International Journal of Technology (2016) 7: 1269-1279
ISSN 2086-9614

PERFORMANCE EVALUATION OF LARGE AND MEDIUM SCALE MANUFACTURING INDUSTRY CLUSTERS IN EAST JAVA PROVINCE, INDONESIA

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(Received: July 2016 / Revised: October 2016 / Accepted: October 2016)

ABSTRACT

East Java Province in Indonesia is the centre of the eastern Indonesia region and it has a fairly high economic significance, which has contributed 14.85% to the national Gross Domestic Product (GDP). The role of Large and Medium Scale Manufacturing Industry (LMSMI) clusters in this province is very important and strategic as one of the main drivers for economic progress and it becomes a part of the efforts to improve the society's life. Therefore, it is necessary to evaluate the performance of LMSMI clusters continuously. The purpose of this study is to investigate the productivity changes of LMSMI clusters in East Java Province, Indonesia, so that they will be able to survive, grow and compete in facing global competition. The method used in this study is the method of DEA-based Malmquist Productivity Index. The result of this study indicates that 50% of the LMSMI clusters in East Java Province are in the category of improved productivity, while the remaining clusters are in the category of declining productivity.

Keywords: DEA-based Malmquist Productivity Index; Industry cluster; LMSMI; Performance evaluation

1. INTRODUCTION

The role of the industrial sector is essential for national economic growth in Indonesia, in which it becomes a driving force of economic growth and a pillar of the economy. The industrial sector can generate foreign exchange earnings from export activities and its ability to absorb the workforce capacity. The important characteristics of the industrial sector are: (i) it can absorb the workforce of labour-intensive industries, capital intensive industries, and industries that require knowledge-based and high technology; (ii) it has a relatively high productivity; and (iii) it has the ability to provide linkages and supplies to other sectors. The orientation of the government policy packages is to move and restore the national industry through the construction of an industrial area with facilities, which are friendly to investors, including bonded logistic areas and special economic zones (Tempo, 2016).

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Permalink/DOI: https://doi.org/10.14716/ijtech.v7i7.5229

East Java Province is a province located on the island of Java. Its territory is divided into two major parts, namely: East Java mainland and the island of Madura. The area of East Java mainland covers almost 90% of the entire area of the province of East Java, while Madura Island is only about 10% (BPS, 2014). It has six industrial estates, namely: Surabaya Industrial Estate Rungkut (SIER) in Surabaya, Pasuruan Industrial Estate Rembang (PIER) in Pasuruan, Maspion Industrial Estate (MIE) in Gresik, Ngoro Industrial Park (NIP) in the District Mojokerto, Sidoarjo Industrial Estate Berbek (SIEB) in Sidoarjo and Gresik Industrial Estate (GIE) in Gresik (Jatimprov, 2013).

Based on the data taken from the Department of Industry and Trade of East Java Province in 2013, it follows that the profile of the manufacturing industry in East Java is still dominated by the agro-chemical industry, which is as many as 673,441 units. The metal industry, machinery, textile, and miscellaneous are as many as 115,513 units, while the industrial transport equipment, electronics, and telematics are as many as 14,499 units, in respectively. The agro-chemical industry absorbs the largest workforce which is equal to 2,569,543 people. It is followed by the metal industry, machinery, textile, and miscellaneous which absorb as many as 482,940 people. Meanwhile, the transportation industry, electronics, and telematics are only able to absorb 63,197 people. Overall, Large and Medium Manufacturing Industry (LMMI) is able to provide an investment value of 66,836 billion IDR. The number of LMMI is as many as 6,370 units and it is able to absorb the workforce as many as 1,073,866 persons. The output value of LMMI in 2012 amounted to 543,272 billion IDR (BPS, 2014a).

East Java Province is one of the provinces that became the centre of industry and trading. Its role is very important and strategic to be one of the main drivers for the economic progress and it figures as a part of the efforts to improve the society's life. Therefore, it is necessary to evaluate the performance of industrial clusters continuously so that industrial clusters in East Java Province will continue to survive, grow, and compete in facing global competition (Putri & Chetchotsak, 2015).

2. METHODOLOGY

2.1. Performance Evaluation

Understandings and definitions of the performance evaluation are as follows: (1) it is a significant measurement system; thereby, the company is able to monitor its activities to achieve the targeted goals and allocate resources efficiently (Varmazyar et al., 2016); (2) performance measurement establishes the decisions and communication processes as efforts related to improvements in the company (Rue et al., 2012); (3) performance measurement is an attempt to develop the company by assigning decisions and process communication (Rue et al., 2012); and (4) performance measurement is a measure of the efficiency and effectiveness of the company. It can be achieved in several ways, namely: through the merger, separation, selection, analysis, interpretation and dissemination of appropriate data (Neely, 1998). All companies need a performance evaluation. It is very important for the progress of the company's business at the present time and in the future. By evaluating its performance, a company can find and identify three advantages: (i) to be able to know the strengths and weaknesses of the business operations of the company; (ii) to be able to prepare the company's business better to meet customer satisfaction; and (iii) to be able to identify business opportunities for the company through the improvement of operational business processes and the development of new products, processes, and services (Cook & Zhu, 2008).

2.2. DEA-based Malmquist Productivity Index

One of the methods used to evaluate the relative efficiency of a set of the same decision-making unit (DMU) is a method of Data Envelopment Analysis (DEA). It is a non-parametric method, which is a mathematical approach originated by Charnes et al. (1978). In order to produce multiple outputs, generally DMU then uses several inputs (Tolooa & Babaee, 2015). It is used to evaluate the relative efficiency of the same department or unit. It has also been applied in all walks of life. Three of the biggest advantages of DEA method compared to other methods are: (i) it is purely technical; (ii) it does not require progress, which is known by the production function with parameters; and (c) in order to compare the efficiency between different distribution networks, it provides an excellent model (Yuzhi & Zhangna, 2012). The measurement of productivity change has been developed in a DEA-based Malmquist Productivity Index. Two components outlined in the index are the change in the technology and in the technical efficiency. The Malmquist Productivity Index can be expressed as follows in Equation 1 (Cook & Zhu, 2008):

$$Mo = \frac{\theta_o^{t}(x_o^{t}, y_o^{t})}{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \left| \frac{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})}{\theta_o^{t}(x_o^{t+1}, y_o^{t+1})} \quad \frac{\theta_o^{t+1}(x_o^{t}, y_o^{t})}{\theta_o^{t}(x_o^{t}, y_o^{t})} \right|^{1/2} \tag{1}$$

where Mo measures the productivity change in the time range (t, t+1)**;** Mo > 1 (productivity declined); Mo = 1 (productivity remains constant); Mo < 1 (improved productivity); θ_o is the efficiency; x_o is the input; y_o is the output. The technical efficiency change (TEC) in the time range (t, t+1) is defined as shown in Equation 2:

$$TEC = \frac{\theta_o^{t}(x_o^{t}, y_o^{t})}{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \tag{2}$$

where TEC > 1 (technical efficiency declined); TEC=1 (technical efficiency remains constant); TEC < 1 (technical efficiency improved). The shift in the frontier (FSo) in the time range (t, t+1) is defined as shown in Equation 3:

$$FSo = \left| \frac{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})}{\theta_o^{t}(x_o^{t+1}, y_o^{t+1})} \quad \frac{\theta_o^{t+1}(x_o^{t}, y_o^{t})}{\theta_o^{t}(x_o^{t}, y_o^{t})} \right|^{1/2} \tag{3}$$

where FSo > 1 (there is a regression in the frontier technology); FSo = 1 (no shift in the frontier technology); FSo < 1 (there is progress in the frontier technology).

2.3. Cause and Effect Diagram

A cause and effect diagram (Ishikawa's diagram) is a diagram which enables a company to determine and classify the factors that affect the processes or the events in an overall problem. This tool is universal and has been applied in virtually all areas of human activity, such as in the areas of organizational, economic and social issues, construction, technology, etc. (Simanováa & Gejdošb, 2015; Ishikawa, 1985). Key causal analysis is used to investigate the cause of a particular event. The related causes for a specific problem are grouped in categories and arranged in a diagram (Dobrusskin, 2016; Ishikawa, 1991). The main causes of business process problems consist of six classic categories. These will indicate the reasons for the problems associated with problem type and its difficulty level. Six of those categories consist of processes, environment, management, people, materials and equipment (Bose, 2012; Ishikawa, 1986).

2.4. Industry Cluster

Regional autonomy policy can create local governments (from the district, city, and province) to optimally build up their regions by exploring the potentials and excellence in the region. As a result, added value for the economic development of the region may be provided by creating a centre of excellence in a commercially competitive region. Industrial cluster development is a strategy to encourage regional development. The underlying reasons are: (i) the potential of region can develop better and be focussed, because it will be analysed in a comprehensive manner; and (ii) the industrial cluster is an instrument of industrial policy, which is an effective platform to achieve economic decentralization and effective industrial development (Putri & Supardi, 2014).

3. RESULTS

3.1. Classification of Large and Medium Scale Manufacturing Industry (LMSMI)

In this study LMSMI is composed of individual companies, each with a workforce of 20 people or more. Classification of the type of manufacturing industry used in this survey is a classification based on the International Standard Industrial Classification of all Economic Activities (ISIC), Revision 4, which has been adapted and adjusted to the conditions of Indonesia and it is known as the Standard Industrial Classification of Indonesia (ISIC) 2009 (BPS, 2013). The classifications are shown in Table 1. There are 16 industry classifications and their ISIC codes are used in this study.

Table 1 Classification of large and medium manufacturing industry (LMMI) based on ISIC Code

ISIC Code (Sub Sectors)	Industry Name
10	Industry of food product
12	Industry of tobacco
13	Industry of textiles
15	Industry of leather
16	Industry of wood and made of wood products
17	Industry of paper and paper products
21	Industry of pharmacy, medicinal & traditional product
22	Industry of rubber and plastic products
23	Industry of non-metallic mineral product
24	Industry of natural metal
25	Industry of metal goods, non-metallic and equipment
26	Industry of electrical equipment
27	Industry of machinery and equipment YTDL
29	Industry of other transport equipment
30	Industry of furniture
31	Industry of other manufacturing

Source: BPS−Statistics of East Java Province

The input and output data of LMSMI for period 2012−2013 used in this research are the following: (i) input cost data consist of raw and supported materials (Input 1); fuel, electricity and gas (Input 2); and rent of building, machinery and equipment (Input 3); (ii) the output data consist of goods produced (Output 1); other receipts from service of non-manufacturing (Output 2); and value of semi-finished goods stock (Output 3) (BPS, 2013; BPS, 2014b). The input and output data of LMSMI for period 2012 and period 2013 are shown in Table 2 and Table 3, respectively.

Table 2 Input cost and output value of large and medium scale manufacturing industry by industry sub sectors for period 2012 (000 IDR)

ISIC Code (Sub Sectors)	2012 DATA					
	INPUTS			OUTPUTS		
	Raw and Supported Materials Input 1	Fuel, Electricity and Gas Input 2	Rent of Building, Machinery and Equipment Input 3	Goods Produced Output 1	Others Receipts from Service of Non-Manufacturing Output 2	Value of Semi Finished Goods Stock Output 3
10	48,539,246,237	4,729,074,750	696,455,886	77,865,557,977	2,368,500,402	1,266,676,582
12	30,462,355,000	1,206,322,090	47,643,725	88,368,722,635	5,643,397,299	357,547,011
13	5,237,810,695	607,962,686	108,089,874	8,324,578,131	469,038,746	139,734,504
15	10,601,817,653	646,494,434	207,942,032	19,162,335,220	536,705,672	384,851,211
16	5,676,152,494	502,242,092	48,979,852	9,046,753,501	564,854,264	421,105,952
17	16,630,804,072	1,563,590,248	16,766,464	32,088,580,576	429,297,290	74,230,944
21	1,252,457,465	96,390,153	11,621,219	2,389,473,955	179,329,660	141,555,988
22	13,328,264,198	5,435,987,947	81,815,989	25,976,708,355	3,101,230,311	626,335,181
23	8,998,212,990	3,386,286,375	65,216,896	23,382,472,915	185,436,246	517,073,680
24	14,092,294,913	4,094,354,729	5,925,767	23,338,073,184	1,804,450,702	278,406,223
25	6,852,382,718	400,487,968	21,376,332	11,306,209,276	770,500,021	426,264,839
26	601,508,370	148,694,548	4,903,436	1,470,722,905	21,163,832	8,269,352
27	2,168,297,705	188,172,028	33,650,025	5,286,629,593	148,384,328	103,940,141
29	6,874,402,117	605,162,928	12,563,172	12,177,820,948	369,580,421	25,695,927
30	1,965,836,818	117,164,437	2,238,879	3,510,189,476	592,037,338	23,030,670
31	4,772,395,142	313,208,943	35,612,268	8,653,045,632	383,412,166	154,135,337

Source: BPS−Statistics of East Java Province

Table 3 Input cost and output value of large and medium scale manufacturing industry by industry sub sectors for period 2013 (000 IDR)

ISIC Code (Sub Sectors)	2013 DATA					
	INPUTS			OUTPUTS		
	Raw and Supported Materials Input 1	Fuel, Electricity and Gas Input 2	Rent of Building, Machinery and Equipment Input 3	Goods Produced Output 1	Others Receipts from Service of Non- Manufacturing Output 2	Value of Semi-Finished Goods Stock Output 3
10	70,957,920,405	6,785,835,647	1,083,817,790	155,811,957,487	3,412,607,662	2,181,161,703
12	26,016,129,070	2,664,853,742	749,835,328	77,474,984,824	4,474,941,305	217,933,649
13	4,513,780,515	624,866,713	25,554,545	7,784,762,531	60,588,621	241,251,417
15	5,941,198,983	367,792,174	127,073,128	12,885,512,419	136,888,744	601,569,284
16	5,832,110,402	401,787,174	42,426,223	10,026,818,751	182,945,600	345,428,963
17	18,284,776,992	1,624,112,729	25,138,065	33,462,477,726	93,333,017	600,029,183
21	1,512,862,372	121,531,261	12,449,717	2,949,020,507	105,494,956	108,268,047
22	8,434,263,838	803,463,557	43,604,757	15,980,688,226	131,974,514	160,274,605
23	4,380,850,644	1,570,158,214	27,997,884	13,537,876,980	28,680,603	183,185,818
24	17,781,643,592	1,205,577,327	13,336,873	37,186,818,061	973,847,574	193,181,982
25	8,744,407,008	513,593,705	15,859,495	14,312,278,760	201,601,929	64,959,076
26	1,585,366,854	83,168,671	84,852,112	2,945,964,272	43,327,672	27,859,699
27	5,265,695,674	286,734,590	8,338,210	10,675,274,386	48,920,763	95,537,410
29	1,681,426,064	241,520,594	9,321,582	3,869,861,865	161,291,728	32,748,788
30	7,979,736,970	115,686,026	6,196,474	15,220,967,227	59,571,730	67,705,126
31	2,755,051,762	168,005,260	25,482,588	6,377,710,200	75,983,143	109,939,281

Source: BPS−Statistics of JawaTimur Province

3.2. Malmquist Index Calculation

The input and output data were organized in a Microsoft Excel spread sheet by using the solver function to obtain the optimal solution (based on a linear programming technique). It consists of four (4) components, namely the cells for: (a) the variables of decision (λ and θ); (b) the function of objective (efficiency, θ); (c) the formula for calculating the reference set of DEA (right-hand-side of constraints); and (d) the formula for calculating the efficiency of Decision Making Unit (DMU) under evaluation (left-hand-sided of constraints) (Cook & Zhu, 2008).

Table 4 Malmquist spread sheet for calculating θ_o^t (x_o^t, y_o^t)

DMU	ISIC Code (Sub Sectors)	2012 DATA						λ	Efficiency θ
		INPUT			OUTPUT				
		Input 1	Input 2	Input 3	Output 1	Output 2	Output 3		
1	10	4.9E+10	4.73E+09	6.96E+08	7.79E+10	2.37E+09	1.27E+09	0	0.5503
2	12	3E+10	1.21E+09	47643725	8.84E+10	5.64E+09	3.58E+08	0.0948	1.0000
3	13	5.2E+09	6.08E+08	1.08E+08	8.32E+09	4.69E+08	1.4E+08	0	0.5450
4	15	1.1E+10	6.46E+08	2.08E+08	1.92E+10	5.37E+08	3.85E+08	0	0.6190
5	16	5.7E+09	5.02E+08	48979852	9.05E+09	5.65E+08	4.21E+08	0	0.5455
6	17	1.7E+10	1.56E+09	16766464	3.21E+10	4.29E+08	74230944	0	1.0318
7	21	1.3E+09	96390153	11621219	2.39E+09	1.79E+08	1.42E+08	0	0.8408
8	22	1.3E+10	5.44E+09	81815989	2.6E+10	3.1E+09	6.26E+08	0	0.6753
9	23	9E+09	3.39E+09	65216896	2.34E+10	1.85E+08	5.17E+08	0	0.8892
10	24	1.4E+10	4.09E+09	5925767	2.33E+10	1.8E+09	2.78E+08	0	0.8892
11	25	6.9E+09	4E+08	21376332	1.13E+10	7.71E+08	4.26E+08	0	0.7589
12	26	6E+08	1.49E+08	4903436	1.47E+09	21163832	8269352	0	1.0452
13	27	2.2E+09	1.88E+08	33650025	5.29E+09	1.48E+08	1.04E+08	0	0.8352
14	29	6.9E+09	6.05E+08	12563172	1.22E+10	3.7E+08	25695927	0	0.5654
15	30	2E+09	1.17E+08	2238879	3.51E+09	5.92E+08	23030670	0	0.7696
16	31	4.8E+09	3.13E+08	35612268	8.65E+09	3.83E+08	1.54E+08	0	0.6215

Constraints	Reference set		DMU under Evaluation	16	Efficiency θ
Input 1	3E+09	<	2.97E+09		0.6215
Input 2	1.6E+08	<	1.95E+08		
Input 3	4902448	<	22134689		
Output 1	8.7E+09	>	8.65E+09		
Output 2	5.6E+08	>	3.83E+08		
Output 3	1.5E+08	>	1.54E+08		

This study needs to run 4 DEA models for each LMSMI, namely: θ_o^t (x_o^t, y_o^t), θ_o^{t+1} (x_o^{t+1}, y_o^{t+1}), θ_o^t (x_o^{t+1}, y_o^{t+1}) and θ_o^{t+1} (x_o^t, y_o^t). t and t+1 are the period of 2012 and 2013, respectively. Table 4 shows the Malmquist spread sheet by calculating θ_o^t (x_o^t, y_o^t), which is the efficiency based on 2012 LMSMI data. The result of calculating θ_o^t (x_o^t, y_o^t) in Table 4 shows the efficiency value of each DMU as follows: DMU1-ISIC10 (0.5503), DMU2-ISIC12 (1.0000), DMU3-ISIC13 (0.5450), DMU4-ISIC15 (0.6190), DMU5-ISIC16 (0.5455), DMU6-ISIC17 (1.0318), DMU7-ISIC21 (0.8408), DMU8-ISIC22 (0.6753), DMU9-ISIC23 (0.8892), DMU10-ISIC24 (0.8892), DMU11-ISIC25 (0.7589), DMU12-ISIC26 (1.0452), DMU13-ISIC27 (0.8352), DMU14-ISIC29 (0.5654), DMU15-ISIC30 (0.7696) and DMU16-ISIC31 (0.6215). In the same way as shown in Table 4, the efficiency value based on 2013 LMSMI data can be obtained by calculating θ_o^{t+1} (x_o^{t+1}, y_o^{t+1}).

Table 5 shows the Malmquist spread sheet by calculating θ_o^t (x_o^{t+1}, y_o^{t+1}), which is the efficiency score based on 2012 LMSMI data used as the reference set. The result of calculating θ_o^t (x_o^{t+1}, y_o^{t+1}) in Table 5 shows the efficiency score value of each DMUas follows: DMU1-ISIC10 (0.7459), DMU2-ISIC12 (1.8598), DMU3-ISIC13 (1.8598), DMU4-ISIC15 (0.5868), DMU5-ISIC16 (1.8640), DMU6-ISIC17 (1.8640), DMU7-ISIC21 (0.8933), DMU8-ISIC22 (0.6847), DMU9-ISIC23 (1.0612), DMU10-ISIC24 (1.0612), DMU11-ISIC25 (1.0612), DMU12-ISIC26 (0.6371), DMU13-ISIC27 (0.6371), DMU14-ISIC29 (0.7920), DMU15-ISIC30 (1.8169) and DMU16-ISIC31 (0.7833). In the same way as shown in Table 5, the efficiency score based on 2013 LMSMI data is used as the reference set, which can be obtained by calculating θ_o^{t+1} (x_o^t, y_o^t).

Table 5 Malmquist spread sheet for calculating $\theta_o^t (x_o^{t+1}, y_o^{t+1})$

DMU	ISIC Code -Sub Sectors	2013 DATA						λ	Efficiency Score (θ)	2012 DATA used as the reference set					
		INPUT			OUTPUT					INPUT			OUTPUT		
		1	2	3	1	2	3			1	2	3	1	2	3
1	10	7.1E+10	6.8E+09	1.1E+09	1.56E+11	3.4E+09	2E+09	0	0.7459	4.9E+10	4.73E+09	7E+08	7.8E+10	2.4E+09	1E+09
2	12	2.6E+10	2.7E+09	7.5E+08	7.75E+10	4.5E+09	2E+08	0.0721	1.8598	3E+10	1.21E+09	4.8E+07	8.8E+10	5.6E+09	4E+08
↓															
16	31	2.76E+09	1.7E+08	2.5E+07	6.38E+09	7.6E+07	1E+08	0	0.7833	4.8E+09	3.13E+08	3.6E+07	8.7E+09	3.8E+08	2E+08

Constraints	Reference set		DMU under Evaluation	16	Efficiency θ
Input 1	2.16E+09	<	2.2E+09		0.7833
Input 2	1.11E+08	<	1.3E+08		
Input 3	3506475	<	2E+07		
Output 1	6.38E+09	>	6.4E+09		
Output 2	75983143	>	7.6E+07		
Output 3	1.1E+08	>	1.1E+08		

3.3. Technical Efficiency Change Analysis

The productivity measurement results of technical efficiency change (TEC) between period 2012 and 2013 are shown in Table 6. By using Equation 2, the TEC value of each DMU is as follows: DMU1-ISIC10 (0.6801), DMU2-ISIC12 (1.0000), DMU3-ISIC13 (0.8896), DMU4-ISIC15 (0.6190), DMU5-ISIC16 (0.7535), DMU6-ISIC17 (1.1170), DMU7-ISIC21 (0.9164), DMU8-ISIC22 (0.9090), DMU9-ISIC23 (0.8892), DMU10-ISIC24 (0.8892), DMU11-ISIC25 (1.0028), DMU12-ISIC26 (1.3125), DMU13-ISIC27 (0.8756), DMU14-ISIC29 (0.5812), DMU15-ISIC30 (0.7696) and DMU16-ISIC31 (0.6369).

Table 6 Productivity measurement results of technical efficiency change

DMU	ISIC Code (Sub Sectors) & Industry Name		2012 DATA Efficiency $\theta_o^t (x_o^t, y_o^t)$	2013 DATA Efficiency $\theta_o^{t+1} (x_o^{t+1}, y_o^{t+1})$	Technical Efficiency Change (Equation 2)
1	10	Industry of food product	0.5503	0.8091	0.6801
2	12	Industry of tobacco	1.0000	1.0000	1.0000
3	13	Industry of textiles	0.5450	0.6127	0.8896
4	15	Industry of leather	0.6190	1.0000	0.6190
5	16	Industry of wood and made of wood products	0.5455	0.7239	0.7535
6	17	Industry of paper and paper products	1.0318	0.9238	1.1170
7	21	Industry of pharmacy, medicinal & traditional product	0.8408	0.9176	0.9164
8	22	Industry of rubber and plastic products	0.6753	0.7429	0.9090
9	23	Industry of non-metallic mineral product	0.8892	1.0000	0.8892
10	24	Industry of natural metal	0.8892	1.0000	0.8892
11	25	Industry of metal goods, non-metallic and equipment	0.7589	0.7568	1.0028
12	26	Industry of electrical equipment	1.0452	0.7963	1.3125
13	27	Industry of machinery and equipment YTDL	0.8352	0.9538	0.8756
14	29	Industry of other transport equipment	0.5654	0.9728	0.5812
15	30	Industry of furniture	0.7696	1.0000	0.7696
16	31	Industry of other manufacturing	0.6215	0.9759	0.6369

3.4. Frontier Shift Analysis

The productivity measurement result of frontier shift (FS) between period 2012 and 2013 is shown in Table 7. By using Equation 2, the FS value of each DMU is as follows: DMU1-ISIC10 (1.0798), DMU2-ISIC12 (1.6723), DMU3-ISIC13 (0.6090), DMU4-ISIC15 (1.4520), DMU5-ISIC16 (0.9048), DMU6-ISIC17 (0.6585), DMU7-ISIC21 (1.4818), DMU8-ISIC22 (1.8956), DMU9-ISIC23 (0.9321), DMU10-ISIC24 (2.1022), DMU11-ISIC25 (1.4316), DMU12-ISIC26 (0.9479), DMU13-ISIC27 (1.2830), DMU14-ISIC29 (1.3445), DMU15-ISIC30 (2.0819) and DMU16-ISIC31 (1.5052).

Table 7 Productivity measurement results of frontier shift

DMU	ISIC Code (Sub Sectors) & Industry Name		2012 ref score Efficiency Score $\theta_o^t (x_o^{t+1}, y_o^{t+1})$	2013 ref score Efficiency Score $\theta_o^{t+1} (x_o^t, y_o^t)$	Frontier Shift (Equestion 3)
1	10	Industry of food product	0.7459	0.5915	1.0798
2	12	Industry of tobacco	1.8598	5.2012	1.6723
3	13	Industry of textiles	1.8598	0.6137	0.6090
4	15	Industry of leather	0.5868	0.7658	1.4520
5	16	Industry of wood and made of wood products	1.8640	1.1499	0.9048
6	17	Industry of paper and paper products	1.8640	0.9029	0.6585
7	21	Industry of pharmacy, medicinal & traditional product	0.8933	1.7974	1.4818
8	22	Industry of rubber and plastic products	0.6847	2.2364	1.8956
9	23	Industry of non-metallic mineral product	1.0612	0.8198	0.9321
10	24	Industry of natural metal	1.0612	4.1703	2.1022
11	25	Industry of metal goods, non-metallic and equipment	1.0612	2.1810	1.4316
12	26	Industry of electrical equipment	0.6371	0.7514	0.9479
13	27	Industry of machinery and equipment YTDL	0.6371	0.9183	1.2830
14	29	Industry of other transport equipment	0.7920	0.8320	1.3445
15	30	Industry of furniture	1.8169	6.0608	2.0819
16	31	Industry of other manufacturing	0.7833	1.1303	1.5052

3.5. Malmquist Productivity Index Analysis

Based on the productivity measurement results of technical efficiency change (Table 6) and the productivity measurement result of frontier shift (Table 7), we can determine the result of Malmquist productivity index (MPI), as shown in Table 8. By using Equation 1, the MPI value of each DMU is as follows: DMU1-ISIC10 (0.7344), DMU2-ISIC12 (1.6723), DMU3-ISIC13 (0.5418), DMU4-ISIC15 (0.8988), DMU5-ISIC16 (0.6818), DMU6-ISIC17 (0.7356), DMU7-ISIC21 (1.3579), DMU8-ISIC22 (1.7231), DMU9-ISIC23 (0.8288), DMU10-ISIC24 (1.8694), DMU11-ISIC25 (1.4356), DMU12-ISIC26 (1.2442), DMU13-ISIC27 (1.1234), DMU14-ISIC29 (0.7814), DMU15-ISIC30 (1.6023) and DMU16-ISIC31 (0.9587).

Table 8 Results of malmquist productivity index

DMU	ISIC Code (Sub Sectors) & Industry Name		Technical Efficiency Change	Frontier Shift	Malmquist Productivity Index
1	10	Industry of food product	0.6801	1.0798	0.7344
2	12	Industry of tobacco	1.0000	1.6723	1.6723
3	13	Industry of textiles	0.8896	0.6090	0.5418
4	15	Industry of leather	0.6190	1.4520	0.8988
5	16	Industry of wood and made of wood products	0.7535	0.9048	0.6818
6	17	Industry of paper and paper products	1.1170	0.6585	0.7356
7	21	Industry of pharmacy, medicinal & traditional product	0.9164	1.4818	1.3579
8	22	Industry of rubber and plastic products	0.9090	1.8956	1.7231
9	23	Industry of non-metallic mineral product	0.8892	0.9321	0.8288
10	24	Industry of natural metal	0.8892	2.1022	1.8694
11	25	Industry of metal goods, non-metallic and equipment	1.0028	1.4316	1.4356
12	26	Industry of electrical equipment	1.3125	0.9479	1.2442
13	27	Industry of machinery and equipment YTDL	0.8756	1.2830	1.1234
14	29	Industry of other transport equipment	0.5812	1.3445	0.7814
15	30	Industry of furniture	0.7696	2.0819	1.6023
16	31	Industry of other manufacturing	0.6369	1.5052	0.9587

4. DISCUSSION

4.1. The Results of Technical Efficiency Change, Frontier Shift and Malmquist Productivity Index Analysis

Based on the productivity measurements of technical efficiency change as shown in Table 6, productivity of the LMSMI cluster can be classified into 3 groups. It consists of the industry group of improved efficiency technical category (TEC < 1) which has the largest percentage of 75% (= 12/16×100%). The other two groups are declining technical efficiency (TEC > 1) and technical efficiency that remains constant (TEC = 1), which has a percentage amount of 18.75% (= 3/16×100%) and 6.25% (= 1/16×100%), respectively. Based on the productivity measurement results of frontier shift shown in Table 7, productivity of LMSMI cluster can be classified into two groups. It consists of the industry category of being regressive in frontier technology (FSO > 1) which has the largest percentage amount of 68.75% (= 11/16×100%); and the other group is progressive in the frontier technology (FSO < 1) with the percentage amount of 31.25% (= 5/16×100%). Based on the result of Malmquist productivity index as shown in Table 8, productivity of LMSMI cluster can be classified into two groups. It consists of the industry category of improved productivity (Mo < 1) and declining productivity (Mo > 1), in which both of them have the same percentage amount of 50% (= 8/16×100%). The percentage composition of technical efficiency change, frontier shift, and Malmquist productivity index are shown in Table 9 below.

Table 9 Percentage composition of technical efficiency change, frontier shift, and malmquist productivity index

Technical Efficiency Change (%)	Frontier Shift (%)	Malmquist Productivity Index (%)
Improved efficiency technical (75%) Technical efficiency declined (18.75%) Technical efficiency remains unchanged (6.25%)	Regress in the frontier technology (68.75%) Progress in the frontier technology (31.25%)	Improve Productivity (50%) Productivity Decline (50%)

4.2. Factors of the Improved Productivity and Declining Productivity

By using cause-and-effect matrix method, the results of the research (as the effect) in general can be analysed and classified into two categories, namely: (1) The factors which cause improved productivity such as: sensitivity to the needs of the market, targeted marketing capabilities, benchmarking performed to determine the condition of the market, availability of human resources, the expertise, skills and experience of human resources, availability of raw materials, machine/production facilities that meet the standards, availability of working capital, ease of getting credit from banks, quality products, scale of local products, scale of export products, strategic location, flexible product prices (bargaining), the existence of price cuts, management information systems which are increasingly sophisticated, new technologies that can be adopted, role of local government and relevant agencies, high population growth, the existence of research and development institutions, the existence of education and training institutions, the role of non-governmental organizations (NGOs), purchasing power, export opportunities abroad, good relationships with suppliers, assistance in the selection of suppliers of raw materials, the emergence of competitors that spurs an increase in quantity and quality, and having good relationships with customers; and (2) The factors which cause declining productivity, i.e.: low marketing strategy, the level of sales of products that do not match the target, the quality and availability of human resources who are low trained/educated, the production process using old technology, the lack of manufacturing facilities, low quality of raw materials, limitations in the procurement of raw materials, capital resource constraints, low financial administration, high production costs, slow product innovation, distribution network in certain regional areas, the lack of promotions, weakened currency values of IDR in relation to USD, high inflation rate, the decline of the country's economy, government policies to reduce the public subsidy, unstable domestic political situation, the emergence of many new competitors, strict competition, rapid product innovation and widespread promotions done by competitors, lots of choice for consumers for the same product, low price demands of the customers, demand for quality products at an increasingly competitive price, customer complaints, rising raw material prices, and the decline in the availability of raw materials.

5. CONCLUSION

The results of this study indicate that 50% of the LMSMI clusters in East Java Province are in the category of improved productivity, while the remaining clusters are in the category of declining productivity. The groups of industrial clusters in each category are: (1) improved productivity, which include: food products industry, textile industry, leather industry, wood and wood products industry, paper and paper products industry, non-metallic mineral products industry, other transport equipment industry, other manufacturing industry; and (2) declining productivity, which includes: tabacco industry, pharmaceutical industry, medicinal & traditional products industry, rubber and plastic products industry, natural metals industry, metal goods industry, non-metallic and equipment industry, electrical equipment industry, machinery and equipment industry YTDL, and the furniture industry.

The results of this study can also be used as the basis for local government to formulate the development strategies of LMSMI clusters in East Java Province, Indonesia, which could be accomplished in the following ways: (1) identify the factors that cause the decrease in productivity of the LMSMI clusters; and (2) continuously evaluate the factors that cause improved productivity and declining productivity, such as marketing strategy, human resource, operation and production, finance/working capital, product quality, place, price, promotion, technology, social, economy, customers, suppliers, and competitors.

6. ACKNOWLEDGEMENT

This work was supported by Research Unit on System Modelling for Industry (Grant No.SMI.KKU 3/2558) Khon Kaen University Thailand; and International Relation Division of Khon Kaen University Thailand that had provided first author the University Scholarship for ASEAN and GMS Countries' Personnel of Academic Year 2015.

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