Determinants Factor of Technical Efficiency in Machinery Manufacturing Industry in Malaysia

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***Abstract*— Machinery manufacturing industry has been introduced since the beginning of the industrial era from European countries and developed until today. However, major challenges in machinery industry still driven by traditional production factors such as capital and labour that caused the industry still left out. Thus, the objective of the study are to analyse the level of TE and identifying determinant factors influenced to technical efficiency in the machinery manufacturing industry in Malaysia. The study was conducted by using the method of Data Envelopment Analysis (DEA) two stages. The first stage involves the calculation a score of efficiency through the DEA by using firm's data while the second stage Regression Tobit Analysis used to identify significant factors influencing to technical efficiency in machinery industrial. This firm's data are categorized into 3 sub-industry 3-digit according to the Malaysian Standard Industrial Classifications which are consists of Manufacture of General-Purpose Machinery, Manufacture of Special Purpose Machinery and Manufacture of Installation Machinery Industrial and Equipment. A total of 636 machinery industry firms were involved in this study. Results showed the average efficiency score is at the medium level while the determinant factors were significant are wage rates, the standard of education and research and development (R&D). The implications of this study show that the machinery industry should focus their attention to the significant factors to improve the level of technical efficiency of the machinery industry.**

***Keywords*—** *Technical Efficiency, Manufacturing Industry, Firms, Data Envelopment Analysis (DEA)*

1. Introduction

Efficiency is the effectiveness of the use of inputs effectively influenced by the production techniques, technological innovation, management skills and labour skills. While technical efficiency is the ability of firm to produce the maximum output when given a set of inputs [1]. The concept of technical efficiency have become the cord and driver to the development of techniques to estimate the relative efficiency of a firm [2]. [3] pointed out the overall factor productivity growth reflects the increase in productivity as a result of the use of inputs that improved as a result of advances in technology and efficiency of the economy as a whole.

Machinery manufacturing industry have been introduced since the beginning of the industrial era in European countries and developed until today. There are various policies introduced by the government such as the National Development Policy (NDP), Industrial Master Plan (PIP), the New Economic Policy (NEP) and the Malaysia 9th Plan (RMK-9) to increase the competitiveness of the manufacturing sector for reach and drive manufacturing industries to build innovative economy towards high income nations.

Based on the report of the Ministry of International Trade and Industry Malaysia 2016 (MITI), machinery and equipment industry have improved their performance in a trade with the approval of 88 investment projects worth RM1.54 billion. The value of exports of industrial machinery and equipment in year 2015 is 36.16 billion driven by manufacture of general purpose machinery and equipment industry especially air conditioning. In addition, export activity also supported by manufacture of special purpose machinery for certain industries such as civil engineering, oil and gas exploration, production and semiconductor parts to produce another products. The destinations of export for machinery and equipment industry are Singapore, Thailand, the United States, China and Vietnam.

According to National Productivity's Report, (2015/2016), Industrial of Machinery has recorded double-digit productivity growth which is 20.5 percent. Industrial of machinery is also being one of the most important sector in the country when the main role is to assist other manufacturing sector to produce various machinery and equipment such as power generating machine, machine specific processing, carpentry and metal general industrial activities. The production from machinery manufacturing industries are able to support Small and Medium Enterprises (SMES) to produce other products to export either in domestic or international level.

However, the challenges of machinery industry is still driven by traditional production which are capital and labour that contribute to 70 percent towards Malaysia's Gross Domestic Product that cause machinery industry

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still left out and led to the acceptance of low salary (Report of National Productivity, 2015/2016). Wages rate can affect the efficiency and productivity that cause a reduction of competitiveness against firms, whether local or international level.

In fact, the most of Small and Medium Enterprises (SMES) that produce machinery does not require high technology and skilled workers but more focus on cost effectiveness (Report of National Productivity, 2015/2016). Therefore, this approach shows the industrial machinery failed to maximize use of input and difficult to compete with other industry that are more consistent right now.

The past research found a study of technical efficiency on the machinery industry in Malaysia is lacking of attention. The empirical studies about technical efficiency in industrial machinery is the study from [4] in Romania and J. [5] in France. In addition, there are also have a research on TE made in Malaysia is not related to the manufacture of machinery industry. In addition, most past research are use data at industry level compare to firm's data. [6] pointed out estimation by using firm's data was better than use of industry's data because firm's data could analyze the determinant factors that influencing towards technical efficiency. Level of technical efficiency can be measured more accurate when using the firm's data and can determine the factors that influence efficiency to make some improvement.

Therefore, this research could find out and answer the questions of how far the level of TE and what is factors affect the level of technical efficiency of machinery industry in Malaysia. The second section of this article reviews previous studies. The third section discusses the research methodology, data sources, and model specification. The fourth section analyzes the results of the empirical analysis, and the fifth section provides the conclusions and the implications of this study.

2. Literature Review

This chapter discusses about past research that has been done by researchers about technical efficiency. This empirical study consists from domestic and international research.

2.1. Technical Efficiency Concept and Definition

Measurement of modern efficiency began with Farrell [1] which defines a measure the efficiency of firms into the use of input. The technical efficiency consists of two components, namely technical efficiency which implies the ability of a firm to obtain the maximum output from a set of input given and allocative efficiency which implies the ability of a firm to use input in optimum rating.

Technical efficiency refers to the ability of the firm to produce the highest output by using the set of inputs given. According to [7], the level of technical efficiency of firms shall operate through the relationship between the latest with potential production. The concept of technical efficiency have become the cord and driver to the development of techniques to estimate the relative efficiency of a firm [2].

Technical efficiency involve the ability of firms to avoid wastage by producing output maximizing using input. The technical efficiency is a reference for firm performance. [8] a way to improve efficiency is to improve current technology used or upgrade the skills of employees through the achievement of a higher level of education so that existing technology could be used with more efficiently.

2.2. Empirical Study on Technical Efficiency of Machinery Manufacturing Industry

There are two types of main methods that are often used by researchers to identify the level of TE which are parametric and non-parametric approach. Both of these methods are used to evaluate the level of technical efficiency whether using cross sectional data or data panel. Most of the past research has uses parametric and non-parametric approach to get the value of the technical efficiency. [4] researched, the approach of non-parametric has been used to determine the level of efficiency and productivity of industrial machinery in Romania in the period 2001-2010. Studies show the largest increases of machinery industry in efficiency and productivity in Romania. In addition, [5] also conducted studies using non-paramtric method to analyze technical efficiency of industrial machinery in France from 1984 to 1991. According to him, the use of the method of this research is able to detect some of the best technology to measure inefficient techniques in industrial machinery in France.

Based on the study of [9] a total of 35 fruit firm data were used to identify technical efficiency in agricultural machinery and equipment industry in Sri Lanka. The use and acceptance of agricultural new and modern machinery in Sri Lanka improve efficiency and productivity in production operations. Through the study, the increased of efficiency in agricultural machinery industry in Sri Lanka due to the acceptance of the strategy of new machinery. Therefore, the use of

new technologies is one of the factors that affect the technical efficiency in manufacturing industries.

In Malaysia, the study of TE against machinery manufacturing still lack of attention. The studies of [10] and [5] which mainly focused on the whole manufacturing industries focusing on machinery manufacturing in detail and accurate. In addition, research from [11] use DEA method to analyze TE in small and medium-scale industry. In addition, a technical efficiency study from A. [12] using SFA method only lead to transportation manufacturing industries from the year 2010 to the year 2015. Similarly, the study of Noor [13] which only focuses on transportation manufacturing industry that shows the industry is at a positive level. In contrast to industrial of machinery manufacturing, lack of research on the industry resulted in the study was conducted by using 3 sub-industry that is sure to give a more significant value TE and accurate. This implies that the objectives, selection of input and output as well as the study environment is different from the study will be made of this.

2.3. Empirical Study on Determinant Factor

There are seven determinant factors in the study, namely labour-capital ratio, training expenses, capital, education, status, firm size, wages rate, expenses, information technology and research and development (R&D)

The first determinant factor is the ratio of capital-labor. Human capital is a concept which considers labour or employees possesses different qualities. Study of [14] found that the ratio of labour, the quantity of capital and labour efficiency affect the productivity of the manufacturing sector in Malaysia. [15] on the other hand has identified that human capital is the most important factor affecting worker productivity in manufacturing industries based on packed in Iran. The importance of labor capital in production activities is as a primary source that innovate another source in the process of producing output. [16] show that educated human capital has a positive relationship with technical efficiency.

Second determinant factor involved in this research is the aspect of training expenses to the workers. Training is one of the alternatives in order to produce a workforce more competent, knowledgeable and skilled. [17] training in the organization is a learning program designed to enhance the knowledge, skills and competence of employees. [18] also said training refers to the efforts that have been planned by an organization to encourage workers to learn skills related to their work in order to enhance the quality of one's work. [19] found that the effectiveness of the training provided by firms influence the level of efficiency and productivity directly, in particular technical and computer skills. Clearly training is an important element that can contribute to the efficiency of an employee in managing all resources provided.

The third determinant factor was standard of education. The firms have well-educated workers is better because it can control existing technology as well as adopting new or modern. [20] found an increase in the education community will increase the output of true of approximately 20 percent in Brazil. In addition, [21] found that there is a significant relationship between factors of education (the literacy rate and education expenses) with 16 economic growth although exports still is the biggest contribution made in Malaysia. Studies such as [22] have found that the provision of education to human capital contributes to economic growth. Human capital improvement primarily through education has been much discussed since it is one of the contributors to the efficiency of a thing [23]; [24]; [24].

The fourth determinant factor is the size of the firm. There are some empirical studies that received strong support on the hypothesis made about the positive relationship between the size of the firms and the efficiency of the firm [25], [16]. Larger firms are assumed to have a higher efficiency than small firms because market forces bigger, better access to the source material and the effects of economies of scale. However, small firms were also said to be able to achieve a high level of efficiency because they are more vulnerable to competition from larger firms and have strong incentives to address their own weaknesses to surviving. [26] argue that employees of small firms may be more motivated due to the incentive scheme based on competitive rather than finance. Therefore, there are researchers who assumes that small firms are more efficient. [16] found that the relationship between firm size and the efficiency of the technique is the same. [27] did find that the average of technical efficiency for large firms is higher than small and medium enterprises (SMES). Therefore, the size of the firm can be said to be able to impact the level of technical efficiency in all industries, whether small or large.

The determinant factor for fifth is rate of wages. Grant of wages in a given production activities is a reward to labour on performance that has contributed in production activities. Hypothesis stating wages rate in relation to positive with efficiency because higher wages will give stimulus to labour to intensify efforts in their work and in turn leads to improved productivity.

[28] in his study of the relationship of wages true with labour productivity in New Zealand found efficiency in producing an output influencing labour productivity that allows workers to received bigger salary. The rate of wages, bonuses and payment of the allowance is to encourage employees to work harder that contribute to efficiency and higher productivity [18]. [29] pointed out that the payment of wages rate that commensurate to enhance motivation in carrying out its duties in a firm. [30] agree with other arguments as find a reduction wage rates cause a firm to be weak and result in productivity also become weak due to the decline in the rate of wages.

Recent studies show plays a role in promoting technology development in industrial countries develop [31]. Research has shown that technology adopted by developing country firms can give big impact to their economic performance ([32]; [33]; [34]) By [35], information technology is used effectively in the course of human management such as promotions, rewards, recruitment and dismissal of employees in the United States. Although in theory shows the impact of ICT is positive period of time, but some studies have shown that the results obtained will vary ([36]; [37]). Study of [38] found a negative effect of ICT equipment worker productivity manufacturing industries in the United States. The argument given by him about this decision was due to excessive ICT capital investment (excessive) or disapproval by (disagreement) in human capital and technology.

The last determinant factor is research and development (R&D). [39] noted the progress of the GDP per capita was caused R&D. R&D can maintain the existence of innovation as a step that gives various benefits to development. This is because empirical studies such as [40], [41], [42] and [43] found that R&D is one of the important contribution to increase efficiency and productivity of firms up to give a positive impact to the company and the country. [44] measurement of the effectiveness of R&D is important in determining whether investment affects efficiency and productivity to business firm or otherwise. [45] found the firm that provide of an R&D has useful strategies to focus on measuring the efficiency of their product development programs.

3. Methodology

The Data Envelopment Analysis (DEA) is a mathematical programming approach of non-linear basis for estimating parametric borders. DEA is a data-oriented approach to evaluate the performance of a firm that has been widely used. DEA is also intended to assess the performance of efficiency as decision-making unit (Decision Making Units-DMU) within a firm. This method was founded by [1] which estimate the boundaries for a production firm by using programming methods. This approach is followed by some theoretical connections that have been issued by the researchers such as [46], [47] Initial approach of DEA [47] proposed a model that is input-oriented CCR Model and assume Constant Returns according to the Scale (constant return to scale = CRS). Then advanced from the reviews [46] has proposed a Model Returns vary with Scale (scale = variable return to VRS) known as the BCC Model with alternative assumptions.

3.1.1 CCR Model

[47] and [49] conducted the extension to identify the level of efficiency and propose a model input-oriented of Charnes, Cooper and Rhodes (CCR Model). The model is known as a model CCR-CRS which gives a score of technical efficiency General Technical Efficiency (GTE) is assumes that the reduction of input or output is at a fixed rate (constant returns scales-CRS) for each DMU [50]. Calculation of DEA is designed to maximize the relative efficiency scores for each DMU, subject to the constraints set weight obtained in this way for each DMU which should be implemented for all of the DMU including samples. Efficiency score that can be calculated by using the following mathematical programming;

CCR models with CRS assumption can be summarized as follows;

$$\min l_0 - \varepsilon \left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ \right)$$

Subject to:

$$\sum_{=1}^{N} \lambda_f x_{if} = l_0 X_{if0} - S_i^-$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ - y_{rf0}$$

$$\lambda_f \geq 0, f = 1 \dots N, S_i^-, S_r^+ \geq 0 \; \forall \; i \; dan \; r$$

$$where \; i = 1 \dots m$$

$$where \; r = 1 \dots s$$

where x_{if} and y_{rf} is the level of input *i* and output *r* used by the firm (or DMU) *f*, while N is the number of firms;

is any small positive number ε (non-Archimedes) to be used as limit down to input and output; S_i^- is the deviation of the input while S_r^+output deviation model is in the first stage of efficiency and optimization allows the calculation of the difference between the estimated target inefficient firm efficiency and real value of input ; l_0 is oriented efficiency scores in input efficiency optimization model and the first stage of the event is equal to one and both value of slak is equal to zero, then the firm of f_0 was described as efficient.

CCR model assumed that between the size of the operation and efficiency of a significant relationship does not exist because the competency score obtained is CRS. CRS turn assumed to just fit the storekeeper phoned all DMU operating at optimal levels. However, firms in the machinery manufacturing industry is likely to experience the State of the economies of scale of uncertainty either increased or decreased (increasing number of maximum output from the use of a minimal amount of input). Therefore, if the assumption CRS done but not all of the DMU operating at optimum levels, then the calculation efficiency scores will be confined to the technical efficiency of scale.

3.1.2 BCC Model

[46] has improved CCR model which assumes that all of the DMU is CRS. BCC model was introduced to assess efficiency score having DMU features assumptions or input reduction increase output is at a rate which is not fixed (Returns vary with Scale-VRS) with provide Local efficiency score Pure Technical Efficiency (LPTE) [50]. BCC-VRS model is to measure technical efficiency score without detecting economic scales. The existence of the inefficiencies of scale which is Efficiency Techniques = PTE x SE only if there is a difference between technical efficiency with scores from LPTE on a particular DMU. This situation shows that the ability to use firm's resources granted and refers to exploit economy of scale of operating on the border point production showing the CRS.

BCC model with input-oriented assumptions VRS formulated as a linear programming problem can be written as;

$$\min l_0 * -\varepsilon(\sum_{i=1}^{m} S_i^{-*} + \sum_{r=1}^{s} S_r^{+*})$$

Subject to :

$$\sum_{f=1}^{N} \lambda_f x_{if} = l_0 X_{if0} - S_i^{-*}$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^{+*} - y_{rf0}$$

$$\sum_{f=1}^{N} \lambda_f = 1$$

$$\lambda_f \geq 0, f = 1.. \ .N, S_i^{-*}, S_i^{+*} \geq 0 \ \forall \ i \ dan \ r$$

$where \ i = 1 \ldots m$

$where \ r = 1 \ldots s$

where S_i^{-*} and $S_r^{+*}$is the input and output of slak to model in efficiency optimization of the second stage; $l_0^*$is input-oriented efficiency score in second-level efficiency optimization model. Input-oriented in DEA model (1) is the first stage of efficiency optimization with calculating $_0$notwithstanding any slakwhile model (2) is at the second stage of optimization efficiency by optimising the slak through improvement l_0^*.

3.1.3 Regression Tobit Analysis

[49] proposed an environment variables can be included in the analysis method of DEA. Environment variables refer to factors affecting the efficiency in a firm otherwise the factors are outside the control of the manufacturer. Based on equation (2), DEA score will go down between the interval 0 and 1 ($0 \leq \leq 1$) that will make the dependent variable become limited variable. Tobit model known and legally privileged in controlling a character distribution measurement of inefficiency. DEA efficiency scores obtained in the first stage will be used as the dependent variable in the second stage and analyze the characteristics of firms and other environment variables.

Tobit model are followed as;

$$y_i^* = \beta' x_i + \varepsilon_i$$

$$y_i = \{y_i^*, jika \ y_i^* > 0$$

$$y_i = \{0, jika \ y_i^* = 0$$

$$\varepsilon_i \sim N(0, \sigma^2)$$

where X_i is the vector of independent variables, β is a vector of parameters to be estimated, $y_i^*$is a latent variable, and DEA efficiency score is y_i.

3.2 Source of Data

This study has used manufacturing industry firm's data derived from Investigation Machinery Manufacturing Industries (IMS) and the Department of Statistics (DOS). The selection of the data supplied by the DOS

amounted to 30 percent of the total aggregate data and categorized into 3 sub-industry level 3 digit, as shown in the table below.

Table 1 Sub-sector in Machinery Manufacturing Industry

No	Item	Sub-sector
1	MSIC 281	Manufacture of General Purpose Machinery
2	MSIC 282	Manufacture of Special Purpose Machinery
3	MSIC 332	Manufacture of Installation Machinery Industrial and
		Equipment

Source: Manufacturing Industry Investigation Report, 2015.

3.3 Data Analysis

This study uses a computer program which are DEAP 2.1, Microsoft Office Excel 2013 and STATA for the purpose of data analysis. DEAP version 2.1 is a software that designated to provide estimates for the production of borderland stochastic. This program calculates estimation for technical efficiency. Microsoft Office Excel 2013 used to help analyse and calculation of data in order to be consistent with the format used by the DEAP software 2.1. Tobit Regression model (STATA) is used to identify the determinant factors that influence to the technical efficiency in a firm.

4. Results and Discussion

This section discusses all the findings in the quantitative results of the analysis using DEA two stage approach. Analysis and findings of this study are described sequentially according to the question of the research and the objective of the study would like to achieve.

4.1 Descriptive Information

This study uses three input consisting of capital, labor, and capital intensity. While total sales referred as output, total sales is a sales of products that have been produced by the firm.

Table 2 Overall Industry Descriptive Variables Summary (2015).

Variables	Mean	Minimum	Maximum	Standard Deviation
Output				
Total Sales	41434	2360	2885991	168341
Input				
Capital	9793	1	405265	30530
Labour	117	4	3734	241.29
Intensity	30136	819	2216817	123782

Table 2 shows the data used as a result of machinery manufacturing consisting of Manufacture of General Purpose Machinery, Manufacture of Special Purpose Machinery and Manufacture of Installation Machinery Industrial and Equipment. This data is data in 2015 which consists of 3 subindustry figures 3-digit Standard Industrial Classification by Malaysia (MSIC 2008). There are 636 machinery industry firms involved in this study obtained from Department of statistics Malaysia

Based on the table above, the average of the output which is the total sales for 636 firms involved amounted to RM41434, minimum total sales is of RM2360 while the maximum total sales amounted to RM2885991 with standard deviation of 168341. While input consists of capital, labour, and capital intensity. The first input is the capital, capital amounted to RM9793, the minimum of capital is RM1, while maximum of capital is RM405265 with standard deviation of 30530. Labour input in turn suffered an average of 117 people, minimum labour amounted to 4 people while the highest is 3734 people with standard deviation 241.29. Last input is capital intensity with an average rate of RM30136, the minimum intensity is RM819 while maximum is RM2216817 with standard deviation of RM123782.

Table 3 shows descriptive information in accordance with sub-industry of machinery in Malaysia by year 2015. The table below is a summary of the descriptive according to the sub-industry consisting of MSIC 281, 282 and MSIC MSIC, 332.

Table 3 Descriptive Variable Summary,

Variables	Mean	Minimum	Maximum	Standard Deviation
Output				
Total Sales	56573	2719	2885991	234674
Input				
Capital	10927	14	405265	33910
Labour	136	4	3001	248.64
Intensity	41437	906	2216817	169393

Table 3 is a descriptive information summary for manufacture of general purpose machinery. Table shows there are 3 input which are capital, labour and intensity while output is total sales. Mean for total sales is RM56573, minimum sales is RM2719 while maximum sales is RM2885991 with standard deviation 234674. For capital, mean is RM10927, minimum is RM14 while maximum is RM405265 with standard deviation 33910. For labour mean is 136 workers, minimum labour is 4 while maximum is 3001 workers with standard deviation 248.62. Lastly, mean for intensity is RM41437, minimum is RM906 while maximum is RM2216817 with standard deviation 169393. All the descriptive information is a progressing in manufacture of general purpose machinery for year 2015.

Table 4 Descriptive Variable Summary, MSIC 282.

Variables	Mean	Minimum	Maximum	Standard Deviation
Output				
Total Sales	32277	2991	910512	91849
Input				
Capital	9642	7	316514	28264
Labour	110	6	3734	249.46
Intensity	23184	1110	847812	74037

Table 4 shows a descriptive information for manufacture of special purpose machinery in year 2015. Average for total sales in this sector is RM32277, minimum sales is RM2991 while maximum sales is RM910512 with standard deviation 91849. Compare to output, average for capital is RM9642, minimum capital for this sector is RM7 while maximum is RM316514 with standard deviation 28264. Labour average is 110 workers, minimum workers is 6 while maximum is is3734 workers with standard deviation 249.46. Lastly is intensity with average RM23184, minimum is RM1110 while maximum is RM847812 with standard deviation is 74037.

Table 5 Descriptive Variable Summary, MSIC 332.

Variables	Mean	Minimum	Maximum	Standard Deviation
Output				
Total Sales	16811	2360	425666	56591
Input				
Capital	5100	1	182608	24199
Labour	67	5	972	128.28
Intensity	12372	819	340740	45377

Table 5 is a summary descriptive information for manufacture of installation machinery industrial and equipment in year 2015. Average of total sales for this sector is RM16811, minimum sales is 2360 while maximum sales is RM425666 with standard deviation 56591. Next is input information which are capital, labour and intensity. Mean for capital is RM5100, minimum capital is RM 1 while maximum is RM182608 with standard deviation 24199. Next, average labour is 67 workers, minimum is 5 workers while maximum is 972 workers with standard deviation 128.28. Lastly, average for intensity is RM12372, minimum is RM819 while maximum is RM340740 with standard deviation 45377.

4.2 Technical Efficiency Result

This section discusses the results of technical efficiency score using program DEAP 2.1. The scores of efficiency analysis are selected based on 2 model which are CCR-CRS model or BCC-VRS model.

Table 6 Efficiency Score between CCR-CRS Model and BCC-VRS Model in Malaysia.

CCR-CRS Model	Mean
	0.531
BCC-VRS Model	Mean
	0.597

The table above shows the average of efficiency score of CCR-CRS model is lower than the average score

efficiency of BCC-VRS model. This decision is a reasonable because a model of CCR-CRS considers that lack of input or output increase will always be at a fixed rate while BCC-VRS model considers the lack of inputs at a lower price or increase output the rate is not fixed because this model assumed other determinant factors are able to influence technical efficiency. Therefore, this study chose a model BCC-VRS for machinery manufacturing industries in Malaysia.

Based on the results of a BCC-VRS model, a firm from machinery manufacturing in Malaysia has been operating with a score efficiency of 0.597 in 2015. This shows that firms in Malaysia operated with medium levels of efficiency as a whole. The level of efficiency of the machinery manufacturing industry lead to performance improvement of trading with the approval of investment projects 88 worth RM1.54 billion (Ministry of international trade and industry Malaysia (MITI) 2016. In addition, the Report of National Productivity (2015/2016) also recorded a 2-digit growth productivity of 20.5 percent. It is proved that the machinery manufacturing industry in Malaysia operating with efficient.

Table 7 is a summary of efficiency score for every machinery industry in Malaysia. The table shows the BCC-VRS model was higher compared to model of CCR-CRS. The results recorded a positive score efficiency because exceed the minimum score level which is 0.5. Total efficiency score for model CCR-CRS is 0.554 while BCC-VRS model was of 0.626. BCC-VRS model have deficits 0.072 is much better than a model CCR-CRS.

Table 7 Efficiency Score Every Each Sub-Industry Summary in Malaysia.

Sub-Sector	CCR-CRS	BCC-VRS
Msic 281	0.552	0.584
Msic 282	0.528	0.588
Msic 332	0.583	0.693
Mean	0.554	0.626

4.3 Regression Tobit Result

[49] say variables can be included in the analysis method of DEA. Based on studies conducted, there is a total of 7 variables consisting of labour-capital ratio or intensity of capital, training expenses to employees, the standard of education, size of firms, research and development, technology spending information and wages rate.

Table 8 Regression Tobit Result

Independent Variables	Coefficient	Statistic t
ICT	2.32E-06	0.166785
K_L	-3.50E-05	-1.020983
KADAR_UPAH	0.001373	3.740001***
R_D	3.27E-06	2.395157**
TRE	-3.55E-06	-0.638855
RATIOSED	0.085743	1.799625*
RATIOTIER	0.030252	0.460416
DFSME	0.007160	0.330420
C	0.531088	22.20877***

Note: ****significant of 1%, **significant of 5%, *significant of 10%.*

Tobit Regression results are reported in the table 5 shows that the determinant factors of wages rate has a significant relationship at the level of 1 percent and has a positive effect on the efficiency. According to the Report of National Productivity (2015), Malaysia recorded a growth of worker productivity by 3.3 percent to RM75, 538 from RM73, 091 in 2014. This productivity growth contributed to the 5 percent growth in the Malaysian economy to RM1, 062.6 billion in the same year. The increase in the average nominal wage growth of employees in all sectors supported by strong productivity growth-oriented exports. In addition, this decision can also be proved in a study of [28] a positive relationship between wages with productivity of labour was true in New Zealand when efficiency in producing an output affect an increase in labour productivity that allows to receive a larger salary. [29] and [55]the payment of wage rates can enhance motivation of workers in carrying out their duties.

Similarly, the determinants factor of research and development (R&D) who have contributed to increase the efficiency of a firm machinery manufacturing. This was proven when factors research and development (R&D) has a significant relationship at the 5 percent significance level and have a positive effect. An analysis about the sophistication of the business during the period of 2010-2015 shows Malaysia have achieved excellent performance with a significant improvement from the 22nd position (2008) to 15th position (2014). According to a report of the national productivity 2015/2016, the Malaysian firms need to move towards high technology, knowledge-intensive production process, increase investment in R&D and improve the quality of local suppliers. This is because firms do R&D is capable of producing or generating a stronger product. Effectiveness of product development provide more accurate information and be able to use resources more

efficiently. The research and development activities need to be multiplied, including increasing expertise, providing appropriate green technology infrastructure and enhancing strategic collaboration between local firms with international firms and local universities [51]. A studies such [40]. [41], [42] and [43] and [52] found that R&D is one of the important contribution to increasing the efficiency and productivity of the firm up to give a positive impact to the company and the country.

Last but not least determinant factor is the status of secondary education stage which is STPM, diploma or below than them. This educational status determinants contribute to the efficiency of the firms have a significant relationship at the level of 10 percent and give the positive effect. According to the Annual Report, (2015), the increase in employment is concentrated primarily on high-skilled jobs that reflected the continued transition of the Malaysian economy to a higher value-added economy. Workers skills especially from vocational school students could increase efficiency because they have experience to handling and installing the components in the manufacture of machinery. Human capital improvement primarily through education has been much discussed since it is one of the contributors to the efficiency of a thing ([23]; [24]; [24], [53]).

5. Conclusion and Implication

Overall, the results of the technical efficiency level towards machinery manufacturing can be considered as efficient at a moderate level. Scores of efficiency for the whole industry in 2015 is 0.597. However, there are still many of firms operated under satisfactory. Based on the results that have been made using program DEAP 2.1, a total of 179 firms operation under the range of values the efficiency of 0.5. While the rest operating at moderate and fully efficient.

Next, the score for each industry also recorded a positive results when all the industries operating in efficiency level. This can be proved when the Ministry of International Trade and Industry Malaysia 2016 (MITI) say that machinery manufacturing industry performance and export have been increase in the year 2016. In addition, the existence of policies introduced by the government such as the New Economic Policy (NEP) and the Industrial Master Plan (PIP) managed to increase the competitiveness of the manufacturing sector in particular manufacturing machinery.

Regression Tobit result shows that there are three determinants factor that involved towards technical efficiency in Malaysia's machinery industry which are wages rate, research & development and educational. According to [54], the existence of a wage increase systems not only improve productivity and efficiency, but employees might be more motivated and be able to assist the competitiveness of firms. The increases of average nominal wage growth of employees supported by growth in productivity and efficiency at once contribute to 5 percent growth in the Malaysian economy in 2016. Second, according to a Report of Productivity (2015/2016), research and development (R&D) play a critical role in the transformation process. Machinery industry working together with industry players, research institutions, associations, technology providers and government to help speed up productivity and thrive in the world market. An analysis about the sophistication of the business during the period of 2010-2015 shows Malaysia to achieve excellent performance with a significant improvement from the 22nd position (2008) to 15th position (2014).Therefore, the research and development (R&D) this influence on the efficiency of the machinery industry because they need to protect their creations as well as while increase quality and branding. Finally, the educational status of the determinants that have an STPM and diploma school approval. The increase in employment focused on skilled workers. The firms have many employees who are educated are better and being able to control existing technology and adopt new and modern technology.

There are several policy implications and recommendations that should be concern and taken immediately as a measure to improve the level of technical efficiency of the machinery manufacturing industry in Malaysia. Giving an attention to the factors which affect the level of efficiency of the machinery industry could be emphasized for future. The determinants factors that influenced to the technical efficiency are Research & Development, education and wage rate.

Education is important factor in various industry because workers have the education are able to contribute the research and development. The existence of schools such as Colleges Vocational and High Institute is one of the government's efforts to produce a local worker in another level. The merger of these elements is a wise step to produce the best human capital in the future. Human capital development program provide skilled manpower especially fabrication components machinery. The existence of this kind of education program produce a quality of human capital and thus be able to further enhance the efficiency of individuals and firms in the industry of machines at this time.

Research and development (R&D) is also a key factor that can influence the efficiency towards machinery manufacturing. According to the National Productivity's Report, (2016), firms must move towards high technology, knowledge-intensive production process, increase investment in R&D and improve the quality of local suppliers. An analysis about the sophistication of the business during the period of 2010-2015 shows Malaysia to achieve excellent performance with a significant improvement from the 22nd position (2008) to 15th position (2014). Firms doing R&D has strategies useful for focusing their product development programs.

Wage rates also play an important role towards the efficiency of machinery manufacturing. According to the Report of National Productivity, (2016), the initiatives are required to induce the sector that have potential which are machinery and equipment, base metals, automotive and transport equipment such as enjoy high salaries to improve their productivity performance by expanding their markets into the global. This is because wages rate play an important role as a motivation to employees to improve efficiency and productivity of a firm. National Productivity Corporation (2015) also show that the implementation of the System of Wage Productivity (SBUP) can provide benefits to the firm because the system ensure that wage rates will be accompanied by increased efficiency and productivity can increase economic growth for firms and countries..

The first recommendation that can be committed to future research is to make comparison between two different border approach model to measure the technical efficiency which are DEA model and SFA model. Comparison between two models of this can be done to identify the differences or similarities to the technical efficiency. DEA model used two stages in order to identify determinants factors while SFA model did not need the second stage.

The second recommendation was the addition of variables that can influence the technical efficiency. The addition of other variables such as foreign investment, exports, imports and economic openness can be used for future study. This study only focused on the issue of the level of technical efficiency in manufacturing of machinery without taking other factors. Empirical studies carried out to find out the factors that influence whether internal or external factors. Therefore, the addition of variables that influence the determinants of efficiency of advanced studies can be done.

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