloom workers and the reasons for their relocation to the Tangail district, Bangladesh. They used case studies and interviews to gather primary data, and research papers, websites, and journals were studied to learn about the industry's history and evolution. They also conducted case studies to determine the root causes of migration. They pinpoint the factors that led to the mass exodus of weavers from Europe to India. They found that the number of businesses in the industry is dwindling at an alarming rate sector is shrinking. In Tangail, they discovered the causes of the decline in the number of handloom weavers. The primary driving factors behind their emigration are communal violence, rising raw material prices, a lack of government financing, inadequate transportation infrastructure, superior infrastructure in India, and a lack of security.

Liton et al., (2014) evaluated Bangladesh's handloom industry's current state and potential future problems. They discovered that Bangladesh's handloom industry is made up of more than 0.183 million handloom units, 0.505 million handlooms, and approximately 1 million handloom weavers, roughly half of whom are female workers. Due to various problems and barriers to development, Bangladesh's ancient and vital cottage industry is on the verge of extinction. This study discovered two handloom weaving units in Bangladesh, each with 505556 looms. The total number of operational looms is 311851, accounting for 61.7 percent of all looms, with the remaining 193705 looms inactive. They have identified several reasons for the closure of looms, including a scarcity of funds, a scarcity of raw resources, insufficient technology, a weak marketing system, and insufficient government support. They encouraged the government to overcome these impediments to promote the handloom sector in the country further.

Rahman (2013) identified the Handloom industry in Pabna, Bangladesh. He cites all of the internal and external elements that have significantly contributed to the current state of the handloom industry in Pabna, Bangladesh. Some preset variables such as a scarcity of Inadequate working capital, high raw material costs, a lack of organizational competency, inadequate innovation and reliability, a lack of governmental support and expertise, a lack of electricity, a lack of credit facilities, and so on were shown.

Islam et al., (2013) attempted to analyze the cost-benefit of handloom weavers in Kumarkhali Upazila, Kushtia district. This study is mainly based on primary data. The data which utilized in this research was gathered by a standardized questionnaire sent to owners of handloom businesses in the study region. For the analysis, 57 handloom units were randomly chosen from around the country. They could determine the profitability of the handloom industries using the cost-benefit analysis method. The results of this study are handloom weaving activity is lucrative, with per-loom profit for small and large-scale units being more significant than for medium-size units.

Raihan (2010) studied the possibilities of reducing rural poverty in Bangladesh through the development of the handloom sector. He has also investigated the reasons that contributed to the closure of handloom operations in Bangladesh. The research discovered that the country's handloom business is deteriorating due to various problems, including a lack of education and competence among employees, a lack of weaver organization, and smuggling of fabric from other countries, particularly India. The investigation also discovered that about 0.2 million looms are closed because of a lack of working capital.

Jaforullah (1999) carried out production technology, the elasticity of substitution, and the technical efficiency of the handloom textile industry in Bangladesh. To determine the production technique and technical efficiency of Bangladesh's handloom textile industry, researchers employed several translog and Cobb-Douglas frontier production models. According to his findings, the industry's technical efficiency in making fabric was just 41%.

An increase in the male/female labor ratio and a decrease in the hired/family worker ratio and labor/capital ratio boosted industrial efficiency. A linearly homogeneous Cob-Douglas function characterized the pro-industry production technology. The fundamental focus of his and his colleagues' research was on the flexibility of substitution that exists within the industry between labor and capital.

Most research has been performed on the current difficulties and potential of the handloom industry (Liton et al., 2016). Furthermore, relatively few studies have been conducted on the handloom industry's present scenario, challenges, and problems they face in their business and prospects (Kalyani, 2017) and (Islam & Hossain, 2012) . Very few literature is discussed the handloom industry’s efficiency (Islam & Hossain, 2015) and (Rahman, 2013). In Sirajganj, there is scant research on the productivity of the handloom sector. However, the study area is the best location for handloom businesses. But there is no individual study on the efficiency of the handloom industry in Sirajganj. Some literature investigated the cost-benefit, profitability (Islam & Hossain, 2018) and (Islam & Hossain, 2013), production technology, and elasticity of substitution (Liton et al., 2016), causes of migration of the handloom worker (Banarjee et al., 2014).

3. Methodology

3.1 Sampling, Study Area and Data Collection

The study is based on primary data that were collected from the owners of handloom units. A total of 50 handloom unit data were collected from three Upazilas and five unions of the Sirajganj district in Bangladesh. The name of the two unions under Ullapara Upazila are Durganagar and Ullapara Municipal, The two unions are Dhukariabera, Bhangabari under Belkuchi Upazila and Shahjadpur Municipal is the only union under Shahjdpur Upazila. The Sirajganj district was selected as a purposive sample. Then using multistage sample techniques, the Upazila is selected first, followed by unions and then handloom units. For data collection, a standardized open- and closed-ended questionnaire was utilized. Data collection was conducted from December 2021 to February 2022.

3.2 Measuring Benefit-Cost Ratio and Technical Efficiency

3.2.1 (a) Net Return from the Handloom Industry

The net return is calculated by subtracting the gross return from the total production costs. Multiplying production as a full volume by the average price yields the gross return. It was made of the primary product's magnitude multiplied by itself. The following formula was utilized to estimate the gross return (GR):

$$GR=\sum QP$$

Where,

GR = Gross return (BDT/Unit Handloom Machine)

Q = Quantity of product (BDT/Unit)

P = Average price Product (BDT/Unit)

Net return is determined by subtracting total production costs from gross return. The overall cost of production is calculated as the sum of the total variable and fixed costs. In this investigation, the following equation was used to determine the net return of handloom production.

$$\Pi=GR-TC\ (TVC+TFC)$$

Where,

Π = Net return

GR= Gross return (Total production * per unit price)

TC = Total cost of production

TVC= Total variable cost

TFC = Total fixed cost

3.2.1(b) Benefit-Cost Ratio (BCR)

The benefit-cost ratio of Handloom has been used to identify whether handloom industries are profitable or not. The following equation is used to determine the BCR:

$$\mathbf{BCR}=\frac{Gross\ Return}{Total\ Cost}$$

3.2.2 The Stochastic Frontier Model

The concept of farm efficiency has been extensively examined and investigated. Technical Efficiency via stochastic edge production. A functional approach and a cognitive approach (Banarjee et al., 2014). Using the stochastic features uncovered by this research, a descriptive analysis model for the handloom industry in the study area was developed.

Meeusen & Brock (1977) suggested the SFA model initially. Additionally, Aigner et al., (1977), assuming an adequate production function is applied, a common functional interpretation of the model would look something like this:

$$Yi = f(Xi, \alpha) + \varepsilon i \tag{1}$$

Where, Yi = output level of the ith farm, Xi = unknown input value of the ith farm, and α = unknown parameter. The parameter to estimate εi = error term which consists of two separate components Vi and Ui, that $\varepsilon_i = U_i + V_i$. Here, V_i error compound member is a bidirectional error. Member and Ui = one-way error member. Random (symmetric) Vi components are assumed to be identical and independent. It is distributed by $N(0, \sigma_v^2)$. It does not depend on Ui, this random error is a random variation in the output due to factors outside the weaver's control that reflect luck, Weather, natural disasters, car breakdowns, and variables effect of input quality and measurement error Output Variables, Statistical Noise, Missing Variables functional form (Aigner et al., 1977). Following, non-negative random user interface variables indicate a stochastic shortage of products in the most efficient production. So Ui related to the technical inefficiency of the handloom unit is considered independent and evenly distributed (Ajibefun et al., 2002). Truncate the quasi-normal distribution by $N(0, \sigma_u^2)$, and it is also independent of the $V_i s$. The parameters of the probabilistic boundary model are scored sequentially for the maximum likelihood score way. The variance of probability features is evaluated as follows:

$$\sigma_s^2 = \sigma_v^2 + \sigma_u^2$$

And,

$$\gamma = \frac{\sigma_u^2}{\sigma_s^2} = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$$

Some empirical research has been conducted to analyze this. Combining production risk and technical efficiency into one skeleton. Kumbhakar (1993) demonstrated the analysis to assess production risks and technical efficiencies using: Flexible production capabilities for product presentation technology. And his model allows negative or positive limits. After the study, Specification error in equation (1), the error specification in equation (1) is

$$\varepsilon_i = g(X_i, \beta)[V_i - U_i] \tag{2}$$

So, in equations (1) and (2), and get

$$Yi = f(Xi, \alpha) + g(Xi, \beta)|Vi - Ui| \tag{3}$$

Equation (3) specifies a probabilistic boundary for probability distribution-production operations with modifiable risk factors (Battese et al., 1997). The handloom received the mean and variance of the production (hazard function), as were the expenses of investment and technology. The inefficiency impact may be approximated using the following formula for the ith handloom:

$$E\left(\frac{Yi}{Xi, Ui}\right) - f(Xi, \alpha) - g(Xi, \beta)Ui \tag{4}$$

And,

$$Var\left(\frac{Yi}{XiUi}\right) = g2(Xi, \beta) \tag{5}$$

The margin is calculated with this variance (hazard function). A partial derivative of the production risk may be derived. Costs and variations in manufacturing that might be favorable or negative. This is

$$\frac{\partial Var(^{Yi}/_{X_i, U_i})}{\partial Xij} > 0 \text{ or } < 0 \tag{6}$$

Thus, the average yield ratio to the ith determines the technological efficiency of the handloom firm (TEi). Handloom owner (taking input resource Xi and the inefficiency impact of his skill value, (Ui) up to the equivalent average maximum. It is possible to characterize possible production (production without technology) inefficiency as follows:

$$TE_i = \frac{E(^{Y_i}/_{X_i,U_i})}{E(^{Y_i}/_{X_i,U_i}-0)} = 1 - TI_i \tag{7}$$

Where TIi is the technical inefficiency. It is characterized as a possible production loss, and is expressed as the following equation:

$$TE_i = \frac{E(U_i, g(X_i,\beta)}{E(Y_i/X_i,U_i-0)} = \frac{U_i, g(X_i\beta)}{f(x_i,u)} \tag{8}$$

Random border production function parameter function is known, the best guess of Ui would be a conditional anticipation of TEi, with an absolute value of random variable $Ei - Vi - Ui$. It can show that is distributed as $N(\mu_i^* \sigma_*^2)$ where μ_i^* and σ_*^2 are determined by;

$$\mu_i^* = -\frac{(V_i+U_i)\sigma_u^2}{(1+\sigma_u^2)} \tag{9}$$

$$\sigma_*^2 = \frac{\sigma_u^2}{(1+\sigma_u^2)} \tag{10}$$

It can also show that,

$E\left[\frac{V_i}{U_i} - U_i\right]$, denoted by,

$E\left[\frac{V_i}{U_i} - U_i\right], \hat{U}_i$

$$\hat{U}_i = \mu_i^* + \sigma_*\left[\frac{\varphi(^{\mu_i^*}/_{\sigma_*})}{\omega(\frac{\mu_i^*}{\sigma_*})}\right] \tag{11}$$

φ(.), and ω(.) represent a typical random variable's density and distribution functions. The predictor for the random variable, Ei provided by equation (11), may estimate the equation (11).

$$TE_i = \frac{\hat{U}_i\, g(X_i,\hat{\beta})}{f(X_i,\hat{\alpha})} \tag{12}$$

After calculating equation (11), equation (8) can be written as in the following equation,

$$TE_i = \frac{\hat{U}_i g(X_i,\hat{\beta})}{f(X_i,\hat{\alpha})} \tag{13}$$

The technical efficiency of the handloom of the i[th] firm is $T\hat{E}_i = 1 - T\hat{I}_i$. The technical efficiency of the i[th] handloom unit may alternatively be worked out as $TE_i - \exp(-u_i) * 100$ (TE is converted to percent by multiplying this equation by 100). Based on the information provided above, the conditional expectation equation is determined and calculated conditioned on the composite error $\varepsilon i = (Vi \quad Ui)$.

3.2.3 Empirical Model

The Translog, a random production frontier model, was used in calculating the degree of efficiency of the handloom industry in the research region. To achieve the study objective the weaver's yearly income from handloom production is taken as a proxy of output for the explanatory variable and inputs of handloom are considered as the independent variables.

The experimental approach for this research is defined as Cobb-Douglas and translog functions (Villano & Fleming, 2004). The Cobb-Douglas distribution is assumed to be suitable for the frontier production function in this analysis.

The stochastic production function for handloom weavers was described as follows:

$$lnY_i = \beta_0 + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + v_i - u_i \tag{14}$$

Where,

Ln = Natural logarithm

Y_i = Yearly income of the ith farm (BDT./year)

X_{1i} = Capital the i-th farm (BDT./ year)

X_{2i}= Labor cost by the i-th farm (BDT./Day)

X_{3i} = Input/Raw materials cost by the i-th farm (BDT./Day)
X_{4i} = Number of machines the i-th farm
β_i = β_0 to β_4 are unknown parameters, and
v_i-u_i = the disturbance term in the production function

The technical inefficiency effects of *Ui* are defined as:

$$U_i = \delta_0 + \delta_j Z_i + W_i$$

Where,

i = (1,2,3)
Z_1=Age of the handloom owners (years)
Z_2=Education of the respondents (Measured in the year of schooling)
Z_3= Family size (no.)
δj is the unknown parameters to be estimated and
Wi= Random error of technical inefficiency model

4. Results and Discussion

4.1 Socioeconomic, demographic and unit-specific characteristics

Table 1 displays the estimation variables and associated sample data, including the handloom owner's maximum and minimum values, mean, and standard deviation about their Socio-Demographic variables (Age, Education, Family Size), Economic Variables (Labor cost, Input Cost, Capital, Yearly income), Situational Variables (Number of Handloom Machines, Experience), Production Cost and Selling Price of the Handloom Product\per unit (Sari, Gamsha, Orna).

Table 1: Socioeconomic, demographic, and unit-specific characteristics

Variable	Minimum	Maximum	Mean	Standard Deviation
Age (Years)	26	63	47.3	9.45
Education (Years)	0	15	4.02	4.17
Family Size (Numbers)	3	9	4.83	1.97
Labor cost in a Day (BDT)	150	6600	1282	1133.15
Input Cost in a day	170	24000	4702.4	5651.51
Capital (BDT)	10000	580000	136200	107544.77
Yearly income (BDT)	20000	300000	119100	64866.98
Number of Handloom Machines (Numbers)	1	28	7.94	5.38
Experience (Years)	5	45	24.74	10.423
Production Cost of the Handloom Product (BDT)				
Sari	80	700	368.91	126.33
Gamsha	35	115	76.67	28.19
Orna	75	80	77.33	2.89
Selling Price of the Handloom Product (BDT)				
Sari	90	800	404.22	143.05
Gamsha	40	120	82.33	30.24
Orna	80	90	83.33	5.78

Source: Author's calculation using filed-survey data, 2021-2022

The average age of handloom owners is 47.30 years which indicates they are all in middle age. From this, it is clear that young individuals are not entering in this business. The handloom owner's average number of years in school is 4.02, this indicates they are not fulfilling their primary-level schooling. Each family has an average of four members.

The minimum labor cost per day is BDT.150, the maximum labor cost per day is BDT.6600, and the average labor cost per handloom unit is BDT. 1,282. The average daily input cost is BDT. 4702.40. The average annual income is BDT.119100, and the average capital worth is BDT.136200. The ratio of capital to annual income indicates that the output is comparatively smaller than the invested capital.

Minimum of one (1) and maximum of twenty-eight (28) handloom machines are owned by handloom owners.

The average experience (working age) of handloom owners is 24.74 years which indicates that handloom owners are not encouraged in recent times. Those who were previously involved in this business are now doing this business.

Production Cost of the Handloom Product: The average production costs for Sari, Gamsha, and Orna are 369.91, 76.67, and 77.33, with the lowest and highest cost values being 80, 35, 75, and 700, 115, 80, respectively.

Selling Price of the Handloom Product: The average selling price of Sari, Gasha, and Orna is 404.22, 82.33, and 83.33, with the lowest and highest selling values of 90, 40, 80, and 800,120, 90, respectively.

Table 1 also shows the standard deviations of the variables. The standard deviation of variables is measured by the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates that the values are spread out over a wider range.

4.2 The Stochastic Production Function

Table 2: Maximum Likelihood Estimates for Parameters of Cobb-Douglas Stochastic Normalized Cost Frontier and Economic Inefficiency Effect Model

Independent Variables	Parameters	Coefficient	Standard error	P-value
Stochastic Frontier				
Constant	β_0	4.225*	.000	0.000
Ln Capital (X_1)	β_1	.125*	.000	0.000
Ln Labor cost (X_1)	β_2	.221 *	0.000	0.000
Ln Input/Raw materials cost (X_3)	β_3	-.087*	.000	0.000
Ln Number of machines (X_4)	β_4	.060*	.000	0.000
Inefficiency effect model				
Constant		1.212	.877	0.167
Age(years) Z_1		-.0109	.011	0.332
Education (years of schooling) Z_2		-.134***	.073	0.068
Family size (no.) Z_3		-.0758	.152	0.619
Variance parameters				
Sigma-squared		0.142*	.114	0.001
Gamma		0.999		
Log-likelihood function				
Likelihood Ratio		24.404		

Source: Author's calculation using filed-survey data, 2021-2022

Table 2 describes * (0.01) or 1%, ** (0.05) or 5% and *** (0.10) or 10% indicate significance levels of probability.

The stochastic frontier results revealing that the coefficients of the variables are positive except in the case of the x_3 (Input cost). All variables have statistically significant at 1% level. Despite input, cost impacts negatively on firm production, but these are statistically significant.

To measure technical inefficiency Maximum likelihood estimator is used. Generally, a negative indication of the predicted variables means a decrease in technical inefficiency or an increase in technical efficiency. In table 2, the inefficiency effect model outcomes indicate that the education variable is significant at a 10% significance level.

The value of the variance parameter σ^2 is positive and 0.142, which is statistically significant at 1% level. This value conveys that there prevails enough evidence to believe that technical inefficiencies are present in the model.

Thus it also indicates the differences between the observed (actual) and frontier (potential) output are due to inefficiency and not chance alone. Theoretically, it can say that the estimated model and distributional assumptions for the error terms are appropriate.
The variance ratio Gamma *(γ)* is the total production variation owing to technical efficiency from the frontier level of output. In the recommended truncated normal model, the anticipated value of (the ratio of output variance owing to technical efficiency) is 0.99. It may estimate that around 99 percent of the discrepancy between observed and anticipated output is related to the inefficiency variables that are under the control of the farmers in the study region.

Table 3: Technical Efficiency of Handloom Firms

No of Farms	Technical Efficiency			
	Mean	**Maximum**	**Minimum**	**Standard Deviation**
50	.789	1	.375	.166

Source: Author's calculation using filed-survey data, 2021-2022

It is seen in table 3 that the mean technical efficiency for the sample is 79 percent, with a minimum of about 38 percent and a maximum of hundred percent. This indicates that the handloom unit can obtain 79 percent of potential output from a given mix of production inputs. This result tells us that in the short run, there is room for increasing handloom production in the study area by 21percent by adopting more advanced technology and techniques.

Table 4: Frequency Distribution of Technical Efficiency of Handloom Production

Number of firms under different efficiency levels %		
Below 50	50-below 75	75-100
3	14	33

Source: Author's calculation using filed-survey data, 2021-2022

Table 4 describes the frequency distribution of the efficiency estimates obtained from the stochastic frontier model. The sample data exposes the estimated firm efficiency as almost one. About 66 percent of firms' efficiency level is in between 0.75 to 1.00. Only 6 percent of the firm has an efficiency score under fifty percent. Twenty-eight percent of firm efficiency level ranges between fifty to below seventy-five percent.

4.3 Benefit-Cost Ratio from Handloom Units in the Study Area

Here, family labor was not included in labor costs. Because they can't take money on daily basis rather than share their profit for a specified period of time. While collecting data, it was seen that fixed cost was included as materials of products and processing costs.

Table 5: Benefit-Cost Ratio of the Handloom Industry

Items Cost/Unit	Sari (BDT)	Silk Sari (BDT)	Gamsa large (BDT)	Gamsa Medium (BDT)	Orna (BDT)
Labor Cost	95	80	25	13	32
Input Price	275	182	60	22.5	43
Material Processing Cost	8	8	2	1	2
Fixed Cost	7	10	3	1.5	3
Total Cost/Unit	385	280	95	38	80
Total Revenue/Unit	425	315	120	40	90
Net Profit/Unit	**40**	**35**	**25**	**2**	**10**
BCR	**0.10**	**0.12**	**0.26**	**0.05**	**0.12**

Source: Author's calculation using filed-survey data, 2021-2022

Net Profit: The net profit is determined by subtracting total revenue from total costs. Total revenue for one unit of sari Silk Sari, Gamsa (Large), Gamsa (Medium), and Orna is 425, 315, 120, 40, and 80 BDT, respectively. BDT 285, 280, 95, 38, and 80 are the costs per unit production of a handloom product. So, the total profit for each one is 40, 35, 25, 2, and 10 BDT, respectively.

Benefit-Cost Ratio: The benefit-cost ratio is calculated in the above table by dividing total revenue and total cost on a full-cost basis. The Benefit-Cost Ratio (BCR) on the real cost is 0.1025, 0.125, 0.263, 0.053, and 0.125 for the handloom pre-unit sari Silk Sari, Gamsa (Large), Gamsa (Medium), and Orna, respectively. The Benefit-cost ratio (BCR) on a full cost basis is highest on Gamsa (Large) which shows the return over cost is almost One-fourth, which indicates the return from the handloom product is very low.

5. Conclusion

The purpose of the research was to determine the technical efficiency of the handloom industry in the Sirajganj district, along with the technical efficiency, socio-demographic state, and current hazards and prospects of the handloom industry in the six unions of the three Upazila in Sirajganj district, and throughout Bangladesh. Sirajganj was purposefully sampled, and the individual samples were multistage random samples. A total of 50 handloom owners shared preliminary data. Tabular and econometric tools were used to analyze data.

All variables except input cost have positive stochastic frontier coefficients. Capital, labor cost, and the number of handloom machines all affect handloom production (Yearly Income). Negative calculated parameters indicate technical inefficiency which is input cost, age, education, and family size. Gamma represents production divergence from the frontier. The technological efficiency ratio (truncated normal model) is 0.99. Almost 99 percent of observed and frontier output disparities are due to inefficient handloom owners. The sample's mean technical efficiency is 79 percent (38-100 percent). The handloom farm's inputs may create 79 percent of its potential output. Modern technologies can enhance handloom productivity by 21 percent. 66 percent of handloom firms have efficiency scores of 0.75-1.00. The handloom industry's efficiency is 49 percent. The industry's efficiency is between 50 percent and 75 percent. The Benefit-cost ratio (BCR) on a full-cost basis is highest from Gamsa (Large) which shows the return over cost is almost One-fourth, which indicates the return from handloom product are very low. This study also investigated socio-demographic variables (age, education, and family size), economic variables (labor cost, input cost, capital, and yearly income), situational variables (number of handloom machines and experience), and production cost and selling price of different handloom products.

The tradition of the Bangladesh weaving industry is well-known all over the world which is the most potential industry in Bangladesh. The history of weaving is one of the most glorious in the art world of Bangladesh. The weaving industry can be a significant example of how this industry can economically benefit people and how small and cottage industries can meet the needs of SDGs like decent work and economic growth.

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