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Efficiency Assessment of Transport Manufacturing Firms using a Stochastic Frontier Analysis Approach

(Penilaian Kecekapan Firma Pembuatan Pengangkutan menggunakan Suatu Pendekatan Analisis Stokastik Perbatasan)

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ABSTRACT

This paper aims to analyze the level of technical efficiency and determinants of technical inefficiency of transport manufacturing firms in Malaysia using Stochastic Frontier Analysis (SFA) approach from 2005 to 2010. Through SFA approach, hypothesis test is conducted in order to select Cobb-Douglas or Translog production function and testing the effects of technical inefficiencies. While the determining factors that been taken into account include the capital-labor ratio, training expenses, education level ratio, wage rate, information and communication technology expenditure, and firm size. Hypothesis test results show that the Cobb-Douglas production function is rejected. While the test for the effect of technical inefficiency shows its existence. Training expenses, secondary and tertiary education level ratios, wage rates and information and communication technology expenses are significant determinants for transportation manufacturing firms. However, the capital-labor ratio was found that it has reduced the level of technical efficiency. The implications of these results show that firms need to focus on investing in human capital, information technology and increase motivation among employees such as rising wage rates and reducing the use of capital appropriate to the technology.

Keywords: Manufacturing; stochastic frontier analysis; technical efficiency; technical inefficiency; transportation

ABSTRAK

Kertas ini bertujuan untuk menganalisis tahap kecekapan teknik dan faktor penentu ketidakcekapan teknik firma pembuatan pengangkutan di Malaysia menggunakan pendekatan Analisis Stokastik Perbatasan (SFA) dari tahun 2005 hingga 2010. Melalui pendekatan SFA, ujian hipotesis dijalankan terlebih dahulu untuk memilih fungsi pengeluaran Cobb-Douglas atau Translog dan ujian kesan ketidakcekapan teknik. Manakala faktor penentu yang diambil kira termasuklah nisbah modal-buruh, perbelanjaan latihan, nisbah tahap pendidikan, kadar upah, perbelanjaan teknologi maklumat dan komunikasi dan saiz firma. Keputusan ujian hipotesis menunjukkan fungsi pengeluaran Cobb-Douglas ditolak. Manakala ujian kesan ketidakcekapan teknik menunjukkan kewujudannya. Perbelanjaan latihan, nisbah tahap pendidikan menengah dan tinggi, kadar upah dan perbelanjaan teknologi maklumat dan komunikasi merupakan faktor penentu yang signifikan bagi firma pembuatan pengangkutan. Namun, nisbah modal-buruh didapati telah mengurangkan tahap kecekapan teknik. Implikasi daripada keputusan ini menunjukkan bahawa firma perlu menitikberatkan pelaburan terhadap modal manusia, teknologi maklumat dan meningkatkan motivasi di kalangan pekerja seperti kenaikan kadar upah serta pengurangan terhadap penggunaan modal yang sesuai dengan tahap teknologi.

Kata kunci: Analisis stokastik perbatasan; kecekapan teknik; ketidakcekapan teknik; pembuatan; pengangkutan

Introduction

Technical efficiency is important to determine the level of efficiency of a firm or an industry. The term efficient in economics refers to the comparison between the observed input and output values and the optimum input and output values used in the production process (Karlaftis & Tsamboulas 2012). According to Kumbhakar and Lovell (2003), technical efficiency is the ability to reduce the use of inputs to produce outputs or the ability to maximise output with existing input. Meanwhile, allocative efficiency reflects the firm's ability to use inputs at an optimal rate based on the cost and production technology. These measures are combined to provide a measure of the total economic efficiency (Coelli et al. 2005).

The existence of the ASEAN Free Trade Area (AFTA) trade block and the removal of trade barriers among ASEAN countries (MITI 2013) have resulted in the efficiency of transport manufacturing firms undergoing low encouraging performance. Common Effective Preferential Tariff (CEPT) and the promotional activities of various regional integration schemes implemented further pressured the industry in the ASEAN region (Khalifah & Talib 2008). Meanwhile, deficit growth was recorded with an increase in imports which is RM21.7 billion compared to RM5.3 billion with contributions to Gross Domestic Product (GDP) decreased in 2010 (2.4%) compared to 2005 (3.0%) (Annual National Accounts (GDP) 2012). Overall, the average annual growth of this firm is -0.4% (MITI 2013; NAP 2014) while this industry is one of the industries that can increase the total factor productivity (TFP) as highlighted in the National Key Result Areas (NKRA). In fact, the efficiency level of the industry should be high in preparation for changes in the efficiency of new techniques and technologies as well as the emergence of new operations (Fahmy-Abdullah et al. 2019a; Idris et al. 2019; Sabli et al. 2019).

However, the study of technical efficiency of transport manufacturing firms in Malaysia has been receiving less attention from researchers compared to other industries. Most studies such as Hamdan et al. (2019), Idris et al. (2019), Latif et al. (2019), and Sabli et al. (2019) discuss other manufacturing industries. This study makes a significant contribution to previous efficiency studies where it is possible to find out the extent of efficiency and the determining factors of transport manufacturing firms using the SFA method. The objective of this article was to analyse the technical efficiency of transport manufacturing firms in Malaysia in a five-year period using firm level data and SFA method. Two analyses are involved, the first analysis determines the level of technical efficiency, and the second analysis identifies the determinants of technical inefficiency among the firms studied. The rest of this paper is organized as follows: the next section of this article reviews previous studies; subsequent section discusses the research methods, data sources, and model specification; the following section analyses the results of the survey; and the last section provides the conclusions and the implications of this study.

Literature Review

Studies on technical efficiency have been widely conducted in various fields and organisations, depending on the context of the objectives, the selection of input and output as well as the environment of the study. According to the initial theory and the methods of technical efficiency, many researchers used different techniques to estimate the production frontier and technical efficiency.

Review on the literature showed that numerous studies have analysed the technical efficiency of manufacturing industries, specifically on the transportation manufacturing sector. The study on manufacturing firms by Njikam (2003) in Cameroon compared the technical efficiency before and after the trade reforms from 1989 to 1992 and from 1995 to 1998. The measure of trade liberalisation was found to have a positive effect on firm performance. In fact, the study found that the average profit in the technical efficiency change was 9.1 percent, and a gain in technical change produced 147 percent of average profit due to trade liberalisation impact. Besides, Karunaratne (2012), who conducted a survey in Australia showed a lower aid transaction and that new technology strengthened the existing capital. The changes also increased the level of technical efficiency and productivity of some industries including transportation manufacturing sector in the country. Meanwhile, the studies of Alvarez and Crespi (2003), and Chu and Kalirajan (2011) in Chile and Vietnam show that the level of TE of the transport manufacturing sector has made a significant contribution to the manufacturing industry. Similarly, a study conducted by Karunaratne (2012) was carried out in Australia. In addition, a study conducted by Petrin et al. (2011) in the United States found a slow growth in the transportation manufacturing sector although the level of TE as a whole contributed significantly to the economic growth of the country.

There are also other studies that measured the technical efficiency of manufacturing industry in developing countries and specifically discussed on the transport manufacturing sector. The study by Yao and Zhang (2001) and Wu et al. (2003) in China showed that manufacturing sector, including rail transportation, automobile, motorcycles, bicycles, and aircraft and aeronautics, exhibited a high technical efficiency level. In addition, factors such as firm size, number of trained employees, education levels, staff training expenses, and percentage of professional employees were significant determinants for the firms' technical efficiency. Meanwhile, Amornkitvikai et al. (2013) conducted a study to determine the inefficiency factors of 3,894 firms from small and medium enterprises (SMEs) including those from the transport manufacturing sector in Thailand and showed that factors such as firm size, age of firm, foreign ownership, location, and state aid promoted higher firm efficiency. There are also studies that pay full attention only on the services and management sectors in the transportation industry such as Holmgren (2013), Hossain et al. (2012), Oum and Yu (2012), and Sami et al. (2013).

In Malaysia, studies on the technical efficiency of transportation manufacturing firms receive less attention compared to the studies on the firms in other industries. Previous studies have discussed transportation manufacturing firms in general and as a part of studies on the manufacturing industry. A study conducted by Nik Mustapha and Basri (2004) found that transportation equipment industry was the most inefficient industry. Only Khalifah (2013) and Fahmy-Abdullah (2017) focused on the technical efficiency of the automotive sector. Khalifah (2013) study showed that technical efficiency was positive. The study compared between local ownership and foreign ownership. Besides, the study also found that small firm and white workers were capable to improve the efficiency of the industry. Fahmy-Abdullah et al. (2017) showed that the average level of technical efficiency is moderate. The estimated result identifies the important determinants of technical inefficiency which are due to employee wage rates as well as the cost of information and communication technology in 2010.

Based on this discussion, the study on technical efficiency of transport manufacturing industry is still inadequate. Therefore, this present study attempted to fill this gap to determine the level of technical efficiency of transport manufacturing industry in Malaysia as a whole using firm level data. In addition, this study also identified the determinants of technical inefficiency based on previous studies.

Methods, Data and Model Specification

The Stochastic Frontier Analysis (SFA) model has been widely used by researchers to estimate technical efficiency (Chu & Kalirajan 2011; Fahmy-Abdullah et al. 2019b; Karunaratne 2012). The SFA method was also used by Fahmy-Abdullah et al. (2017), Holmgren (2013), Hossain et al. (2012), Sami et al. (2015), and Von Hirschhausen and Cullmann (2010) to determine technical efficiency, allocative efficiency, and economic efficiency in the transportation industry.

The main advantage of the SFA method is that it can produce good results in terms of efficiency. Statistical methods tend to make assumptions regarding the stochastic characteristics of the studied data. In addition, this method is easily adapted to the environment variables (Coelli 2005, 1996). The SFA method is also capable of building a parametric boundary that considers the stochastic errors that can estimate the technical efficiency of the firm and develops a model of technical inefficiency based on several assumptions (Coelli et al. 2005; Zahid & Mokhtar 2007). In addition, this approach is also able to identify inconsistent data if such data exists in the analysis. Cullinane et al. (2006) stressed that the SFA method can analyse structure and examine the determinants and the performance of the manufacturer. In fact, the SFA method was not only capable of measuring technical inefficiencies, but it can also identify random shocks that were beyond the manufacturers' control, which could impact their production (Sami et al. 2015).

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 transport manufacturing firms in Malaysia were analysed.

The two-factor Cobb-Douglas production function that utilises cross-sectional data can be written as in (1) (Coelli 1996):

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

where Y_i is the output, and the two inputs are the values of the capital (K_i) and labour (L_i). X variables are the log of inputs, while subscripted j and i indicate the inputs; is a non-negative random variable, representing the technical inefficiency, and is assumed to be independently distributed as truncations at zero of the distribution; v_i is a random error assumed to be iid ; where $\mu = {}_i$ and variance ; and $_i$ is the $(1 \times p)$ vector of explanatory variables associated with technical inefficiency of the transport manufacturing firms over time; where is a $(p \times 1)$ vector of unknown parameters.

Then, the Transcendental-Logarithm (Translog) production function using cross-sectional data can be expressed as in (2) (Coelli 1996):

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

where Y_i is the log of the observed output of the i-th establishment and t is the time variable. X variables are the log of inputs, while subscripted j and i indicate the inputs; u_i is a non-negative random variable, representing 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 $(1 \times p)$ vector of explanatory variables associated with technical inefficiency of the transport manufacturing firms over time; where δ is a $(p \times 1)$ vector of unknown parameters.

The first objective of this study was to determine the level of technical efficiency of transportation manufacturing firms. Therefore, the measurement of a firm's technical efficiency can be obtained using FRONTIER 4.1 program by Battese and Coelli (1995) (Technical efficiency measurements were performed annually because the amount of acquired firm level data was different from one year to the next. This was an advantage because the results of technical efficiency (TE) obtained were improved and significant because the analyses were conducted using data at firm level). The second objective was to determine the determinants of technical inefficiency of transportation manufacturing firms for each year. Therefore, the variables incorporated within the technical inefficiency component of the stochastic frontier model are as follows in (3):

$$u_i = \delta_0 + \delta_1 \ln K/L_i + \delta_2 \ln TRE_i + \delta_3 \ln SEC/L_i + \delta_4 \ln TIER/L_i + \delta_5 \ln W/L_i + \delta_6 \ln ICT_i + \delta_7 DFSME_i \quad (3)$$

where u_i represents technical inefficiency; K/L_i represents the ratio of the total capital divided by the number of employees in the i-th firm; TRE represents the total expenditure for employee training for the i-th firm; SEC/L_i represents the ratio of workers with education at diploma and STPM level or equivalent for the i-th firm; $TIER/L_i$ represents the ratio of workers with education at higher levels, which include postgraduate degrees or equivalent for the i-th firm; W/L_i represents the wage rate for the i-th firm; ICT_i represents the communication spending for firm i-th; DFSME is a dummy for the i-th firm with small firms representing 1, while the others represent 0.

The estimation of a stochastic frontier production can be used to validate two null hypotheses: cobb-douglas or translog; and absence of the effects of technical inefficiency. These two hypotheses were tested using the generalised likelihood-ratio test (LR test), λ, given by (4):

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

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 used the firm level data obtained from the Survey of Manufacturing Industries (SMI), operated by the Department of Statistics (DOS), Malaysia. One of the advantages of using firm level data as an individual is that further analysis on the factors affecting the level of efficiency can be conducted. Battese and Coelli (1995) pointed out that by considering the factors of technical inefficiencies, data at firm level can play an important role to obtain an accurate value of technical efficiency. In addition, this micro data is also more efficient compared to the time-series data as the researcher has the advantage of solving some of the problems associated with the estimates and the bias aggregation to aggregated industry data (Md Isa 2005). This present study involved the cross-sectional data from 2005 to 2010, and this data can be categorised into six subsectors at 3-digit levels, according to the Malaysia Standard Industrial Classification (MSIC) 2000 and 2008 includes manufacture of motor vehicles, manufacture of passenger car, and manufacture of commercial vehicles (MSIC 341/291), manufacture of chassis (coachwork) for motorized vehicles, and manufacture of trailer and semi-trailer (MSIC 342/292), manufacture of spare parts and accessories for motorized vehicles (MSIC 343/293), ship and boat building, shipbuilding and floating structures, and the construction of cruise and sports boats (MSIC 351/301), construction of air and spacecraft, and related machinery (MSIC 353/303) and manufacture of transportation equipment, which activities are not elsewhere classified (n.e.c) and manufacture of motorcycles and bicycles, and manufacture of invalid carriages (MSIC 359/309).

Based on the data, 611 transport manufacturing firms were involved in this study, and the number of firms were different each year. In 2005, there were 114 firms involved, whereas in 2006 and 2007, there were only 100 firms. Meanwhile, 85 firms were involved in 2008, 82 firms in 2009, and in 2010, there were 130 firms. 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 2005 Malaysian Ringgit.

Results and Discussion

The results for the hypothesis test were obtained using the FRONTIER 4.1 program (Battese & Coelli 1995). The program also provided the estimates for the parameters in (1) and (2), and measured the technical efficiency score of transportation manufacturing firms. This study conducted two hypothesis tests. The results of confirmation tests for the null hypothesis for transportation manufacturing firms from 2005 to 2010 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 each year. The results showed that the Cobb-Douglas production function was rejected in each year of study, thus, the more general 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 consistently 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). Sami 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 transport manufacturing firms. Table 1 shows that the statistical values were greater than the critical value at a significance level of 5%, indicating the existence of the effects of technical inefficiency in transportation manufacturing firms 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. Results of hypotheses testing

	2005	2006	2007	2008	2009	2010
Null Hypothesis			(1) Cobb-Douglas (H_0 :)			
LR statistics	9.50**	26.26**	8.10** (1)	10.62**	8.42**	15.32**
Critical Value			7.82**			
Decision	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o
Null Hypothesis			(2) No Technical inefficiency Effects ($H_0 : {}_0 \; {}_1 \; \dots \; {}_9 \; 0$)			
LR statistics	33.65**	20.16**	(2) 33.22**	14.16*	14.24*	50.00**
Critical Value			13.40**			
Decision	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o	Reject H_o

Note: * are significant at 10%, **are significant at 5% levels, respectively

ANALYSIS OF RESULTS OF STOCHASTIC FRONTIER ANALYSIS

Table 2 shows the results of technical inefficiency variables. The negative sign obtained from the analysis results showed that when there was an increase in one of the variables, it can reduce the technical inefficiency of transport manufacturing firms. On the other hand, if a positive sign was obtained from the results, then it will increase the firm's technical inefficiency. Based on the results of the analysis, it was found that the determinants such as training expenses for employees, the ratio of workers with education at the secondary and tertiary levels, employees' wage rates, and communication and information technology expenses were negative and significant. These determinants can reduce the level of technical incompetence for transportation manufacturing firms in Malaysia.

Upon observation, the factor of training expenses for employees reduced technical inefficiencies in 2005 and 2007, thus, leading to positive increases in productivity during those years. These findings were in line with the findings of the studies conducted by Ajibefun (2008), and Hamdan et al. (2019). The ratio of workers who were educated at the secondary level also reduced the technical inefficiencies in 2009, while the ratio of workers who were educated at the highest level reduced the technical inefficiencies in 2006. The schooling period or level of education is one of the important factors in identifying the performance of the firm (Honig 2001; Latif et al. 2019; Sabli et al. 2019) and have a positive relationship with productivity growth (Ajibefun 2008; Obwona 2006).

In addition, employees' wage rates also reduced the technical inefficiencies. These results indicated that the employees' wage rate can play an important role, as also reported by Fahmy-Abdullah et al. (2019), Idris et al. (2019), and Wu et al. (2003). Therefore, a firm that is capable of increasing the wage rate to its employees can motivate the employees and increase the production and productivity of the firm. Furthermore, expenses for communication and information technology also contributed to the reduction of technical inefficiencies to the transportation manufacturing firms in Malaysia in 2007, 2008, and 2010. These expenses include hardware consultancy, maintenance and software supply consultancy, data processing and database activities services as well as through online communication or facsimile.

However, the capital-labour ratio was found to have a significant relationship with increased technical inefficiency along the years studied, except in 2007. This result was in contrast with the results from previous studies such as by Stevens and Kneller (2003). These paper suggested that it may be possible to use available capitals for other aspects other than improving employee's productivity, i.e. production output. In addition, there was the likely occurrence of increased capital, such as for technological improvements, which did not encourage improvements in the efficiency of existing employees. This can affect the increase of technical inefficiency because employees would have to adapt to the newly acquired technologies.

TABLE 2. Determinants of technical inefficiency, 2005 - 2010

Variables	Parameters	Estimated MLE coefficients					
		2005	2006	2007	2008	2009	2010
Constant	δ_0	0.293	-1.565	2.473	1.361	-0.321	1.183
		(0.345)	(-1.540)	(3.775)	(1.833)	(-0.310)	(1.683)
K/L	δ_1	0.933***	0.888***	-0.065	0.485***	1.037***	0.721***
		(6.465)	(2.809)	(-1.275)	(3.436)	(3.467)	(3.759)
TRE	δ_2	-0.233**	-0.059	-0.171***	0.020	-0.090	0.956
		(-2.029)	-1.251	(-3.817)	(0.350)	(-0.851)	(0.914)
TIER/L	δ_3	-0.440	-0.435***	-0.182	-0.945	1.263	-0.199
		(-0.338)	(-3.313)	(-0.521)	(-0.932)	(0.897)	(-1.377)
SEC/L	δ_4	0.985	0.706	0.175	0.801	1.375**	1.186
		(0.998)	(0.980)	0.194	(1.370)	(1.973)	(1.373)
W/L	δ_5	-0.579	-0.275	-0.005	-0.523*	-1.176***	-0.779***
		(-1.512)	(-1.108)	-0.050	(-1.681)	(-3.074)	(-3.568)
ICT	δ_6	-0.269	-0.085	-0.339***	-0.196**	-0.098	-3.633***
		(-1.513)	(-1.007)	(-3.729)	(-2.095)	(-0.673)	(-3.786)
Firms Size	δ_7	-0.450	-0.491	-0.005	-0.319	-0.254	0.019
(-0.939)	(-1.540)	(-0.022)	(-1.095)	(-0.062)	(0.067)		

Note: *are significant at 10%, **are significant at 5% and ***are significant at 1% levels, respectively
Value in ( ) is the t-statistic

Conclusion

Although the study of technical efficiency has been extensively conducted in Malaysia, the technical efficiency of transport manufacturing industry has received lower attention from researchers compared to other industries. In fact, the limitation to obtain data at firm level makes it more difficult to perform such a study. In addition, most previous studies have disregarded the determinants of inefficiency, thus, resulted in inaccurate and insignificant results.

The main contribution of this study is that it used firm level data, which was in contrast to previous studies that used aggregated data. The use of firm level data can provide more accurate information, thereby improving the accuracy and reliability of the results from the analyses. Additionally, this study attempted to explain the determinants of technical inefficiency with direct relationships with transport manufacturing firms. This study conducted two hypothesis tests to determine the appropriate production function, in addition to determining whether the effect of inefficiency was present. Overall, the results consistently showed that Translog production function was more appropriate than Cobb-Douglas production function, and it was found that effect of technical inefficiency was present. Almost all determinants of technical inefficiency were significant and can reduce the level of inefficiency in transport manufacturing firms in Malaysia. Only the firm size variable was found to have no effect on the firm's technical inefficiency. Meanwhile, the capital-labour ratio showed a significant effect on the increase of technical inefficiency.

In conclusion, it can be said that most of the transport manufacturing firms in this study achieved a moderate level of technical efficiency. Therefore, it is critical that these firms take efforts to further improve their infrastructure and existing facilities to increase for optimal production. The results obtained in this study can be associated with some policy implications. First, increasing the number of employees with tertiary and secondary qualifications can produce a higher number of effective employees, while simultaneously increasing the efficiency of the firm. Firms can achieve optimal amounts of output if more efficient production operations are carried out by increasing the quality of labour or capital. Therefore, continuous investments in human capital are very important, and the government's emphasis on this aspect should be continued. Second, the importance of training expenses for employees, employees' wage rates, and communication and information technology costs should not be ignored. The improved quality of labour can be done when continuous trainings are carried out to the employees. In addition, these firms will have to contribute to the ICT capital investment, wages, and several forms of trainings and skills that can contribute to the increased productivity of a firm.

The limitation in this study was that the amount of data collected was inconsistent or varied each year because each firm had a different management system. It is hoped that the results obtained in this study can help the policy makers understand and know better about the importance of the determinants of inefficiency. In addition, the policy makers should also know the importance of using data at firm level to obtain significant and better efficiency values, because - if it is not too much to mention - this is the first comprehensive assessment ever conducted on the transportation manufacturing firms in Malaysia.

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