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Technical Efficiency in Malaysian Textile Manufacturing Industry: A Stochastic Frontier Analysis (SFA) Approach

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ABSTRACT

The textile industry is a targeted industry under the Third Industrial Masterplan (IMP3) as it is the Malaysian 10th largest export revenue source. However, the recent main concern is on performance of workers and rapid technological development in the supply chain which demands the industry to demonstrate a high level of technical efficiency in order to address the emergence of new operations and new technologies that ultimately enhance the momentum of the country's economic growth. Therefore, this article aims to measure the level of efficiency and analyze the factors of technical inefficiency of the textile manufacturing industry in 2015. The determinants include capital-labor ratios, training expenses, educational level ratios, wage rates, information and communication technology expenses, firm size and research and development expenditure. This article uses data of 1010 firms based on the latest census of 2015 obtained from the Department of Statistics, Malaysia. The Stochastic Frontier Analysis (SFA) approach is used. The results show that the firms' overall technical efficiency level is high. The determinants of inefficiencies, i.e. the ratio of capital-labor, the level of secondary and high education, wage and communication costs and information technology can reduce the inefficiency level of firms. The basic implication is that the textile manufacturing industry needs to provide a better approach to high technology production that is in line with the workforce efficiency level, emphasis on school years, increase employee motivation by increasing rewards and expanding cooperation with local and international parties and appointing experts in the industry of textile manufacturing.

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INTRODUCTION

Efficiency is the effectiveness in using inputs to produce outputs. It is mainly influenced by production techniques, technological innovation, management skills and labor skills. The optimum efficiency can be generated and influenced by efficient input factors such as the quality of workers, while technical efficiency (TE) illustrates the ability of firms to produce maximum output when given a set of inputs (Farrell, 1957). Long-term efficiency can contribute to the growth of Overall Factor Productivity (TFP) (Ismail and Sulaiman, 2007). Productivity is the most important aspect at every stage of economic development planning policy in Malaysia (RMKe-7, 1995-2000 to RMKe-11, 2015-2020). Additionally, it is also the main policy of economic growth to increase the contribution of the country's Gross Domestic Product (GDP).

In this context, the textile manufacturing industry has the potential to increase national income if productivity can be improved. This is because the textile manufacturing industry is the country's 10th largest export revenue source, which contributed to the volume of manufactured exports in 2014 (Malaysian Investment Performance Report, 2014). In 2015, the textile manufacturing industry registered an increase in the number of establishments; operating at 49,101 compared to 39,669 in 2010 and continued to grow with the contribution of the total number of manufacturing industries at 18.6 percent (Economic Census, 2016). In addition, the manufacturing index's performance for the textile industry increased by 122.4 points in 2015 and continued to increase by 133.3 points in 2016 (Global Competitiveness Report, 2016/2017). As for export performance of textile manufacturing, there was an increase of RM9238 million in 2016 and it was an important component in the national economy (Economic Census, 2016).

However, the textile manufacturing industry's index remained stagnant at 7.2 percent in 2015 and 2016. In fact, the contribution of the textile manufacturing industry had also dropped from 26.5 percent in 2010 to 18.6 percent in 2015 due to concerns about performance among workers (Economic Census, 2016). In addition, the rapidly expanding technological development has resulted in the lack of technology utilization in textile industry’s supply chain (Lee et al., 2016). This situation shows that the level of TE and productivity should be high to address the emergence of new operations, TEC and new technologies that ultimately able to enhance the momentum of the country's economic growth and ensure that the textile manufacturing industry can grow over the time. Industries that are not willing to increase TE levels will undoubtedly increase the momentum of the country's economic growth as a result of economic openness and trade liberalization (Kim et al., 2007; Adhikary, 2011).

Past research found that the study on TE of textile manufacturing industry in Malaysia is still lacking compared to other industries. Based on our knowledge, no TE study has been conducted on the textile industry in Malaysia. Most studies such as Sulaiman and Rashid (2013) and Jajri and Ismail (2014) only discussed the textile manufacturing industry in general in their surveys. In addition, research on the determinants of technical inefficiency is also not considered as the TE study for the textile manufacturing industry in Malaysia has never been done before. The TE level can be measured more accurately when the data at firm-level are used and by taking into account the inefficiency factors that can intensify the improvement effort. Tingley et al. (2005) stressed that budgeting by using firm data as individuals is better as further analysis of factors affecting the level of budgeting can be assessed. In fact, research on factors in technical inefficiency also disregards efficiency and productivity. Battese and Coelli (1995) emphasized on factors of technical incompetence, and that data at firm-level play an important role in obtaining more precise TE values. In conclusion, new empirical findings can be generated when firm-level data are used by taking into account the technical inefficiency factors; besides, it also results in the TE value being more significant and accurate.

This study uses firm-level data of 2015 through the SFA approach which involves two analyses. The first analysis determines the level of technical efficiency, and the second analysis identifies the determinants of technical inefficiency among the firms studied. The second section of this article reviews previous studies. The third section discusses the research methodology, data sources, and model specification. The fourth section analyses the results of the survey, and the fifth section provides the conclusions and the implications of this study.

LITERATURE REVIEW

The TE study has been widely used by various fields or organizations depending on the objective, context, selection of inputs and outputs and the conduct of the study. According to TE's initial theory and methodology, most researchers have used different techniques to estimate production boundaries, TEs and productivity. There are two main methods to measure the level of TE, namely parametric and non-parametric approaches. Both approaches are often used to assess TE levels by either using cross-section data or panel data. Based on previous studies, many studies measure TE especially in the manufacturing industry that is closely related to the textile manufacturing industry. Most textile manufacturing industries are generally described in those studies.

Farrell (1957) was the first to study the size of efficiency and inefficiency properties of a unit of production. He pointed out that this could happen when maximum output cannot be achieved from the use of inputs selected for processing purposes. Sun et al. (1999) showed that the TE level of textile manufacturing industry in China is still low at 0.49 per cent. Similarly, Lundvall and Battese (2000) found that the level of TE of textile manufacturing in Kenya is low. Meanwhile, Kneller and Stevens (2006) also found that TE level of textile manufacturing industry globally is very low. Bhandari and Maiti (2007) showed that the textile industry in India, which is the oldest industry, contributed 20 percent to the total industrial production. On the other hand, Destefanis and Sena (2007) conducted a study on the level of TE of manufacturing industry in Italy and found that the textile manufacturing industry has a moderate TE level of 0.77 percent. Meanwhile, Amornkitvikai and Harvie (2011) showed that the textile manufacturing industry in Thailand reached a high TE level of 0.79 per cent.

Another study conducted by Mohd Noor et al. (2007) on manufacturing firms using survey data with Two Ranking DEA method found that most firms are relatively inefficient. The study concluded that all these inefficient firms operated in the share returns in line with the skeleton. The size of the firms and the level of mechanization also showed a positive and significant impact on firms' TE value. Meanwhile, Radam et al. (2008) who studied small and medium-sized industries' (SMIs) TEs in Malaysia found that the value of SMIs is lower compared to large-sized industries. Based on the SFA method used, it also found that the number of firms considered to be efficient was only 3.06 per cent of the total firms, while TEs were within the range of 0.30 per cent to 97.1 per cent. The conclusions of this study are that the small industry is relatively more efficient than the medium and small industries; and it also has higher technical inefficiency value compared to SMIs. Ismail and Jajri (2008) noted that most transport equipment sub-industries have a higher technological change (TEC) than technological change (TC) in TFP growth and found that when appropriate technology is used, TE will increase; thus boosting TFP growth.

The study conducted by Ismail and Tendot Abu Bakar (2008) found that the level of TE of manufacturing firms of Malay ownership was still low as well as there was lack of competitiveness; and firm size and education level were significant in determining TE level of firms being studied. In addition, Fauziyah (2010) who studied TE and technical inefficiency sources for tobacco product production found the four factors affecting efficiency; those are other sources of income, agricultural assistance, corporate contracts and farmers' participation in cooperatives. Meanwhile, Charoenrat and Harvie (2013) measured TE for manufacturing industry in Thailand and found factors such as firm size, firm age, skilled manpower, firm location, type of ownership, and foreign investment contribute to the technical efficiency of the industry. Le and Harvie (2010) conducted a study on the manufacturing industry in Vietnam and found factors such as firm age, firm size, location, type of ownership, cooperation with foreign partners, subcontracting, product innovation, competition and government assistance affect TE. However, the export factor was unlikely to affect TE.

In addition, Olatunji and Ibidunni (2013) discussed the factors of allocative efficiency by using firms in Lagos and found that the level of allocative efficiency is still low. The frequent cost-effectiveness crises resulted in high costs in the manufacturing environment in Nigeria. Cost efficiency increases with firm size, lack of local ownership, demand intensity and investment in technology hardware. However, other determinants such as firm age, age of key production equipment and production time proportions using public utilities as a power source have positive coefficients but are statistically insignificant. In addition, Fahmy-Abdullah et al. (2017) showed that the inefficiencies in determining wage rates and information and communication technology spending affect firms' technical competence.

Based on our knowledge, none of the studies had studied the level of TE and the determining factors inefficiency of the textile manufacturing industry in Malaysia. Hence, based on the problems and gaps in this study, an effort is taken to investigate the extent of the efficiency and the determinants of the inefficiency of the textile manufacturing industry in Malaysia using the latest data source. This study is very important, in line with the national target to develop the textile industry as one of the competitive industries not only locally but also internationally based on current performance. In fact, the industry needs to be more productive and competitive to increase productivity levels (Malaysia Productivity Corporation Report 2015/2016). This illustrates how far the technological efficiency and the inefficiency factors of textile manufacturing industry will be in the long run. This study is also able to find out and answer the question of how well the efficiency level is, as well as determine the factors of the technical inefficiency of the textile manufacturing industry in Malaysia. Therefore, this article aims to evaluate the TE level and determine the determinants of the industry's inefficiencies as the textile industry is one of the key components of the national economy (Economic Census, 2016). Besides, it is a source the country's 10th largest export earnings (Malaysia Investment Performance Report, 2014) with an increase in the number of establishments of 80.7 per cent during the period 2010 to 2015 (Economic Census, 2016) as well as the performance of a robust manufacturing manufacturing index (Global Competitiveness Report 2016/2017).

METHODOLOGY, MODEL SPECIFICATION AND DATA

Stochastic Frontier Analysis (SFA) Model are the most commonly used approaches to estimate the maximum output level (Jarboui et al., 2012). SFA model has been proposed by Aigner et al. (1977) and Meeusen et al. (1977), and Battese and Coelli (1995) to get the firm's TE value. The main advantage of the SFA approach is to produce better results when the statistical method used tends to assume the stochastic features of the data obtained. In addition, this method is easily adapted into the environmental variables (Coelli, 1996; Coelli et al., 2005). In addition, the SFA approach also identifies inconsistent data in the analysis, allows for the conduct of traditional statistical tests of hypotheses and cost frontier and distance function can deal with multiple outputs. Cullinane et al. (2006) stressed that the SFA method can analyze structure and examine the determinants and the performance of the manufacturer. Tingley et al. (2005) demonstrated that the measured level of technical efficiency using the SFA method is better and more consistent because of the low variance value. In fact, the SFA method is not only capable of measuring technical inefficiencies, but it can also identify random shocks that are beyond the manufacturers' control, which could impact their production (Jarboui et al., 2015).

The original SFA specification involves production model of cross-sectional data with conditions for errors; and there are two components, where the first explains random effect (v_i). The second is technical inefficiency (u_i). The original specification can be found from comprehensive studies such as Forsund et al. (1980), Schmidt (1985), Bauer (1990) and Greene (2008). Meanwhile, Kumbhakar (1990) and Battese and Coelli (1995) proposed a simple model that can be used to measure inefficiency. Following that, Battese and Coelli (1995) have proposed a SFA model that contains firm effect assumed to be distributed as truncated normal random variable.

The specification of Battese and Coelli (1995) model can be expressed as follows:

$$\mathrm{Y}_i = \mathrm{X}_i\beta + (v_i - u_i) \quad (1)$$

where, Y_i is the logarithm for the production of the i-th firm (i = 1, 2,…, N). X_i is the (k x 1) vector of the transformation of the input quantities of the i-th firm. β is the (k × 1) vector of unknown parameters. U_i is a non-negative random variable, represents the technical inefficiency, and is assumed to be independently distributed as truncations at zero of the $N(\mu, \sigma_U^2)$ distribution. V_i is a random error assumed to be iid $N(0, \sigma_V^2)$; where $\mu = z_i\,\delta$ and variance σ_U^2; and z_i is the (1 × p) vector of explanatory variables associated with technical inefficiency of the textile manufacturing industry over time; where δ is a (p × 1) vector of unknown parameters. Equation (1) specifies the stochastic frontier production function in terms of the original production values. However, the technical inefficiency effect, U_i, is assumed to be a function of a set of explanatory variables, z_i, and an unknown vector of unknown parameters.

The coefficient of the frontier and inefficiency effect model in Equations (1) can be measured using the maximum likelihood estimation (MLE). Battese and Broca (1997) parameter is used to replace σ_v^2 and σ_u^2 with $\sigma^2 = \sigma_v^2+\sigma_u^2$: $\gamma = \sigma_u^2 / (\sigma_v^2 +\sigma_u^2)$ (see Coelli and Battese, 1996) where γ has a value between zero and one. If H_0: $\gamma = 0$ is rejected, this proves that the actual data's deviation from the boundary functions is due to technical inefficiency. This means the null hypothesis about no technical inefficiency is rejected. Basri (2006) states that MLE is more efficient, constant and variance ($v_i - u_i$) is consistent compared to Ordinary Least Square (OLS) method. In addition, MLE estimation also overcome heteroskedasticity and multicollinerity problems (Coelli et al., 2005). Following Battese and Coelli (1995), the technical inefficiency effect, U_i, in the stochastic frontier model (1) can be explained as follows:

$$U_i = z_i \delta + W_i \tag{2}$$

where U_i is the mean technical inefficiency effect in the model. z_i is a vector of explanatory variable of inefficiency. δ is a (p×1) vector of unknown parameters. W_i is a random variable, as defined by the truncated normal distribution with zero mean and variance (σ^2). The specification of these two models has been widely used by past studies to determine the value of TE all together. The production TE for the i-th firm is defined as the actual output ratio with potential output as;

$$TE_i = E[\exp(-u_i)] \tag{3}$$

In view that u_i is a non-negative variable, the efficiency is located between the values of zero and one. A firm is technically competent if the TE value is the same as one (i.e. the firm has an ineffective effect equal to zero). Various models can be used to investigate the relationship between input and output. The two most popular models are Cobb-Douglas production function and Transcendental Logarithmic (Translog) production function (Coelli et al., 2005). In this study, a hypothesis test was conducted to determine the appropriate model by selecting the best maximum likelihood estimation (MLE). After the appropriate production function was selected, a technical inefficiency impact test was conducted. Subsequently, the level of technical efficiency and the determinants of technical inefficiency among textile manufacturing industry in Malaysia were analysed.

SFA model based on Cobb-Douglas function can be written as follows:

$$\ln Y_i = \beta_0 + \sum_{j=1}^{n} \beta_j \ln X_{ij} + (v_i - u_i) \tag{4}$$

SFA model based on Translog function can be written as follows:

$$\ln Y_i = \beta_0 + \sum_{j=1}^{n} \beta_j \ln X_{ij} + \frac{1}{2}\sum_{j}^{n}\sum_{l}^{n} \beta_{jl} \ln X_{ij} \ln X_{ij} + (v_i - u_i) \tag{5}$$

where Y_i is the log of the observed output of the *i*-th establishment. *X* variables are the log of inputs, while subscripted *j* and *i* indicate the inputs. In Equation (4) and (5), Y_i is the output, and the three inputs are the values of the capital (K_i), labor (L_i) and intermediate input (II_i). These three inputs are often used by past studies to measure TEs in the industry including Ismail and Sulaiman (2007), Mazumder and Adhikary, M. (2010), Jarboui et al. (2012) and Fahmy-Abdullah et al. (2017).

The first objective of this study is to measure the level of technical efficiency of the textile manufacturing industry in Malaysia. The FRONTIER 4.1 program developed by Coelli (1996) will be used to analyze the data used. Meanwhile, the second objective is to determine the factors determining the inefficiency of the textile manufacturing industry in Malaysia for year 2015. For the variables involved in the technical inefficiency of the SFA model are as follows:

$$u_i = \delta_0 + \delta_1 \ln RKL_i + \delta_2 \ln TPL_i + \delta_3 \ln RSDIP_i + \delta_4 RDEG_i + \delta_5 \ln W_i + \delta_6 \ln ICT_i + \delta_7 \ln DFSME_i + \delta_8 \ln R\&D_i \tag{6}$$

where u_i represents technical inefficiency. RKL_i represents the ratio of the total capital divided by the number of employees in the i-th firm. TPL_i represents the total expenditure for employee training for the i-th firm. $RSDIP_i$ represents the ratio of workers with education at diploma and STPM levels or equivalent for the i-th firm. $RDEG_i$ represents the ratio of workers with education at higher levels, which includes postgraduate degrees or equivalent for the i-th firm. W_i represents the wage rate for the i-th firm. ICT_i represents the communication expenses for firm i-th. DSME is a dummy for the i-th firm with small firms representing 1, while the others represent 0. R&D represents the research and development for the i-th firm. All independent variables are selected based on past studies including Stevens and Kneller (2003), Murthy et al. (2009), Charoenrat and Harvie (2013), Essmui et al. (2013), Olatunji and Ibidunni (2013) amd Fahmy-Abdullah et al. (2017).

The estimation of a stochastic frontier production can be used to validate two null hypotheses: (1) cobb-douglas or translog; (2) absence of the effects of technical inefficiency. These two hypotheses were tested using the generalised likelihood-ratio test (LR test), λ, given by the following Equation (7):

$$\lambda = - 2 \{\ln[\lambda(H_0) / \lambda(H_1)]\} = - 2 \{\ln[\lambda(H_0)] - \ln[\lambda(H_1)]\} \tag{7}$$

where $\lambda(H_0)$ and $\lambda(H_1)$ denote the value of the log of the likelihood function under the null and alternative hypotheses, respectively (Coelli et al., 1998). The necessary tests, with respect to other estimated parameters of the variables, were performed as in the case of the normal analyses, and by using the chi-square distribution table as well as the Kodde and Palm (1986) table.

This study uses data at the firm-level obtained from the Survey of Manufacturing Industries (SMI) conducted by the Department of Statistics (DOS) Malaysia through the latest Economic Census conducted in 2015. This study involved 6 sub-industries 3-digit level according to Malaysian Standard Industrial Classification (MSIC) 2008. Based on the original data obtained from the DOS, the screening process was once again carried out with some firms being dropped due to lack of relevant information such as incomplete data (output or unquoted capital); and the number of employees was very small and did not meet the purpose of small and medium firms (less than 5 employees or 0) that will give effect to sample analysis. In total, 1010 firms involved in this study are based on the latest Economic Census of 2015. As a common practice in SFA studies, these variables had been mean-corrected prior to estimation. Besides that, all monetary variables are expressed in real 2010 Malaysian Ringgit.

RESULTS AND DISCUSSIONS

This study conducted two hypothesis tests. The results of confirmation tests for the null hypothesis for textile manufacturing industry are as shown in Table 1. In order to determine whether the Cobb-Douglas or the Translog was the best production function, the hypothesis test applied a generalised likelihood-ratio (LR) statistic. The first hypothesis test involved selecting whether to use the Cobb-Douglas or the Translog production functions. The null hypothesis was that the Cobb-Douglas production function was the most suitable function to represent the entire data. The LR statistic to test the null hypothesis, H_0: $\beta_{ij} = 0$ was calculated in 2015. This value is then compared with critical value of χ^2_6 distribution (1% significance level) which is 16.81. The results showed that the Cobb-Douglas production function was rejected in 2015, thus the Translog production function was selected and considered as more appropriate to represent the analysed data. Results of this study showed that the Translog production function was better than the Cobb-Douglas production function.

Many studies have shown that the underlying technologies are flexible (not of a Cobb-Douglas form) and have proposed other more flexible functional forms, such as the widely-used Translog formulation (Karlaftis, 2010). Jarboui et al. (2013) stated that the Translog production function is a flexible function because it does not require assumption about production constant elasticity's or substitution elasticity between the inputs. In this present study, the second hypothesis test was conducted to confirm that there was no effect of technical inefficiency ($H_0 : \gamma = 0$) in the textile manufacturing industry. Table 1 shows that the statistical values were greater than the critical value at a significance level of 1 percent (19.38), indicating the existence of the effects of technical inefficiency in textile manufacturing industry in Malaysia. This test was very important to ascertain the existence of the effects of technical inefficiency in firms. Further tests can be performed to identify the determinants of inefficient firms.

Table 1 Generalized Log-Likelihood Tests of Hypotheses

	$(H_0 : \beta_{ij} = 0)$	$(H_0: \gamma = 0)$
LR statistic (Chi-Square)	345.77***	176.92***
Critical Value	16.81	19.38
Decision	Reject H_0	Reject H_0

Note: *** signifies significant at 1% confidence level

Based on data obtained from DOS, 1010 textile manufacturing firms in 2015 were selected in this study. Table 2 shows a descriptive statistic of variables used to estimate SFA. This table shows that the average total output produced by the textile manufacturing industry is RM 10 million with a minimum sum of RM 67 thousand and a maximum of RM 2.5 billion. Meanwhile, capital is a major expense for the industry with an average spending of RM 4.3 million between RM1 thousand to RM1.3 billion. In addition, the average number of workers employed was 70 persons and the number of employees employed was from 5 to 5,944 workers. Meanwhile, the average input mediation is RM 7.8 million with minimum of RM10 thousand to maximum of RM2 billion. The study also shows that the ratio between capital and labor ranges from RM 45 thousand to RM 665 thousand with an average of RM 26 thousand. Meanwhile, the average cost of employee training is RM 5 thousand with expenses of between RM 0 to RM 822 thousand. The average ratio of workers with moderate qualifications, i.e. diploma and Malaysian High School Certificate or its equivalent, is 0.108 ranging from 0.000 to 1.000. The average ratio of employees with highest qualification, which includes advanced degree or equivalent, is 0.038; ranged from 0.000 to 0.600. In addition, the firm's average wage rate is RM 1,900, and ranged between RM 328 and RM 3,250. Firms have also spent on communication and information technology with an average of RM 25 thousand, ranging from RM 1,000 and a maximum of RM 4 million. Meanwhile, 90 percent of the firms involved in the study are small and medium sized firms. Finally, the amount spent by firms on research and development has an average of RM 16 thousand with total expenditure ranging from RM 0 to RM 6 million. Standard deviation showed that the variance fell over the entire sample. The result also showed that there was much dispersion in the textile manufacturing industry.

Table 2 Descriptive statistics of the variables

Variable	Mean	Minimum	Maximum	Standard deviation
Y	10,538	67	2,554,178	87848.766
K	4,361	1	1,358,994	48493.440
L	70	5	5,944	295.115
II	7,898	10	2,009,579	68986.448
RKL	26.148	0.045	665.786	59.612
TPL	5	0	822	38.863
RSDIP	0.108	0.000	1.000	0.150
RDEG	0.038	0.000	0.600	0.077
W	1.944	0.328	3.250	0.560
ICT	25	1	4,150	162.877
DFSME	0.937	0	1	0.244
R&D	16	0	6,319	218.107

Table 3 shows the estimates of parameters using the Translog production function approach in 2015. The results show that variables ln employees, ln intermediate inputs, (ln capital)^2, (ln employees)^2, (ln intermediate inputs)^2 and (ln capital of intermediate inputs) show a significant relationship at the 1 percent significance level. These results show that these inputs meet the maximum requirements of the textile manufacturing industry. Whereas the capital, (ln capital of the workers) and (ln capital of the intermediate inputs) have no significant relationship with the textile manufacturing industry. This decision is associated with excess inputs resulting in inefficiency and the amount of output produced does not reach the maximum level (Law of Diminishing Return). Overall, gamma parameter (γ) obtained showed positive and significant values. This proves that technical inefficiency has a significant impact on the level and change of production of textile manufacturing industry in Malaysia. In addition, the sigma value of squared ($\sigma^2 = \sigma_v^2+\sigma_u^2$) is also significant showing that there is a firm in the study not operating efficiently.

Table 3 Estimated SFA Parameter Results

Variables	Parameter	Maximum Likelihood Estimation (MLE) coefficient
Constant	β_0	2.989 (32.544)***
Ln Capital	β_1	-0.025 (-0.986)
Ln Workers	β_2	0.844 (21.642)***
Ln Intermediate Input	β_3	0.129 (4.445)***
$(\text{Ln Capital})^2$	β_4	0.013 (2.739)***
$(\text{Ln Worker})^2$	β_5	0.154 (8.179)***
Cont. Table 3		
$(\text{Ln Intermediate Input})^2$	β_6	0.158 16.273)***
(Ln Capital) * (Ln Worker)	β_7	-0.005 (-0.627)
(Ln Capital) * (Ln Intermediate Input)	β_8	-0.007 (-1.428)
(Ln Capital) * (Ln Intermediate Input)	β_9	-0.150 (-13.365)***
Sigma-squared	$\sigma^2 = \sigma_v^2+\sigma_u^2$	0.043 (19.197)***
Gamma	γ	0.108 (3.249)***
Log- Likelihood function		161.960***

Note: *** signifies significant at 1% confidence level and Value in ( ) is t statistics.

Overall, the level of technical efficiency of the textile manufacturing industry in Malaysia was at a high level in 2015. The results show that the average level of technical efficiency is as much as 0.805 as shown in Table 4. This shows that almost all firms are operating at a high level to produce output or their production is at an optimum level. This is due to increase in the number of establishments operating at 49,101 in 2015 as compared to 36,669 in 2010 (Economic Census, 2016). In fact, in 2015, the performance of manufacturing indices for the textile manufacturing industry increased by 122.4 points in 2015 and increased by 133.3 points in 2016, leading to an increase in production output (Global Competitiveness Report, 2016/2017).

Table 4 Technical Efficiency of Malaysia Textile Manufacturing Industry

Firm	Mean Overall Technical Efficiency
1010*	0.805

Note: * data of latest Economic Census conducted in 2015

Table 5 shows the results of the technical inefficiency variables in 2015. The negative sign obtained from the analysis shows that when there is an increase in the variables, there is a reduction in the inefficiency of textile manufacturing industry in Malaysia. On the other hand, if a positive sign is obtained, it indicates an increase in the inefficiency of the firm's technique. Based on the analysis performed, the ratio of the ratio of the labor-capital ratio shows a negative and significant relationship at 1 percent significance level; which means the technical inefficiency of firm's can be reduced. When there is an increase in the capital-labor ratio by 1 percent, the inefficient technique can be reduced by 0.05 percent. Based on the Economic Census Report of 2016 (2017), there has been an increase of 1.63 percent in the textile-manufacturing industry's capital-labor ratio in Malaysia in 2015. This situation clearly shows that the increase in capital-labor ratios can reduce the inefficiency of firm techniques and at the same time improves technical efficiency. The findings also show that the composition of the capital-labor ratio in the textile manufacturing industry is balanced and consistent with the findings of Stevens and Kneller (2003) and Ismail and Sulaiman (2007). Meanwhile, Bertrand (2013) emphasized that the high composition of capital utilization has a positive impact on technical efficiency and productivity growth when production levels increased in the event of increased use of machines in the production process.

Table 5 Results of Technical Inefficiency Determining Factors for Textile Manufacturing Industry

Variables	Parameter	Maximum Likelihood Estimation (MLE) Coefficient
Constant	δ_0	0.762 (11.466)***
Ln Capital-Labor ratio	δ_1	0.057 (-3.662)***
Ln Training expenses	δ_2	0.1979 (0.402)
Ln SDIP ratio	δ_3	-0.176 (-2.991)***
Ln DEG ratio	δ_4	-0.459 (-3.125)***
Ln Wage Rate	δ_5	-0.149 (-8.962)***

Cont. Table 5

Ln ICT Expenditure	δ_6	-0.049 (-5.064)***
SME Dummy	δ_7	-0.460 (-1.369)
Ln Research and Development	δ_8	-0.029 (-1.375)

Note: *** signifies significant at 1% confidence level and value in ( ) is t statistics.

The study also shows that the proportion of employees with high and middle levels' approval can reduce the inefficiency of the textile manufacturing industry in Malaysia with a significant at 1 percent significance level. When there is an increase in the proportion of the graduates with a 1 percent graduates, the technique inefficiency can be reduced by 0.17 percent. Likewise, when the ratio of workers with the highest level of approval increased by 1 percent, technical inefficiencies would decrease by 0.46 percent. In details, 11 in every 100 workers in the textile manufacturing industry in 2015 with secondary education and 3 with the highest level (Economic Census, 2016). This proves that the school year in the textile manufacturing industry plays an important role in identifying firm performance, in addition to output, profitability and productivity. In fact, improving the quality of education among employees can increase the production of a firm, the level of technology and influence the firm's efficiency and productivity (Benhabib and Spiegel, 1994; Andersson et al., 2002; Ajibefun, 2008; Murthy et al, 2009, Fahmy-Abdullah et al., 2017).

Similarly, the determinant of wage rates can reduce the inefficiency of the textile industry's manufacturing in Malaysia. When there is a 1 percent increase in wage rate, technical ineffectiveness can be reduced by 0.15 percent. The industry's tendency to increase wage rates among workers can increase employee motivation; which in turn improves the firm's efficiency and productivity. In fact, appropriate wage rate can increase the workers' self-motivation (Ismail et al., 2009; Muhlau and Lindenberg, 2003) and plays an important role as motivator and stimulant to employees in increasing future production (Fahmy-Abdullah et al., 2017). In addition, information and communication technology's spending factors have also shown to reduce the inefficiency of textile industry's manufacturing in Malaysia. Increase in ICT spending by 1 percent, technical inefficiencies can be reduced by 0.05 percent. These expenses include hardware consulting services, maintenance consulting and software consultancy services, data processing services and database activities and communication via online or facsimile communications. Contribution through ICT investment to productivity efficiency can result in significant and positive results in the future. Improvements in capital stock and physical inputs can be made from ICT investments and enhance firm competence (Heshmati and Yang, 2006; Mahadevan and Ibrahim, 2007; Wu, 2008; Fahmy-Abdullah et al., 2017).

Meanwhile, the results found that the determinants of training expenses had no significant relationship to reduce the technical inefficiency. Based on the Economic Census Report 2016 (2017), the textile manufacturing industry spent almost RM5 million in 2015 to provide training to employees but can not reduce the inefficiency of the firm. This situation is likely due to the wastage of the expenses when the training is not in line with the needs of the employees. As a result, the expenses incurred do not provide the proper returns to the textile manufacturing industry. Similarly, the firm's determinant factor which finds no significant relationship to reduce industrial technical inefficiency. This is likely due to nearly 90 percent of the firms involved in the study are small and medium sized firms. According to Batra and Tan (2003), the level of technical efficiency will increase as firms increase. While some small or medium firms operate more efficiently than larger ones, there is no solid and uniform relationship between firm size

CONCLUSION

This study aims to examine the level of efficiency and analyze the factors that determine the inefficiency of the textile manufacturing industry in Malaysia. This study involves 1010 firms obtained from DOS in 2015. Based on the results through the Translog production function, the level of efficiency of the textile manufacturing industry in Malaysia is high with range of efficiency of 0.805. Furthermore, the results show that determining factors include the ratio of capital-labor, the proportion of middle and high graduates, the wage and expenditure of ICT play an important role in reducing the inefficiency of a firm's technique as the findings of previous studies include Mahadevan and Mansor, (2007), Ismail et al. (2009), Murthy et al. (2009), Bertrand (2013) and Fahmy-Abdullah et al. (2017). Furthermore, the results show that determining factors include the ratio of capital-labor, the proportion of middle and high graduates, the wage and expenditure of ICT play an important role in reducing the inefficiency of a firm's technique as the findings of previous studies include Mahadevan and Mansor, (2007), Ismail et al. (2009), Murthy et al. (2009), Bertrand (2013) and Fahmy-Abdullah et al. (2017).

In terms of policy implication, this finding emphasizes that the textile manufacturing industry still needs a lot of effort to further improve its efficiency level, especially by emphasizing on the determinants that can improve firm efficiency. Some basic implications need to be taken as the Third Industrial Masterplan (IMP3) puts the textile manufacturing industry one of the industries that can increase revenue and revenue to the country. First, to motivate and improve the efficiency that can increase the amount of output or output at a minimum, the firms should increase the rate of wages or improve the rewards of their workers. Higher wage rates received by employees will encourage them to work harder and contribute to higher efficiency and productivity (Muhlau and Lindenberg, 2003; Mazumder and Adhikary, 2010).

Second, the transfer of technology and dissemination and changes in the role of the government are needed as to control the firm's innovation system to enhance competitiveness and growth. Hence, investment in communications and information technology needs to be increased as firms can improve their capital stock and physical inputs (Heshmati and Yang, 2006) as well as enhance competitiveness and promote growth as well as improve the efficiency and productivity of firms (Mahadevan and Mansor , 2007). Third, to produce trained and skilled workforce and to focus on the textile industry, adequate education has to be provided. Emphasis should be placed on improving skills and capabilities in areas such as leadership, management, engineering, quality, design and cost management. Human capital development programs can provide specialized talents such as in automated production areas that can enhance automation and diversification processes (Economic Census, 2016). This will reduce the dependency on skilled workers and thus helps to create a high-income local skilled workforce (Economic Census, 2016).

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