MEASURING THE TECHNICAL EFFICIENCY OF FOOD MANUFACTURING INDUSTRY IN MALAYSIA

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Abstract: Malaysia's Third Industrial Master Plan (IMP3) for the years 2006–2020 reported that the food manufacturing industry is generally less prone to economic change and recorded 17.5% increase in 5 consecutive years. This study identifies the level of technical efficiency (TE) and analyzing the factors that determine the technical inefficiency for food manufacturing in Malaysia involving a total of 1,569 firms using Stochastic Frontier Analysis (SFA). The determining factors such as the capital–labour ratio, employee training expenditure, secondary and tertiary education standards, wage rates, information and communications technology (ICT) costs, and firm size. The SFA results indicate that the TE level of food manufacturing companies in Malaysia is 0.779, which is a high level. Additionally, the capital–labour ratio, employee training expenditure, secondary and tertiary education standards, wage rates and ICT costs are significant determining factors of the inefficiency of food manufacturing firms. However, the size of the manufacturing company was found to be an insignificant factor in determining the increased efficiency of food manufacturing companies. These results indicate that food manufacturers need to increase investment in human capital and ICT and motivate employees by raising wage rates and improving the use of capital appropriate to the level of technology.

Keywords: Technical efficiency, stochastic frontier analysis, food manufacturing.

Introduction

Technical efficiency (TE) can be described as a value between one to less than one using Stochastic Frontier Analysis (Porcelli, 2009). It refers to the capability of a company to maximise output rather than minimize input (Kumbhakar & Lovell, 2013).

Moreover, efficiency indicates the effectiveness of input users, which is influenced by production techniques, technological innovation, management skills, and skilled labour (Fahmy-Abdullah, Ismail & Sulaiman, 2017). Looking at the current Malaysian economy, TE is vital to the domestic economy as it can help the country achieve a more encouraging level of growth.

The growth of the Malaysian economy in the last half a century is attributed to the

manufacturing industry (Malaysia Finance Ministry, 2016). The importance of the manufacturing industry to the economy is proven by its contribution to the gross domestic product (GDP). Furthermore, the industrial production index in the manufacturing industry is higher than those in other industries (Malaysia Finance Ministry, 2016). In fact, the value added by the manufacturing sector increased from 4.3% in the first 6 months of 2016 (January–June 2016) to 4.9%, whereas output increased by 4%. According to the economic report released by the Finance Ministry in 2017, the manufacturing industry was one of the main contributors to the national economy.

In the 8th Malaysia Plan, the manufacturing industry recorded an average growth of 4.1%. Whereas, in the 9th Malaysia Plan, it is expected

to grow by 6.7%. By 2020, Malaysia expects the manufacturing industry to contribute 22.1% to the GDP and 18.2% to the total employment in the country. The manufacturing industry includes the manufacture of food products, beverages, tobacco products, textiles, clothing, and so on.

This manufacturing industry can provide great opportunities for the economic development of the country; thus, it requires high technical competence in order to remain competitive given current market conditions.

In this study, the TE in the food manufacturing industry in Malaysia for 2015 is evaluated in detail using company-level data. Research on the determinants can help improve the TE in the food manufacturing industry itself (Roslina, 2005) and can also influence the results of the study. These determinants can help identify the factors that are influencing the efficiency of techniques in the food manufacturing industry in Malaysia.

According to Malaysia's Third Industrial Master Plan (IMP3) for the years 2006–2020, the food manufacturing industry is generally less prone to economic change. However, it is estimated that the global retail sales of food products are worth US\$ 3.5 trillion, and this is expected to increase. Moreover, the employment in the food manufacturing industry has exhibited a high growth.

In 2010, the industry employed a total of 169,084 people, and in 2015, it employed a total of 256,908 people, indicating an increase of between 10.8% and 12.1% (Manufacturing Industry Economic Census 2016 – DoSM). Furthermore, the number of establishments in the manufacturing sub-sector in 2010 and 2015 increased, demonstrating a contribution value of 14.9% in 2010 and 16.4% in 2015.

However, there was no increase productivity recorded in the food manufacturing industry which only recorded a value of only 17.5% for five consecutive years. Therefore, it is clear that the food manufacturing industry requires more efficient techniques to increase its productivity in order to improve the country's economy.

Previous studies on the food manufacturing industry in Malaysia have been conducted, such as that of Ismail (2009), which used sub-industry-level data. In this study, company data was used, which enables a more accurate evaluation of the efficiency of the technique compared with previous studies.

Moreover, the study conducted by Arnornkitvikai and Harvie (2011) focused only on Thailand. In this study, the level of technical efficiency in Malaysia will be investigated. Ismail and Mohd Noor (2007) stated that the level of efficiency of the food manufacturing industry is currently low. However, the time gap between the studies is significant. The latest data are used in this study to yield more accurate study results. In Malaysia, the food manufacturing industry has a great potential in improving the economy. The food manufacturing industry is one of the contributors to the economic development of a country. Thus, this industry needs to exhibit high efficiency, minimize operating costs, maintain the quality of production and skilled labor, and achieve high productivity in order to survive in the economy.

This study can improve the existing information; moreover, it can be used as a reference for future studies. The use of corporate-level data will provide more accurate results and provide clearer data for use to mitigate the weaknesses in the food manufacturing industry. The research methodology used in the study the Stochastic Frontier Analysis (SFA), can not only measure the efficiency of the techniques used but also identify random shocks to the system beyond the control of the manufacturer, which can significantly affect production (Jarboui *et al.*, 2015).

This study will prove useful to all parties on behalf of the government, private sector, and investors or the society as a whole to improve TE and assist in the more efficient distribution and generation of economic resources. Improvements can be made in the food manufacturing industry itself as this study will identify the determining factors to achieve maximum TE in the Malaysian food manufacturing industry.

Based on the problems and study gaps faced by the food manufacturing industry in the country, this study aims to look at the extent of the efficiency and the determinants of the inefficiency of the Malaysian food manufacturing industry using the latest data sources. This study is vital as it is in line with national targets to develop the food manufacturing industry and turn it into one of the key competitive industries not only locally but globally based on current performance.

This can illustrate how good the technical efficiency or how bad the technical inefficiencies in the Malaysian food manufacturing industry is in the long run. This study is also able to answer the question of how efficient the manufacturers are, as well as to determine what factors affect the technical inefficiency of the food manufacturing industry in Malaysia.

Literature Review

According to Shahar *et al.* (2015), technical efficiency exists when more output is produced using optimum input. An increase in productivity needs a combination of quality workers with skills for optimum production. Technical efficiency (TE) refers to the effectiveness of the use of inputs that influence production this includes; the techniques, technological innovation, management skills and labour skill levels (Charoenrat *et al.*, 2013). TE also can be defined as the effectiveness with which a given set of inputs is used to produce an output (Odeck & Brathen, 2012). Meanwhile, according to Farrell (1957), TE is the amount of output when an organization can produce output at the maximum level. TE is important for the assessment of the level of competence of an industry or a firm.

Efficiency in economic terms also refers to the comparison between the observed input and output values, with the optimal input and output values used in the production process (Karlaftis and Tambouslas, 2012). It is usually portrayed as an operational efficiency on a scale of 0 to 1, where a value of 1 indicates the decision-making

unit is, relatively speaking, the most efficient. If the value is less than 1 it indicates the inefficient operation of the decision-making unit (Porcelli, 2009).

The TE study has been widely used in various fields or organisations 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.

Based on available literature, many studies have measured TE especially in the manufacturing industry for companies and sectors that are closely related to the food manufacturing industry. Most food manufacturers are generally described in the study. A study by Nishimizu and Page (2014) found that the TE levels of the food manufacturing industry in Yugoslavia was still low. Similarly, a study conducted by Baten, Kami I and Fatama (2009) in Bangladesh found that the level of TE for the food manufacturing industry in the country was "moderate" at best.

There are also previous studies that not only measure the level of technical efficiency but also examine the determinants of a firm or industry. The capital-labour ratio or intensity is the first determining factor for SFA. An early study by Haskel and Martin (1993) emphasised that the use or investment of capital in the production process helps improve labour efficiency.

Moreover, a study conducted by Rahmah and Idris (2001) found that the ratio of capital-labour has a positive relationship with efficiency, a finding similar to that of a study conducted by Stevens and Kneller (2003), which demonstrates a positive relationship between the two variables. Bertrand (2013) and Fahmy-Abdullah *et al.* (2018) also found that a firm can capitalise on high capital volumes, the positive impact on efficiency and productivity can be achieved in line with the maximum machine utilisation in the production process.

Training employees can increase the workers efficiency. The findings of a study by

Almieda and Carneiro (2009), who conducted a study on the effect of training on organizational efficiency, demonstrated that the training provided by the organization to employees has significant positive effects on its output and efficiency. Training expenses are one of factors that can reduce the firm's TE (Olatunji & Ibidunni, 2013; Ismail & Zainal Abidin, 2015). Fahmy-Abdullah (2017) found that as a means of incentivizing the production of goods and services, training expenses are an important means to improve the skills of the employees that can lead to the creation or innovation of new technologies that can improve the firm's TE.

The third determining factor is the level of education. Rahmah and Noorasiah (2007) and Rahmah and Norlinda (2008) both found that labour capital, such as educational achievements by employees, is an important factor that influences organizational efficiency in Malaysia. The findings of the study conducted by Anderson *et al.* (2002) revealed that improving the education of employees can increase the production of an organization.

Output, profitability and productivity are the key roles education plays in identifying and improving a company's performance (MPC, 2017). It plays a vital role in producing competitive human capital (Fahmy-Abdullah, 2017).

Firm size also plays an important role in increasing the firm's efficiency. According to Fahmy-Abdullah (2017), the firms size plays a significant role in improving the technical competence of an organization. The studies conducted by Charoenrat *et al.* (2013) and Amornkitvikai *et al.* (2014) found that the firms size can affect the TE level of a firm.

Wage rates certainly play an important role as motivation and incentives for workers in a firm. Muhlau and Lindenberg (2003) theorized that in the United States and Japan, labour efficiency increases if the wage rates provided by the firm are higher than the market wage rate.

High wage rates received by employees, including bonuses and allowance payments,

encouraged employees to work hard, indirectly increasing efficiency of the organization. (Fahmy-Abdullah *et al.*, 2018; Fahmy-Abdullah *et al.*, 2019) which tends to increase wage rates.

In addition, information and communications technology (ICT) investments made by a firm can result in a positive impact. Liew *et al.* (2012) stated that organizational change to incorporate more ICT components in day-to-day operations, providing up-to-date ICT training and knowledge to employees and government support in the form of data, incentives, or subsidies to promote innovation development and ICT strategic plan formulation should be done to increase the efficiency of an organization. The study conducted by Rahmah and Shade (2015) reported that ICT improves the TE of a firm.

A study on the TE of the food manufacturing industry in Malaysia by Nik Hashim and Basri (2004) found that the level of TE of the food manufacturing industry in the country is low, a similar finding to that of Ismail (2009). Therefore, the latest research on the level of TE and the determinants of technical inefficiency of electrical and electronic manufacturing firms using corporate-level data should be undertaken to increase the productivity of the industry in the future.

Research Methodology

SFA Model

The Suitability, Feasibility and Acceptability (SFA) approach was employed in this study to estimate the maximum output. This approach is capable of measuring TEs as well as identifying random shocks to the system beyond the control of the manufacturer that can have an impact on production (Jarbouli *et al.*, 2015; Fahmy-Abdullah *et al.*, 2017). The SFA approach has been employed in previous studies to obtain TE values. These studies include those by Aigner, Lovell and Schmidt (1977), Meeusen and van Den Broeck (1977), Battese and Coelli (1995) and Fahmy-Abdullah *et al.* (2019), who suggested the use of the SFA approach to evaluate TE.

This study uses the translog approach, which is expressed as follows:

$$\ln Y_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \frac{1}{2} \beta_3 (\ln K_i)^2 + \frac{1}{2} \beta_4 (\ln L_i)^2 + \beta_5 (\ln K_i \times \ln L_i) + (v_i - u_i) \quad (1)$$

where Y_i denotes the log for the amount of nominal output of the i -th firm; K , the log for the amount of the nominal asset of the i -th firm; L , the log for the amount of labor of the i -th firm; and v_i , the random variable or random effect, identical and normally distributed (independent and identically distributed, i.i.d), normally distributed with $[(0, \sigma^2)]$.

Meanwhile, u_i denotes the nonnegative random variable that can be assumed to explain the inefficiency in production, which is normally assumed to be IID as truncated at zero for distribution $[(u_i, \sigma u^2)]$.

$$u_i = \delta_0 + \delta_1 \ln K/L_i + \delta_2 \ln TRL_i + \delta_3 \ln SEP_i + \delta_4 \ln PT_i + \delta_5 \ln W/L_i + \delta_6 \ln ICT_i + \delta_7 \ln DFSME_i \quad (2)$$

where u_i denotes the TE; K/L_i , the capital–labor ratio of the i -th firm; TRL_i , the amount of employee training expenditures of the i -th firm; SEP_i , the ratio of employees trained at diploma level and STPM or equivalent for the i -th firm; PT_i , the ratio of employees trained at a higher level, including advanced degree or equivalent for the i -th firm; and W/L_i , the total wage rate of the i -th firm.

Data Sources and Analysis

This study uses data at the firm level obtained from the Survey of Manufacturing Industries (SMI) conducted by the Department of Statistics Malaysia (DoSM) through the latest Economic Census conducted in 2015. The data provided by DoSM accounts for 30% of the total aggregate data and can be categorised into eight sub-industries at the 3-digit level according to MSIC 2008. A total of 1,569 firms of food manufacturing industry were involved in this study.

This study aims to measure the value of TE utilizing firm-level data using the Frontier 4.1 software. The SFA model has been chosen to denote the TE value. To obtain an accurate estimate of the TE value, each of the assumptions and rules listed must be followed. The translog production function is first tested. Overall, all approaches and budgeting are performed to meet the study objectives.

Data Analysis

Based on the data obtained from the Department of Statistics Malaysia (DoSM), there are a total of 1,569 food manufacturing firms in 2015 involved in this study. The firm-level data selection was randomly performed in stages of simulated processes, such as firm size identification, big firms, small and medium firms, the number of outputs issued and the number of employees and capital spent.

The implementation of this study required the use of several variables in 2015, including capital, number of employees, capital–labour ratio, firm size, training expenses of employees, ratio of employees with high and secondary levels of education, employee wage rates, and ICT cost information. As can be seen from Table 1, the output variable recorded an average of RM72,292,000.

Whereas with regard to the capital variable, an average of RM10,596,000 for the entire food manufacturing industry was recorded. The average number of employees is 90 people. Moreover, the average of the intermediate input variable is RM66,427,000. For the next variable, the capital–employee ratio had an average of 86,000 for 2015. The average variable for the training expenses of employees is RM22,000.

In addition, the average variable of employee salary rate is as much as RM20,000, whereas the average of the variable for the ICT expenditure is RM62,000 for the year 2015. Table 1 presents a summary of the descriptive variables used in this study to determine the efficiency.

Table 1: Descriptive statistics of the variables

Variable		Mean	Minimum	Maximum
Y (Output)	(RM)	72,292,000	606,000	5,566,970,000
K (Capital)	(RM)	10,596,000	2,000	674,760,000
L (Labour)		90	6	6,097,000
K/L	(RM)	86	84,000	6,454,000
TRL	(RM)	22,000	0	15,000,000
SEP	Ratio	0	0	0.529
PT	Ratio	0	0	1.000
W/L	(RM)	20,000	2,000	1,529,000
ICT	(RM)	62,000	1,000	9,319,000
DFSME	Dummy	1	0	1

Note: *RM is Ringgit Malaysia

Results and Discussion

TE Decision Analysis

Figure 1: TE reading range

Figure 1 presents the frequency and distribution of the TE index of the food manufacturing industry in Malaysia in 2015. Based on the results of the study, an efficiency value of 0.60 was recorded by only five firms. On the flip side, only four firms managed to score the highest

value of 1.00. Consequently, firms with a value below 0.70 must improve TE levels to raise output or production levels. Table 2 presents in detail the frequency and distribution of the TE indices in the food manufacturing industry in Malaysia for 2015.

Figure 2: TE for subindustries food manufacturing in Malaysia

Figure 2 presents the percentage of the TE according to the food manufacturing sub-industry in Malaysia in 2015. As can be seen from the table, the level of TE of each sub-industry is high, between 0.849 and 0.912. The sub-industry with the highest level of TE is the MISC 108 sub-industry, animal feed-manufacturing sub-industry, which recorded a value of 0.912.

The second highest is the MISC 105 sub-industry, dairy product manufacturing sub-industry, which recorded a value of 0.885. The MISC 101 sub-industry, a meat processing and preservation sub-industry, recorded a TE level of 0.861 while, the MISC 107 sub-industry recorded a TE value of only 0.868. MISC 103 sub-industry, fruit and vegetable processing and preservation industry, demonstrated a TE

value of 0.862. The MISC 104 sub-industry, manufacturing industry of oils and fats from vegetables and animals, recorded a TE value of 0.856.

The MISC 102 sub-industry, crustacean and mollusk processing and preservation industry, demonstrated the lowest TE value, which was 0.849. Although the overall reading of the average value of TE for each sub-industry is at a high level, which is 0.779, it can be improved to produce output at the optimum level.

It is important for the industry to determine its level of TE so that it can be further improved. It is important to study for each sub-industry for the economic development of the country indirectly. Table 2 displays the frequency and the index distribution of technical efficiency in the food manufacturing in Malaysia in 2015.

Table 2: Frequency and index distribution of technical efficiency in the food manufacturing Malaysia, 2015

	Range					Average
	≤0.60	≤0.70	≤0.80	≤0.90	≤1.00	
Frequency	5	238	849	473	4	0.779
Percent	0.319	15.169	54.110	30.147	0.255	
Accumulative Percentage	37.644	15.488	69.488	99.745	100	
Firms			1569			

Analysis of Technical Inefficiency Decisions

In Table 3, the negative values obtained from the results of the analysis indicated that when there is an increase in the variables, there is also a reduction in the TE of the food manufacturing

industry. Meanwhile, the positive values indicate an increase in the TE level of a firm. The findings of the study revealed that the firms size is not one of the factors that is significantly correlated with TE in the food manufacturing industry in Malaysia.

Table 3: Technical inefficiency variables result for food industries in Malaysia, 2015

Variables	Parameter	Coefficient Maximum Likelihood Estimation (MLE)
Constants	δ_0	0.869
		8.113***
Ln Total Capital-labor Ratio	δ_1	0.060
		-3.502***
Ln Total Employee Training Expenses	δ_2	-0.009
		-1.783*
Ln Total Level of Higher Education	δ_3	-0.186
		-1.978**
Ln Total Secondary Education Level	δ_4	-0.129
		2.824***
Ln Total Wage Rate	δ_5	-0.138
		-12.121***
Ln Total ICT Expenditure	δ_6	-0.010
		-2.128***
Ln Total DFSME	δ_7	0.025
		0.784

Note: *, ** and *** represent the significance at the level of significance 10%, 5% and 1%

The capital–labour ratio is negative and significant against TEs. This indicates that this factor has a positive impact on the level of TE in the food manufacturing industry in Malaysia. If the capital–labour ratio is further enhanced, the food manufacturing industry in the country will become more efficient. Moreover, the capital–labour ratio can further optimise production in the food manufacturing industry. This is further supported by a study conducted by Stevens and Kneller (2003) who stated that the capital–labour ratio is significantly correlated to TE.

The ratio of employees with higher and secondary levels of education was found to be

significantly correlated to TE. This indicates that the higher the ratio of employees with secondary level education, the higher the level of technical competence in the food manufacturing industry. Previous studies conducted by Rahmah and Norlinda (2008) and Ajibefun (2008) reported that schooling and education levels have a positive correlation to the levels of technical competence in an industry.

Additionally, wage rates were also found to be significantly correlated with TE. Based on the Economic Report 2017–2018 by GDP stated the Salary and Wage Survey Report 2016 by the Department of Statistics Malaysia showed

that the average monthly salary and wages received by employees increased 6.5% to RM 2,463 compared to 2015 which was RM2,312 equivalent to 5.4%. This indicates that firms tend to increase the amount of wages to increase employee motivation and in turn increase TE.

Total ICT expenditure was also found to have a significant negative relationship with the TE of the food manufacturing industry in Malaysia. Liew, Mohd Noor and Tee (2012) stated that the innovation and formulation of the ICT strategic plan need to be performed to improve the TE of an organization.

Discussion, Recommendations and Conclusions

This study aimed to examine the technical efficiency (TE) level and analyze the determining factors of technical inefficiency of the food manufacturing industry in Malaysia. This study involved 1,569 firms, and the data used were obtained from the DoSM in 2015. The translog production function was employed to determine the level of TE and the determining factors of firm inefficiency.

Overall, the level of TE of the food manufacturing industry in Malaysia is high, at 0.779. Results indicate that the determining factors of TE include the capital-labour ratio, ratio of highly educated employees with high levels of education, information and communications technology (ICT) expenditure, training expenses, and wage rates, which all play a significant role in reducing the inefficiencies of a company or manufacturer. In terms of policy implications, this finding emphasises the fact that the TE level of the food manufacturing industry still needs to be improved, particularly with regard to the determining factors that can significantly increase the firm's production.

First, to produce trained and skilled employees, a sufficient level of education needs to be provided. Emphasis should be placed on the improvement of the skills and capabilities of the employees in several areas, such as leadership, engineering, quality, and cost management. This can help the industry reduce

the dependency on low-skilled employees, and create a knowledgeable workforce.

Second, the transfer of technology and the changes in the role of policy makers are required to control the innovation system of a firm to enhance its competency and enable it to grow. Hence, the increase in the investment in ICT expenditure should be continued as it helps the firm increase its business prospects as well as its efficiency and productivity.

Third, training for employees is a long-term asset that can enhance the skills and capabilities of competitive employees. Finally, to motivate and improve efficiency and productivity in order to increase the amount of output, the firm should increase wage rates for workers.

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