Efficiency and Productivity Measurement for Sustainability of Selected Textile Companies in Bangladesh: An Application of Data Envelopment Analysis

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Abstract

Inefficiency and less productivity can create unsustainability. This study aims to analyze the productivity and efficiency for the economic sustainability of selected textile companies in Bangladesh. The study selects Nineteen (19) companies conveniently based on data availability of annual reports and only secondary data of six years has been collected and analyzed. Cost of materials, wages and salaries, energy and fuel costs, and total assets are input variables while sales, gross profit and net profit are used as output variables for this study. The researcher uses the Malmquist Productivity Index (MPI) and also examines the profit trend over the mentioned period. The study results reveal that Rahimtex is efficient whereas Argondenims & Apexspin are relatively efficient; all other companies are inefficient in terms of total factor productivity. However, Maksonspin, MHSML and Zaheenspin are highly deteriorated from the benchmark. Technological change is responsible mainly for such inefficiencies. The study also finds the profit trend of the sample companies is in mixed position and not increasing accordingly as sales and costs. Thus, advanced technology and efficient management are required to increase the productivity & profitability for sustainable textile companies in Bangladesh. Government may provide conditional cash and tax incentives to get advanced technologies and managers can hire the applied knowledge to grow the success seeds in own.

Keywords: Productivity, Efficiency, MPI, Data Envelopment Analysis, Total Factor Productivity.

1. Introduction

Manufacturing industry is playing vital role for economic development by producing distinct products for local customers and by earning revenue from export (Abbas et al. 2020). Textile and garments are the highest contributing sector regarding export, employment, foreign currency, and GDP in Bangladesh that act as the backbone of the fastest growing economy in Bangladesh (Hossain & Khan 2020). Mainly wage differences among the countries was the cause of shifting production of textile & garments. Few years ago, this sector was profitable in Bangladesh but now it is facing trouble with some challenges.

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Modern technologies are helping the textile sector to reduce waste of time and goods and increasing productivity whereas; still it is challenging issue to minimize the costs of input and to maximize the output. This challenging as well as the competitive situation leads the textile for making products with low cost, minimum usages of resources, and increasing outputs. Sometimes, inefficiency can cause a higher production cost. Kapelko and Lansink (2015) claimed that the removal of the Multi-Fiber Agreement (MFA) Quotas in 2005 is increasing challenges forthwith and rapid changes took place on production technology and customer preferences. From that time, small and medium scale garments and textiles are facing tremendous competition with large scale operation locally and globally. But, the Tazreen fashion fire in 2012, Rana Plaza collapse in 2013, and GSP benefits stopped by the USA have created troubles and reasonable challenges. Moreover, WTO imposed new & strict rules for production, and foreign buyers, Bangladesh government, and the environmental community are asking for the sustainable development, labor law & rights, and safety-related clauses. Hence, numbers of small and medium garments and textiles in Bangladesh wiped out and are continuing to decrease.

Papon et al. (2017) highlighted that production and productivity depends on management efficiency that leads to the greater performance of Bangladesh textile. This sector can't change external unfavorable conditions by themselves. Thus, for the sustainable survival, they should improve internal conditions like efficiency and productivity. Labor, raw material and capital are the vital production resources and the issues of textile growth. Productivity change and change of technical efficiency are crucial components of higher growth ratio which may help firms to compete with competitors because the productivity, efficiency, and performance positively affect the future sustainability. Incidentally, Data Envelopment Analysis (DEA) is helpful to determine the efficiency by producing expected outputs through transforming required inputs. Joshi and Singh (2010) claimed the Malmquist Productivity Index (MPI) in DEA has widely recognized as total factor productivity (TFP) measurement tools for decision-making units (DMUs). In Bangladesh, analysis of multiple inputs and outputs-based DEA for textile companies is not available. Thus, the objective of this study is to examine the efficiency & productivity of selected listed textiles in the Dhaka Stock Exchange, Bangladesh. The study aims at to see the level and causes of inefficiencies of the sample textiles. Therefore, inefficient firms can solve their weaknesses, increase productivity through efficiency and make the economy stable.

2. Rationale of the Study

Bangladesh textile sector is the prime industrial sector in employment, foreign currency and overall economy. This sector is fighting with several and severe current issues like the removal of MFA (2005) GSP (2013), increasing costs for sustainable issues, diversified customer choice & preferences, high national & global competitions, and time & costs management, etc. Besides this, the competition provides the benefits to

make the competitor efficient, sustainable, and fit for the survival in the long run. In this situation, efficient use of time, labor, raw materials, and assets can help the company to be efficient. Therefore, the efficiency of production and management is a main concentration of this study. Findings on efficiency and specific area of inefficiency of the selected companies may lead the decision-making process. However, the research result will help the textile executives to borrow the knowledge & skill from the efficient company and may apply to their own field. As a result, reasons for inefficiency may be solved and inefficient company may turn into efficient company. Bangladesh government, Bangladesh Bank and other policymakers may redesign the aid policy, tax holiday scheme, cash incentives and natural resource distribution planning based on the findings. It means that the selected textiles and Bangladesh government can be benefited directly and society will get benefit indirectly. Finally, these improvements can increase productivity and efficiency, reduce production cost and reduce the reckless uses of natural resources. Thus, the efficiency & productivity of the company may provide low production costs, high profit, more contributions to GDP & foreign currency and enhance the social sustainability.

3. Statement of the Problem

Production costs & profit of the developing country may be lower than the developed country for the presence of human capital and the intermediary channel. Many other factors influence and can reduce the export & profit of the textile companies. Moreover, the sustainable development goals offer limited uses of natural resources. Thus, we should concentrate on efficiency, profitability, and productivity through good management. Inefficiencies and less growth of productivity may cause a drawback for global competition. Using low labor costs and good sea-port, Bangladesh can participate more locally and globally by getting improvement in efficiency & productivity in the textile sector. Therefore, the question may come, what are the factors involved in production efficiency? However, the relationship between input and output variables refers technical efficiency (TE). Large scale production & size of the firm indicate the scale efficiency (SE). The advanced, updated & green technology denotes the technological efficiency change (TEC) and good management represents pure efficiency change (PEC). Consequently, another question may arise, where is the efficiency gap and how can they be efficient? Therefore, the investigation of output-oriented Malmquist productivity index based on panel data of the listed textiles is the core issue in this research to measure the efficiency.

4. Literature Review

A literature review is a way to find out what researchers have done in the selected areas and the research gap for the further research. So, the researcher has the following review of existing available literatures to find out the research gap and variables.

Duzakim & Duzakim (2007) stated that the input-oriented method highlights minimize the input to get the same output & the output-oriented focuses on maximizing the production output with the same input production. Hrebick et al. (2014) claimed that DEA is a multiple-criteria decision-making method that has the widespread use of performance evaluation, assessing the effectiveness of investment and benchmarking. Ho (2013) examined the DEA to see the efficiency of twelve (12) Taiwan textile companies and found that two textiles achieved a constant return to scale and other ten under increasing return to scale. Duzakin & Duzakin (2007) analyzed Five hundred (500) Turkey companies based on the super slack DEA model using the number of employees & net assets as input variables and export revenues, EBT & gross value added as output variables. They found that textile and leather companies are not efficient in terms of efficiency & productivity. Saricam & Erdumlu (2012) analyzed efficiencies of textile and apparel companies listed in the Istanbul Stock Exchange using an input-oriented DEA model based on variable return to scale (VRS). The study found that the apparel industry's average efficiency scores are better than the textile industry. Rakhmawan et al. (2015) applied DEA analysis for measuring productivity and efficiency of Indonesian textile companies. They argued that changes in human resource efficiency or capacity and changes in technology would positively affect the growth of productivity. Joshi & Singh (2010) claimed productivity is the force factor to face the competitiveness for any DMUs. They analyzed gross sales as an output variable and net fixed assets, wages and salaries, energy and fuels, and raw materials as input variables for MPI for panel data of Indian textile companies. However, they revealed from TFP, growth of productivity is highly effective through TE but not by the TEC, but it is the cause of declining productivity growth. Naz et al. (2017) employed total sales as an output variable and shareholders' equity, assets & operating expenses as input variables. They outlined that spinning textiles have no contribution to bringing the growth to productivity, whereas composite & weaving textiles are contributing to using technical efficiency changes. They used DEA & found that the TFP is not skewed based on 64 Pakistani firms through panel data and claimed that price information is not required if panel data is available for quantity input and output.

Bhandari and Ray (2012) studied Indian textiles through an annual survey to find out the stages of firm-level TE by using DEA. They suggested that if textile companies can manage to increase output continuously without increasing the use of input may lead to reduce the average cost of textile production. Bhaskaran (2013) studied the productivity and TE of the Indian textile industry with the object of a financial and physical performance regression, correlation, and DEA for measuring the return to scale, input and output slack as well as TE. He used the number of units produced and number of employees as input variables and annual sales & exports as output variables. They found, one textile company increased return to the sale, three (3) textile companies as constant return to scale. He suggested that if companies can ensure the sustainable development between the interrelationship in infrastructure technology, production,

procurement & market, they will be able to reduce cost as well as increase the efficiency and productivity. Mahadevan (2002) claimed longtime productivity of TFP indicates sustainable productivity growth that will ensure the sustainable business.

Ikasari et al. (2014) analyzed efficiency and productivity through DEA and MPI on textile products and textile industries in Indonesia using sales as output variable and labor expenses, cost of raw & auxiliary materials, fuel & power costs, and electricity expenses as input variables. They used cross-sectional data and found efficient industries through the constant return to scale (CRS) & variable return to scale (VRS). They revealed that increased TFP due to TE. Gambhir & Sharma (2015) analyzed output-oriented MPI under DEA to analyze panel data of one hundred and sixty (160) Indian textile companies. They used gross sales as an output variable and raw materials, power and fuel costs, salary and wages, and net block as input variables. They found that TEC and SE are the main drivers to get productivity growth and PEC respective for all firms but irrespective of scale. They suggested to innovate and improve the technology and to reduce textile wastage at the time of resource utilization. Mella et al. (2020) examined the productivity and TE of Chilean manufacturing industry with the labor costs & capital as input variables and total fixed assets, electricity costs, fuel, power & energy costs and material costs as output variables. To be efficient, they suggested that managers should reduce labor & materials costs, reduce cost by energy saving and optimize all maintenance. Finally, they argued for TE and TEC to increase productivity. Yeung and Mok (2004) analyzed the Chinese textile and clothing industry and commented on the Asian clothing and textile industry that they are restructuring and adjusting existing practices by reducing employment and the number of firms and increasing profitability and efficiency. Kapelko & Lansink (2015) examined an international comparative analysis of the clothing and textile industry to see productivity change through bootstrap DEA. They used total sales and other revenue as single output variable and number of employees, cost of goods sold, and tangible fixed assets as input variables and found the increasing insignificant overall productivity with TEC despite decreasing SE and TE. However, Goyal et al. (2017) studied 101 Indian companies with cross-sectional data with DEA. (They used pure, scale & overall technical efficiencies and found 16% average rate inefficiency in which managerial inefficiency is the topmost.) They suggested that utilizing balance resources and refining processes to eradicate and control that inefficiency. Mawson et al. (2003) claimed that TFP is not due to the changes in TE, whereas it would be affected by TEC. Joshi and Singh (2010) argued that in the DEA (MPI) bundle of inputs and outputs can be applied to measure the efficiency and productivity of DMUs which will be better than the single input & output analysis system.

Ahmed & Liza (2013) examined DEA based overall efficiency & Rashedul & Israt (2012) analyzed output-oriented DEA of the Bangladesh Banking sector to measure the efficiency. They found that three (3) banks are efficient under CRS DEA & twelve (12) banks are efficient under VRS-DEA. Azad et al. (2016) investigated fifteen (15)

Bangladeshi microfinance institutions using DEA Malmquist Index (MI) to find out TE, PEC, and SE. Azad et al. (2018) analyzed the Bangladeshi pharmaceutical industry to evaluate TE through the Malmquist TFP index using actual sales as output and cost of raw materials, fixed assets, and salary expenses as input. Ho (2013) used number of employees, total fixed assets, operating cost as input variables, and operating revenue (sales) as output variables for DEA analysis. He argued that profitability & growth are the indicators to measure the efficiency and productivity. But TFP, PEC, TE, SE through DEA analysis is the most effective tool for productivity and efficiency. Saricam and Erdumlu (2012) and Sherman & Zhu (2006) used DEA to evaluate the efficiency and performance of DMUs with multiple input and output variables. They claimed DEA considers all the partial efficiency for total factor efficiency where multiple inputs and outputs can easily be used & the functional relationship of input and output is not required. Abdulah et al. (2018) examined the level of efficiency and determinants of the technical inefficiency of Malaysian textile using stochastic frontier approach. They found, albeit, firms overall TE is high but there are some inefficiencies, reducing these inefficiencies like capital-labor ratios, education levels, wages & communication costs and information technologies may lead to reduce inefficiencies of the firm.

Rasel & Khan (2020) focused that Bangladeshi textile sector is facing challenges from global dominating countries and sustainable issues. These issues and challenges may vary over the company or over the county bordar but are required to solve. Rahman et al. (2020) revealed by the qualitative survey in Bangladesh that minimum wages can cause the higher cost of labor but it will help the firm to increase motivation and productivity. Shah et al. (2020) stated that consumption of imported and domestic materials is largely increased in Bangladesh, India and Pakistan along with lower resource productivity with comparing to developed country. They commented that studied countries are far away from the environmental protection and resource efficiency standard. They found that material intensity decreasing and productivity increasing in Bangladesh. Dhar (2019) analyzed the productivity of Bangladeshi readymade garments based on lean wastes and commented that industrial productivity may improve by reducing industry lean wastes or lead time. Haque et al. (2011) measured the performance of Bangladeshi apparel and textile companies on the supply chain network through key performance indicators (KPI) based on a case study and got supply chain efficiency is only 61%. Islam and Adnan (2016) stated that many researchers tried to focus the increasing productivity by using lead time, lean manufacturing, and line balancing of the Bangladesh garments sector with non-monetary behavioral aspects. However, Shafiqul (2014) analyzed the productivity of informal labor incentives through the case study on Bangladeshi readymade garments and proposed that technological adaption in equipment investment, development of human resources, and sufficient labor pay and incentives strategy may increase the productivity of this sector. Rahman & Amin (2016) studied empirical analysis of the

Bangladeshi garments sector to find out the factor-based production efficiency on the investigation survey method. They found wastage, machine, and sewing problem, late come; shade variation, cutting problem, accessories problem, size mistake, and delay in the input are the bottlenecks of productivity. Based on the time study technique Nabi et al. (2015) proposed that to solve and control the present challenges and problems of the apparel manufacturing industry in Bangladesh, we need to reduce lead time, increase productivity and efficiency with a good quality. Hossain & Oh (2019) studied technical efficiency and TFP of Bangladesh textile using MPI. They found, after Rana Plaza tragedy TFP is declined of this sector and labor cost, internal political unrest and Rana Plaza tragedy has negative effects on TFP of the selected sector.

From the above study, the researcher observed that profitability, productivity, and efficiency are necessary factors for the long run sustainability. Besides, DEA can work effectively with multiple input and output variables to seek the productivity and efficiency with or without price information. There is no available literature on Bangladeshi listed textile companies to examine the efficiency, productivity, and profitability through DEA.

5. Methods:

Rakhmawan et al. (2015) claimed that the DEA estimator is the best practiced, faster, unbiased, consistent, and appropriate production function of the efficiency measurement through a non-parametric deterministic approach. It is a quantitative research and researcher used balanced panel data for the output-oriented Malmquist Productivity Index (MPI) under DEA. Saricam & Erdumlu (2012) claimed that minimum number of DMUs would be (Input + Output +1) or 2 x (input + output)). As a result, DMUs would be (3+4+1) =8 or 2 x (3+4) =14. All the required data is not available in the annual reports and annual reports of all companies are also not available in the websites. The study has taken nineteen (19) companies from fifty six (56) listed companies in Bangladesh based on convenient sampling.

Table-1: Sample selection process

Explanation or sample selection criteria	DMUs/ Companies
Total listed textiles in DSE	56
6 years annual reports not available	22
Annual reports available	34
Down concern or data not available	15
Ultimate selected sample textiles for the study	19

Source: Author's compilation

Input & output variables of 6 (from 2013-14 to 2018-19) years have been collected from the annual reports as secondary data. Researcher involved directly to collect all the data from annual reports. The growth of productivity is the outcome of changes in technical efficiency and technological efficiency. If the TFP values are more than 1 (TFP >1) and less than 1 (TFP <1), would indicate relatively efficient and inefficient respectively. This relative efficiency also indicates perfection of productivity between the time period t & t+1 and relative inefficiency directs deteriorations of the performance over the period t and t+1. However, net profit, gross profit, and net sales are considered output variables, and total assets, cost of materials, labor costs, and costs of fuel, gas, and power are considered as input variables which are supported by the literature.

Table -2: Types of selected variables

Classification	**Name**	**Type**	**Nature**
Output variables	Sales	Continuous	Taka
	Gross profit	Continuous	Taka
	Net profit	Continuous	Taka
	Production units could be the strong output variable. But some selected companies did not provide production units. However, sales can strongly represent the production output variable.		
Input variables			
	Total assets	Continuous	Taka
	Raw materials consumed	Continuous	Taka
	Productive salaries and wages	Continuous	Taka
	Cost of fuel, power, electricity and gas (production)	Continuous	Taka
	Productive salaries and wages are used due to absent of direct labor hours or number of employees.		
Variables are collected from the annual reports of 2013-2014 to 2018-2019			

Source: Author's compilation from selected companies' annual reports.

All these variables are analyzed by the MPI through DEA with panel data and also shown comparative graphical presentation to get trend. Here, MPI is used to identify inefficient company and area of inefficiency. Both input and output-oriented efficiency can be measured by DEA. Input based DEA refers constant output with decreasing input while output based DEA focuses constant input with maximizing output. Both the methods can produce same result under constant return to scale (CRS) technique but may vary under variable return to scale (VRS) (Coelli & Rao 2005). The researcher thinks that all selected listed textiles are financially solvent & working in a strong competitive environment. As a result, constant return to scale (CRS) is used for completing the study. In MPI outputs are presented in form of technical efficiency (TE), technological efficiency change (TEC), pure efficiency change (PEC), scale efficiency (SE) and total factor productivity change (TFP). Graphical presentation is used to see the profitability performance trend where will show the economic efficiency of the selected companies that can ensure the sustainable development by reducing inefficiencies.

6. Analysis and Discussion

Efficiency is simultaneously used as productivity which is a part of effectiveness. If an organization can produce more product with same inputs or same outputs with low inputs that indicates efficiency and can be able to achieve the organizational goals & objectives will call effectiveness. These efficiency and effectiveness ensure partial sustainable development of the organizations and the country. Neto et al. (2019) argued that cleaner production seeks the continuous use of environmental approach in process, production and service after production that leads to increase efficiency and reduce risk for people and environment. Mazumder et al. (2018) claimed that productivity measurement may be practiced to control and provide facilities for decision-making in manufacturing organization. The researcher examined productivity and efficiency for the sampled listed textile companies in Bangladesh through DEA (computer) program (DEAP 2.1) developed by Coelli (1996) for estimating the productivity score shown in the table 3. The last column of the table 3 represents TFP which is the overall performance of the selected companies that reflects the presence of TE, TEC, PEC and SE. Mean of the TFP of the six (6) years for the selected companies from table 3 shows 0.872 (bellow 1). It indicates that they should overcome 12.8% (1- o.872) inefficiency to become efficient with comparing to benchmark 1. In year three (3) sampled companies achieved average productivity of 3.9% (1.039-1) more efficiency due to the positive annual TEC (1.072 which is greater than 1 and only 1 greater value in the TEC column). However, in year 2, 4, 5, and 6 TFP show the decline productivity (less than 1) with the value 0.769, 0.900, 0.776, 0.902 and 0.872 respectively. DMUs should concentrate on the TFP change to uplift the present productivity and efficiency.

Table -3: Results from DEAP Version 2.1, Output orientated Malmquist DEA

MALMQUIST INDEX SUMMARY OF ANNUAL MEAN					
Year	TE	TEC	PEC	SE	TFP
2	1.031	0.745	1.044	0.987	0.769
3	0.969	1.072	0.971	0.998	1.039
4	1.042	0.864	1.028	1.013	0.900
5	1.022	0.759	1.009	1.013	0.776
6	0.939	0.961	1.001	0.938	0.902
mean	1.000	0.872	1.011	0.989	0.872

Source: Author's Compilation

From the annual mean, it is observed that TEC is mainly responsible for such inefficiency and other elements are little bit responsible to some extent. The technical inefficiency indicates the level of failure to produce more production with same inputs or vice versa which means there was a chance to improve. However, the TEC articulates sufficient and skillful use of advanced technology and the PEC focuses efficient planning, directing, and controlling management activities to achieve the organizational objectives. PEC also refers overextend management control and or high uses of fixed costs. Moreover, SE highlights production capacity in the large scale or size of the organization. Thus, based on the annual mean from the table 3, less uses of advanced technology is found.

In the table 4, it is observed that the average annual mean score of all the selected companies is 0.872 that represents the inefficiency of the sample companies at the rate of 12.8%. Based on the TFP, Rahim textile (DMU-12) is stagnated annual average score of 1.008 and DMU 19 (Argon Denims) stagnated annual average score 1.019 that indicates, they are efficient and achieved 0.08% and 1.9% efficiency rate respectively. Here, Rahim textile obtained an efficient position among all other companies with 0.08% technological efficiency change and only this company is fully efficient with all productivity & efficiency terms. Although, TFP of Argondenims is greater than 1 but its technological efficiency change is less than 1. Among others, largest deterioration found in case of Maksonspin and its TFP 0.622 which means 37% inefficient because of 35% inefficiency in TEC. It is an arguable note that, except few, all the selected companies are efficient or relatively efficient with TE, PEC, and SE but they are not efficient on

Table -4: Results from DEAP Version 2.1, Output orientated Malmquist DEA

MALMQUIST INDEX SUMMARY OF FIRM MEANS					
DMUs	TE	TEC	PEC	SE	TFP
APEXSPIN	1.000	0.998	1.000	1.000	0.998
HFL	1.000	0.781	1.000	1.000	0.781
MAKSONSPIN	0.964	0.645	1.000	0.964	0.622
MATINSPIN	1.075	0.825	1.043	1.031	0.888
SAIHAMTEX	1.088	0.893	1.101	0.988	0.972
SIMTEX	1.000	0.946	1.000	1.000	0.946
MHSML	0.956	0.880	0.977	0.978	0.840
ANLIMAYARN	1.033	0.778	1.000	1.033	0.804
GENNEXT	1.000	0.727	1.000	1.000	0.727
AL-HAJTEX	0.817	0.947	1.000	0.817	0.774
DSSL	1.063	0.936	1.058	1.005	0.996
RAHIMTEXT	1.000	1.008	1.000	1.000	1.008
HWAWELLTEX	1.000	0.948	1.000	1.000	0.948
ZAHEENSPIN	0.980	0.807	0.986	0.994	0.791
TOSRIFA	1.000	0.835	1.000	1.000	0.835
SQUARETEXT	1.000	0.953	1.000	1.000	0.953
DSHGARME	1.000	0.851	1.000	1.000	0.851
STYLECRAFT	1.000	0.940	1.000	1.000	0.940
ARGONDENIM	1.053	0.968	1.045	1.008	1.019
Mean	1.000	0.872	1.011	0.989	0.872

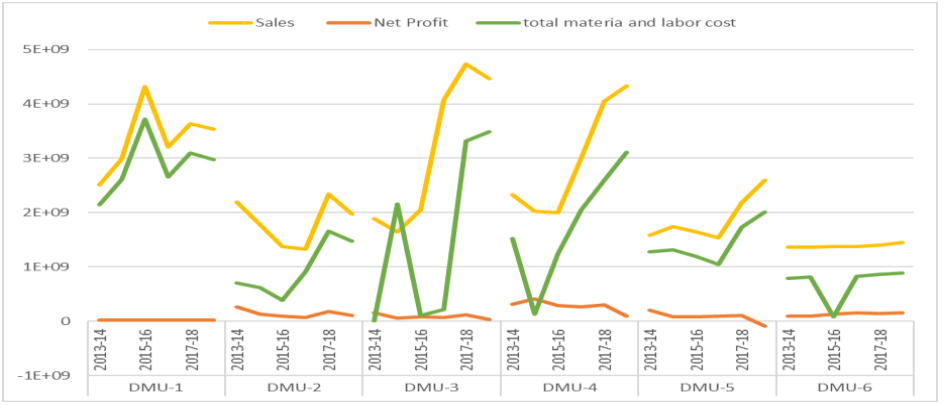
[Note that all Malmquist index averages are geometric means]

Source: Author's Compilation

TFP and it is the consequences of TEC. More interesting research result is TFP inefficiency is equal to TEC inefficiency and both have decreased result is 0.872. Pure efficiency change represents the efficiency of the management and except DMU 7 and DMU14, all sampled companies are efficient. Besides, scale efficiency states the influential size of the company and DMUs 3, 5,7,10 and 14 are not efficient enough so that they have the opportunity to enhance their production capacity to be larger and efficient. Thus, it is clear that TFP change is focused on TEC. The researcher also found that DMUs 3,7,10 and 14 are not efficient in terms of TE to achieve the efficiency comparing to the benchmark. The main focusing area of this study is the technological change under MPI which is required to uplift the present inefficiency to become efficient through the minimizing output slack. Finally, the researcher can conclude that the selected companies can be efficient by increasing output-oriented productivity, and they must improve their efficiency in the technological change i.e. they need to use modern and up to date technologies and machineries. This TEC will take environment friendly footsteps and will increase productivity. Inefficient companies can learn the way and technique to get success from the efficient one. We know, firm's technology is a part of process innovation. The main findings (technological inefficiency of the selected companies) of this study indicates that process innovation is required and this finding is similar with (Waheed 2017) where he found, process innovation is an important item for labor productivity of Bangladeshi firms but significant of product innovation is not well established.

Another part of this study is a graphical presentation of sales, net profit, and materials & labor costs to see the trend and growth of productivity. Without economic sustainability we can't ensure the social and environmental sustainability of the firm and the main tools of economic sustainability are profit & its positive growth. On the other hand, an organization is efficient or not that will depend on the achievement of the core objectives to maximize profit and wealth through

Graph-1

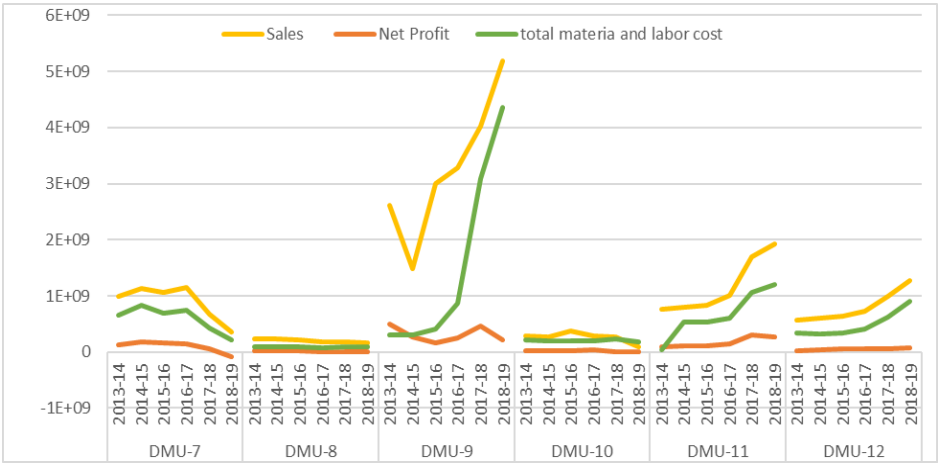


Source: Author's Compilation

increasing production and sale or decreasing various costs and wastage. Thus, the sustainability and efficiency of these selected listed textiles depend on profitability. The sales and costs trend in the graph are increasing, and both patterns are same but few are fluctuating or declining.

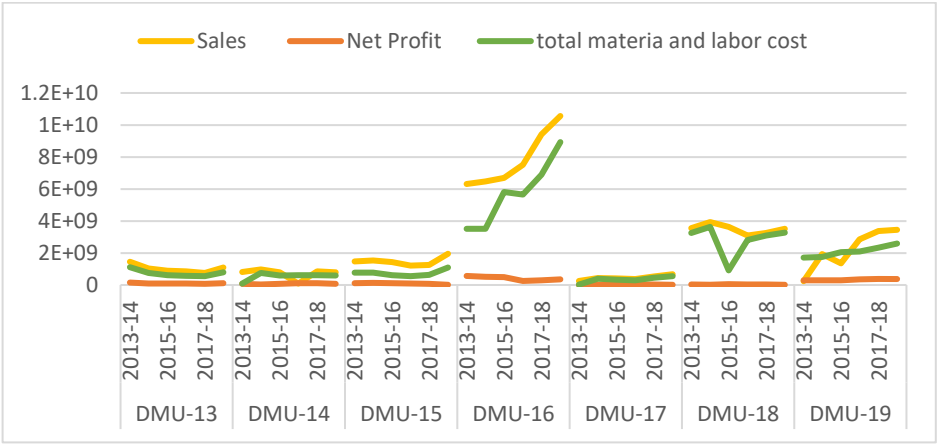
In the graph -2 it can be observed that the sale, cost of materials and labor are almost stable

Graph -2



Source: Author's Compilation

Graph -3



Source: Author's c Compilation

position of Anlimayarn Deying Ltd and Al-Haj Textile Mills Limited. From the graph 1, 2 and 3 the study revealed that almost all the companies' profit trend is declining or in static position. It means that sales & costs are increasing but not profit that is not good for the selected companies and the country's economy. Finally, it is noticed that the DMUs which are inefficient in terms of increasing cost but not increasing profit, almost all DMUs are inefficient in terms of productivity. If the selected firms were able to increase productivity the inefficiency would not be happened. This is happening because of old, weak and slow technology including management inefficiency. Moreover, high fixed cost involvement in operation also causes for scale inefficiency. Albeit, declining or static profit growth creates economic unsustainability, but efficiency and productivity can change this dimension positively.

7. Contribution of this Study

This study is unique and original. As per the global reporting initiatives (GRI), 12th and 13th sustainable development goals (SDGs) (ensure sustainable consumption and production pattern) and (take urgent action to combat climate change & its impacts), each organization should go for the sustainable development. This research demonstrates the ability of listed textiles in Bangladesh to contribute the sustainable economy and environment. Most of the selected companies are not economically (profitability) sound and their production and consumption are not efficient for sustaining long run. However, technological inefficiencies are found clearly of the selected textile companies that lead the TFP declining. Thus, manager of the selected companies can manage advanced technology from the multinational companies even,

they can learn from the efficient or relatively efficient companies to get knowledge, experience and expertise. Government may add new clause to ensure about the using advanced technology against the cash incentive to the textile companies. These implications may help the selected companies to become efficient so that they can contribute more to the country.

8. Conclusions

The study revealed that most of the companies are inefficient, and the cause is technological change that strongly but negatively affects on the total factor productivity change. Based on MPI findings, Rahimtex is efficient, Apexspin & Argondenims are relatively efficient, Maksonspin, MHSML and Zaheenspin are very inefficient companies. Thus, all other selected companies can specially learn from the Rahimtex and some other cases from the Apexspin & Argondenim for increasing their efficiency & productivity. Except Rahimtex, all other companies are inefficient in TEC. As a result, manager of those companies should seek the root causes of technological inefficiencies and weaknesses. It may be happened due to the old technology or insufficient technology or weak technology. These performances may hamper the economic sustainability of these firms. Therefore technological change is required and this change may lead zero defect, less time consuming, rapid production and quick response to the customer. Therefore, selected companies should hire or purchase modern & up to date production technologies and manage skilled workers to be efficient through increasing productivity, efficiency and reducing wastage, rework, inefficiency and cost of the elements. They should also gather knowledge from the efficient companies to get their skill and experience (how they are managing, maintaining and controlling advanced technology). The graph represents the logical trend of sales and cost but the negative or stable trend of profit. The selected textile companies of this study are not efficient in terms of efficiency regarding production & profit-earning growth. Government may add a specific condition for the textile companies of using new & modern production technology and provide them some cash incentives, tax weaver, power and transport facilities for implementing the conditions. Policymakers of the selected companies and government may reveal the root causes of the inefficiencies to ensure the economic sustainability to get the sustainable development. The government may form national capital to help the backward companies with special consideration to manage the fund for getting new technologies and to grab the sustainable efficiency.

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Appendices:

Appendix: A

Name of the sampled companies

DMUs.	Original name	Name used	DMUs	Original name	Name used
1	Apex Spinning & Knitting Mills Limited	APEXSPINN	11	Dragon Sweater and Spinning Limited	DSSL
2	Hamid Fabrics Limited	HFL	12	Rahim Textile Mills Ltd.	RAHIMTEXT
3	Maksons Spinning Mills Limited	MAKSONSPIN	13	Hwa Well Textiles (BD) Limited	HWAWELLTEX
4	Matin Spinning Mills Ltd.	MATINSPINN	14	Zaheen Spinning Limited	ZAHEENSPIN
5	Saiham Textile Mills Ltd.	SAIHAMTEX	15	Tosrifa Industries Limited	TOSRIFA
6	Simtex Industries Limited	SIMTEX	16	Square Textile Ltd.	SQUARETEXT
7	Mozaffar Hossain Spinning Mills Ltd.	MHSML	17	Desh Garmants Ltd	DSHGARME
8	Anlimayarn Deying Ltd	ANLIMAYARN	18	Stylecraft Limited	STYLECRAFT
9	Generation Next Fashions Limited	GENNEXT	19	Argon Denims Limited	ARGONDENIM
10	Al-Haj Textile Mills Limited	AL-HAJTEX			

Source: Author's compilation

Appendix: B

Results from DEAP Version 2.1: MALMQUIST INDEX SUMMARY

year = 2

firm	TE	TEC	PEC	SE	TFP
1	1.000	0.962	1.000	1.000	0.962
2	1.000	0.351	1.000	1.000	0.351
3	0.603	0.198	0.908	0.664	0.120
4	1.462	0.740	1.234	1.184	.083
5	1.091	0.816	1.300	0.840	0.890
6	1.000	0.947	1.000	1.000	0.947
7	1.000	1.008	1.000	1.000	1.008
8	1.178	0.786	1.000	1.178	0.925
9	1.000	0.698	1.000	1.000	0.698
10	1.171	0.979	1.000	1.171	1.147
11	1.284	0.752	1.261	1.019	0.966
12	1.000	1.075	1.000	1.000	1.075
13	1.000	1.036	1.000	1.000	1.036
14	1.000	0.700	1.000	1.000	0.700
15	1.000	0.811	1.000	1.000	0.811
16	1.000	0.975	1.000	1.000	0.975
17	0.914	0.497	1.000	0.914	0.454
18	1.000	0.912	1.000	1.000	0.912
19	1.148	0.861	1.243	0.923	0.988
mean	1.031	0.745	1.044	0.987	0.769

year = 3

firm	TE	TEC	PEC	SE	TFP
1	0.928	1.328	1.000	0.928	1.232
2	1.000	1.168	1.000	1.000	1.168
3	0.818	1.139	0.846	0.967	0.932
4	0.915	0.762	1.000	0.915	0.697
5	0.860	1.143	0.749	1.148	0.983
6	0.964	0.908	0.974	0.989	0.875
7	1.000	0.765	1.000	1.000	0.765
8	1.000	1.011	1.000	1.000	1.011
9	1.000	0.788	1.000	1.000	0.788
10	1.000	0.981	1.000	1.000	0.981
11	0.947	0.992	0.976	0.971	0.940
12	1.000	0.993	1.000	1.000	0.993
13	1.000	0.934	1.000	1.000	0.934
14	1.000	0.778	1.000	1.000	0.778
15	0.903	1.037	0.957	0.943	0.936
16	0.911	1.002	1.000	0.911	0.912
17	1.094	1.243	1.000	1.094	1.360
18	1.000	1.832	1.000	1.000	1.832
19	1.128	2.625	1.000	1.128	2.962
mean	0.969	1.072	0.971	0.998	1.039

year = 4

firm	TE	TEC	PEC	SE	TFP
1	1.078	0.760	1.000	1.078	0.819
2	0.894	1.354	0.920	0.972	1.212
3	2.026	2.554	1.302	1.556	5.174
4	0.811	0.831	1.000	0.811	0.674
5	1.225	0.734	1.230	0.996	0.899
6	1.038	0.952	1.027	1.011	0.988
7	1.000	0.908	1.000	1.000	0.908
8	1.000	0.639	1.000	1.000	0.639
9	1.000	0.684	1.000	1.000	0.684
10	1.000	0.833	1.000	1.000	0.833
11	1.117	0.981	1.079	1.035	1.095
12	1.000	0.747	1.000	1.000	0.747
13	1.000	0.761	1.000	1.000	0.761
14	1.000	1.571	1.000	1.000	1.571
15	0.950	0.799	1.045	0.909	0.759
16	1.098	0.862	1.000	1.098	0.946
17	1.000	1.063	1.000	1.000	1.063
18	1.000	0.471	1.000	1.000	0.471
19	0.926	0.407	1.000	0.926	0.377
mean	1.042	0.864	1.028	1.013	0.900

year = 5

firm	TE	TEC	PEC	SE	TFP
1	1.000	0.993	1.000	1.000	0.993
2	1.118	0.606	1.087	1.029	0.677
3	0.901	0.201	1.000	0.901	0.181
4	1.317	0.878	1.000	1.317	1.156
5	1.235	0.845	1.177	1.050	1.043
6	1.000	0.940	1.000	1.000	0.940

year = 6

firm	TE	TEC	PEC	SE	TFP
1	1.000	1.030	1.000	1.000	1.030
2	1.000	0.862	1.000	1.000	0.862
3	0.926	0.961	1.000	0.926	0.890
4	1.006	0.931	1.000	1.006	0.937
5	1.072	0.984	1.149	0.933	1.055
6	1.000	0.982	1.000	1.000	0.982

MALMQUIST INDEX SUMMARY OF FIRM MEANS

firm	TE	TEC	PEC	SE	TFP
1	1.000	0.998	1.000	1.000	0.998
2	1.000	0.781	1.000	1.000	0.781
3	0.964	0.645	1.000	0.964	0.622
4	1.075	0.825	1.043	1.031	0.888
5	1.088	0.893	1.101	0.988	0.972
6	1.000	0.946	1.000	1.000	0.946

7	0.898	0.808	0.928	0.968	0.726
8	1.000	0.555	1.000	1.000	0.555
9	1.000	0.703	1.000	1.000	0.703
10	0.814	0.945	1.000	0.814	0.769
11	1.000	1.126	1.000	1.000	1.126
12	1.000	0.964	1.000	1.000	0.964
13	1.000	0.884	1.000	1.000	0.884
14	1.000	0.446	1.000	1.000	0.446
15	1.166	0.639	1.000	1.166	0.745
16	1.000	1.032	1.000	1.000	1.032
17	1.000	0.787	1.000	1.000	0.787
18	1.000	0.973	1.000	1.000	0.973
19	1.080	0.979	1.000	1.080	1.058
mean	1.022	0.759	1.009	1.013	0.776

7	0.887	0.930	0.958	0.925	0.825
8	1.000	1.014	1.000	1.000	1.014
9	1.000	0.767	1.000	1.000	0.767
10	0.382	1.007	1.000	0.382	0.384
11	1.000	0.873	1.000	1.000	0.873
12	1.000	1.356	1.000	1.000	1.356
13	1.000	1.177	1.000	1.000	1.177
14	0.903	0.896	0.930	0.971	0.809
15	1.000	0.945	1.000	1.000	0.945
16	1.000	0.907	1.000	1.000	0.907
17	1.000	0.864	1.000	1.000	0.864
18	1.000	0.960	1.000	1.000	0.960
19	1.000	0.942	1.000	1.000	0.942
mean	0.939	0.961	1.001	0.938	0.902

7	0.956	0.880	0.977	0.978	0.840
8	1.033	0.778	1.000	1.033	0.804
9	1.000	0.727	1.000	1.000	0.727
10	0.817	0.947	1.000	0.817	0.774
11	1.063	0.936	1.058	1.005	0.996
12	1.000	1.008	1.000	1.000	1.008
13	1.000	0.948	1.000	1.000	0.948
14	0.980	0.807	0.986	0.994	0.791
15	1.000	0.835	1.000	1.000	0.835
16	1.000	0.953	1.000	1.000	0.953
17	1.000	0.851	1.000	1.000	0.851
18	1.000	0.940	1.000	1.000	0.940
19	1.053	0.968	1.045	1.008	1.019
mea	1.000	0.872	1.011	0.989	0.872

[Note that all Malmquist index averages are geometric means]

Source: Author's compilation