Two-Stage DEA Analysis for Measuring the Performance Efficiency of Creative Industry in East Java

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ABSTRACT

Creative industry plays a big role in terms of creating Gross Regional Domestic Product (GRDP) in East Java that measures the size of a region's economy. In 2016, creative industry in East Java still dominated by these top three leading subsectors - culinary, art and fashion. Performance efficiency assessment from the dominant subsectors which contributes for Gross Regional Domestic Product (GRDP) growth rate is essentials to achieve economic performance improvement. This research aims to analyze the performance efficiency rate of creative industry in East Java. Furthermore, it also helps giving recommendation as a way of creating performance optimization for industry subsector that shows no efficiency by the end of the period. This research can be solved by using Data Envelopment Analysis (DEA) method. The main focus of this research is on the potentials and performances from culinary, art and fashion industries. Besides, it will also use the secondary data from 2011-2015. CRS-DEA scores that shown is reflected the technical efficiency rate of subcategory 03, 06 and 11. Moreover, VRS-DEA scores also determined that efficiency rate from subcategory 01, 02, 03, 06, 08 and 11.

Keywords: Data Envelopment Analysis, technical efficiency, creative industry, East Java, industry performance

1. INTRODUCTION

Indonesia's creative industry is urged to be developed due to its significant contribution in economic growth, create a positive business climate, build up our nation's image and identity based on renewable resources, invent new innovation and creativity, also giving a positive social impact [1].

The idea about this, keeps rolling on and institutional strengthening of the creative economy development continues to be carried out by the government. According to presidential decree No. 92/2011, government has officially formed Ministry of Tourism and Creative Economy, strengthened with two Directorate General whose directly responsible on creative economic development in Indonesia. Furthermore, Badan Ekonomi Kreatif (BEKRAF) is also established as a tool for accelerate economic development in Indonesia. Act of greatness by the government is proven by the existence of Creative Economic Development Plan 2009-2025.

According to Badan Pusat Statistika and Badan Ekonomi Kreatif [2], East Java is the second largest contributor for national economy after West Java – with rate of 20,85% reviewed from export value as seen on Figure 1.
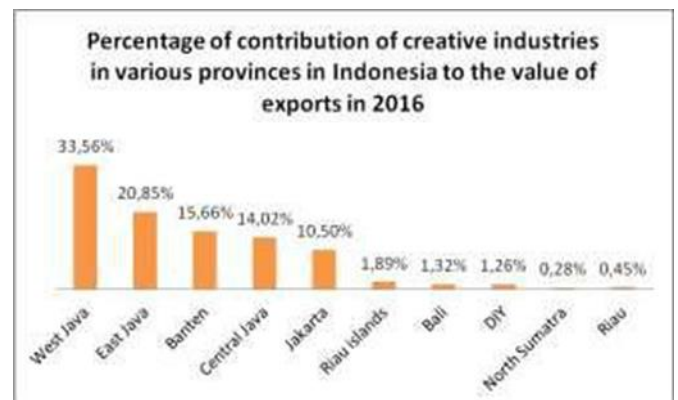

Figure 1. Percentage of contribution of creative industries in various provinces in Indonesia to the value of exports in 2016.
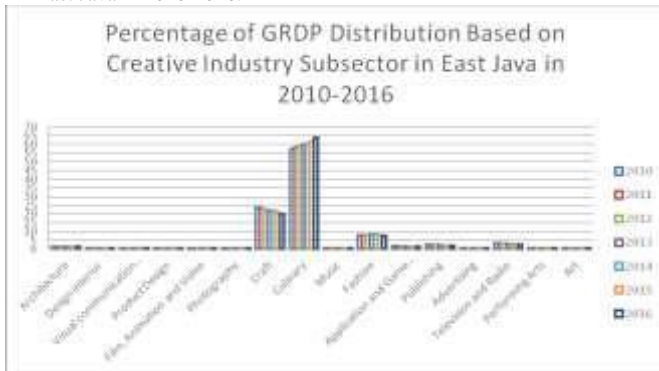
As listed on Law of the Republic of Indonesia No.3/2014 about Industrial Affairs article 43 paragraph 5, which mandates Regional Government to facilitate development and public creativity-innovation utilization by empowering industrial culture and/or local wisdom, so that Regional Government is forced to has quick response on its role to help striving for the development of creative industry in each and every region.

One real action has been done by East Java Provincial Government following the regulation is, issued the Government's Decree No. 427/2011 about East Java Creative Economy Development Coordination Team. The initiation is also a follow up action regarding the Presidential Instruction No. 6/2009 about Creative Economy Development in East Java.

Figure 2 shown that from 2016, creative industry in East Java is still dominated by three subsectors – culinary 63,99%, art 19,87% and fashion 7,53%. In conjunction with that, up to 2016 still concluded that the biggest contributors for subsector creative industry are culinary, fashion and art – with percentage 41,40% for culinary, 18,01% for fashion and 15,40% for craft [3].

The potentiality of creative industry in East Java is very possible to grow on the following years, by hiring many workers that can boost up the local or national economy growth from various creative industry subsectors, especially on the top three leading subsectors (craft, culinary and fashion) which dominate Gross Regional Domestic Product (GRDP) or Gross Domestic Product (GDP).

Figure 2. Distribution of GRDP by creative industry subsector in East Java in 2010-2016.

The development of creative industries in the future will continue to be an important alternative in improving economic performance, quality of life of the community, forming images, fostering innovation and forming creativity, and strengthening the identity of an area (City/Regency), especially in the area of East Java Province. Therefore, the research that will be carried out is aimed at analyzing the level of efficiency of several industrial subcategories to be able to strive for an increase in economic performance through GRDP growth. In addition, this study was also conducted to see which industry subcategories were the most efficient and inefficient in the East Java region to be able to determine strategic steps that could be taken as an effort to improve industrial performance.

2. LITERATURE REVIEW
2.1. Creative Industry

According to Suryana [4], Creative industry is an industry that relies on talent, skills and creativity which are the basic elements of each individual. The main elements of the creative industry are creativity, expertise and talent that have the potential to improve well-being through offering intellectual creations.

According to UNCTAD [5], creative industry is 1) the cycle of creation, production, and distribution of goods and services using creative and intellectual capital as the main input; 2) part of a series of knowledge-based activities, focusing on art, which has the potential to generate income from trade and intellectual property rights; 3) consists of products that can be touched and intellectuals that cannot be touched or artistic services with creative content, economic value, market objectives; 4) cross-sectoral nature between arts, services and industry; and 5) part of a new dynamic sector in the world of trade.

2.2 Classification of the Creative Industry Subsector

Based on Presidential Regulation No. 72 of 2015 concerning Amendments to Presidential Regulation No. 6 of 2015 concerning the Badan Ekonomi Kreatif, has reclassified the creative industries subsector into 16 subsectors. The definition of the sixteen sub-sectors of the creative industry refers to the publication "Creative Economy: Indonesia's New Power Towards 2025, the Medium-Term Action Plan 2015-2019, Ministry of Tourism and Economy.

According to the Badan Ekonomi Kreatif [6], the creative industries in Indonesia are classified into sixteen sub-sectors, consisting of: Applications and games; Architecture; Design interior; Visual communication design; Product design; Fashion; Films, animation and video; Photography; Craft; Culinary; Music; Publishing; Advertising; Performing arts; Art; Television and radio.

2.3 Data Envelopment Analysis (DEA)

DEA is a non-parametric methodology that is based on linear programming and is used to analyze production functions through a production frontier mapping [7]. The DEA Model application has been used as a measurement in various scientific disciplines and various operational activities [8].

According to Bhat [9], the use of the DEA model as a device to measure performance efficiency has several advantages compared to other models, including:
1. Can accommodate many inputs and outputs
2. Does not require assumptions of certain functional forms in relation to input and output
3. Accommodate input and output in many different dimensions

4. Perform efficiency calculations for each organizational unit, while parametric methods with statistical averages of all units.

Rickard [10] mentions that there are several terms used in connection with DEA, including:

a. Decision Making Units (DMUs)
   In practice, DMUs are usually in the form of branch companies, business offices, company divisions, product groups, subsidiaries, work teams, and so on. The basic assumption of an inefficient DMU depends on the decision taken from the unit itself.
b. Technical Efficiency
   Technical efficiency indicates the presence or absence of waste of input factors. DMUs can be said to be efficient, if they can reach the expected level of output with a smaller number of inputs.
c. Slacks
   Comparing the value of technical efficiency of various DMUs with two aspects, both excessive input consumption and lack of production. These slacks are related to inefficient DMUs.

2.2.1. CCR- DEA Model (Charnes-Cooper-Rhodes)

he first DEA primal model was used, known as the constant return to scale (CRS) model which assumed that each DMUs had operated at an optimal scale [11]. The initial model used, known as the CCR ratio, is a non-linear equation (1):

$$\text{Max} \quad h_n = \frac{\sum_j u_j y_{jn}}{\sum_i v_i x_{in}}$$

$$\text{s.t} \quad \frac{\sum_i \sum_j u_j y_{jn}}{\sum_i v_i x_{in}} \leq 1$$

$$u^i_j, v_i \geq \varepsilon \qquad (1)$$

The goal of equation (1) is to find the largest amount of output weighted from DMUn, by keeping the amount of input weighted at a value and so that the ratio between output weighted to weighted input, of all DMUs, is less than or equal to one.

The value of technical efficiency in DEA not only identifies inefficient units, but also the degree of inefficiency. This analysis explains how inefficient units are to be efficient by giving a percentage decrease in input (input-oriented DEA) to produce the same output or giving a percentage increase in output (output-oriented DEA) for the same number of inputs

2.2.2. BCC-DEA Model (Banker-Charnes-Cooper) dan Scale Efficiency

The constant return to scale (CRS) model assumes that all DMUs operate at an optimal scale [12]. However, imperfect competition, limited funds, and so on cause DMUs cannot compete on an optimal scale. Thus, Banker [13] suggested the development of the DEA-CRS model in a variable return to scale (VRS) situation. In order for the return variable to be scaled, it is necessary to add a convexity condition for the λ weight values by entering in the $\sum \lambda_n$ model above (2).

$$= 1 \qquad (2)$$

The use of CRS specifications where DMUs actually do not operate at an optimal scale, will result in a measure of technical efficiency (TE) being defeated by scale efficiency (SE). In other words, the value of technical efficiency (TE) obtained from the DEA-CRS formulation (TE$_{CRS}$) can be decomposed into two components, namely: 'pure' technical efficiency (TE$_{VRS}$) and scale efficiency (SE).

The efficiency values of BCC performance measurement are called pure technical efficiency values, this is related to the values obtained from the model that allow scaled return variables, so that the existing scale can be eliminated.

The difference between PPC and PP$_V$ is expressed as SE = APC / APV as shown in Figure 3. So that it can be expressed in this mathematical equation (3).
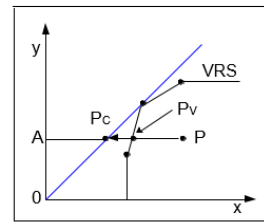

Figure 3. Scale Efficiency in DEA

$$SE = \frac{TE_{CRS}}{TE_{VRS}} \qquad (3)$$

2.2.3. Peer Groups

According to Nugroho [14], the peer group is used to determine the DMU that will become a reference for an inefficient DMU with the aim of increasing its efficiency (improving its efficiency). Some DMUs with relatively low efficiency can be improved by referring to other DMUs that are relatively more efficient. Determination of input and output target improvement can be calculated by multiplying the weight of the peer group with the input and output DMU that is used as a reference.

3. METHOD

3.1. Preparation Stage

Identifying various existing problems and formulating them into a main problem that will be discussed in this study. At the same time, the researcher also studies the literature (literature study) in order to define the research objectives.

3.2. Model Specification Stage

Based on its orientation, the basic DEA model is classified into two, namely input orientation and output orientation. This orientation depends on the limitations of control by the management / user of the DEA model, both to the input or output owned by the unit. The input orientation is chosen, if management has limited control on the output or there is no link at all between the input and the output. Meanwhile, the output-oriented DEA model is used on units that have adequate inputs, so that the unit's management only focuses on output and development through strategies. If an organization is technically inefficient from an input-oriented perspective, it will also be technically inefficient from an output-oriented perspective.

The data used in the Data Envelopment Analysis (DEA) method is based on secondary data from the Badan Pusat Statistik (BPS) of East Java Province in 2011-2015. This research focuses on 3 dominant sub-sectors of creative industries in East Java (culinary, craft, and fashion). Meanwhile, the output-oriented DEA model is used on units that have adequate inputs, so that the unit's management only focuses on output and development through strategies. The initial steps that can be taken are defining the concepts of input, output, and DMUs variables in this study.

- *Determine Decision Making Units (DMUs)*
  DMUs are defined as units to be analyzed in this study. In determining the number of DMUs, it is determined based on the number of sub-sectors / sub-categories classified as processing industries. As mentioned earlier, this DEA analysis will focus on three industry sub-sectors that have a dominant and dominant contribution to the economy in East Java, namely culinary, fashion, and crafts.
- *Determine input and output variables*
  a. Input variable
     The input variable is the amount of resources used to produce an output. In this study using four input variables, including: the number of companies, the amount of labor, input costs, and labor costs. In this study, input variables are determined based on important components of the Large and Medium Industry Statistics (IBS) according to the 2 Digit KBLI in East Java in 2011-2015.
  b. Output variable
     The output variable of this study is the PDRB of the creative industries in East Java Province. GRDP is used as an output variable because

GRDP is one indicator used to measure economic activity in an area. Current GDP (nominal) shows the ability of resources that are produced by a region.

The choice of input and output variables in DEA is very dependent on the availability of data [15]. In addition, there is no standard consensus in determining inputs and outputs in using DEA.

3.3. Model Implementation Stage

Calculation of the efficiency of the performance of creative industries in the regional economy of East Java Province is mathematically modelled based on the Output-Oriented DEA, which is used to measure technical efficiency as a proportional increase in output.

a. *Technical Efficiency* (TE)
   The value of efficiency (Technical Efficiency, TE) is calculated by a mathematical model of DEA based on constant return to scale (TECRS) with the assumption that all DMUs operate at an optimal scale. After calculating the efficiency, it will be known which DMU is considered efficient or inefficient, with the TECRS output value having the following rules:
   - If the efficiency of DMU = 1, then the DMU is declared efficient
   - If the efficiency of DMU is > 1, then the DMU is declared inefficient

   DMUs which are inefficient will be sought by peer groups to then calculate the target of adding output to be efficient.

   The evaluation of the productivity of the performance of the creative industries in all regions of East Java is modelled based on the output-oriented DEA which measures technical efficiency as a proportional increase in output. Thus, the formulation structure is mathematically modelled in equation (4):

   Objective function:

   $$\text{Max} \qquad \theta_n + \varepsilon \left(\sum IS_i + \sum OS_j \right)$$

   Limiting function:
   a) *Output* 1: East Java's GRDP
   $$\sum_i y_{1n} \lambda_n - \theta_n x_{1o} + IS_1 = 0$$
   b) *Input* 1: Number of Companies
   $$\sum_i X_{1n} \lambda_n + IS_1 = X_{1o}$$
   c) *Input* 2: Labor
   $$\sum_i X_{2n} \lambda_n + IS_2 = X_{2o}$$
   d) *Input* 3: Input Costs or Intermediate Costs
   $$\sum_i X_{3n} \lambda_n + IS_3 = X_{3o}$$
   e) *Input* 4: Labor costs
   $$\sum_i X_{4n} \lambda_n + IS_4 = X_{4o} \qquad (4)$$

   Index:
   n = DMUs, $n = 1,..,17$; $j = output, j = 1,...,5$; $i = input, i = 1,..., 4$

Data:

yjn = value of the j-th output from DMU to n

xin = the value of the i-th input from DMU to n

ε = a small positive number (10^{-6})

yjo and xio is the DMU output and input values being observed.

Variables:

θn = the relative efficiency of DMUn

ISi , $OS j = slack$ of *input i, output j* ($\geq$ *0)*

λn = the weight of DMUn (≥ 0) to the evaluated DMU

b. *Scale Efficiency* (SE)

Technical efficiency is calculated based on the formulation of variable return to scale (TE$_{VRS}$) with the assumption that (it could be) that optimal conditions do not occur so that DMUs cannot operate in an optimal scale. TE$_{VRS}$ output is in the form of technical efficiency (pure) value and does not contain scale efficiency (Scale Efficiency, SE) as in DEA-CRS.

The difference in the technical efficiency output of TE$_{CRS}$ and TE$_{VRS}$ shows the value of scale efficiency (SE). If the TE$_{CRS}$ and TE$_{VRS}$ outputs are the same, in other words SE = 1, the DMU is said to have operated optimally.

In order to improve the efficiency of the performance of the creative industries in several related regions (DMUs) which in the last period were still inefficient, Peer groups were given as objects for benchmarking the operationalization of efforts to increase efficiency and the target of adding output as realistic targets in the future. Determination of improvement targets for ineffective DMUs can be achieved through the calculation of variable slack as well as proportionate values referring to weak projection and strong projection.

Furthermore, the processing and calculation of DEA model data in this study were completed using MaxDEA 7 Basic software.

3.4. Analysis and Conclusion Stage

Interpretation and analysis of the results of data processing that has been done in the previous stage, is used to answer the research objectives that have been formulated at the beginning of the study. At the stage of interpretation and analysis of data in this study was conducted to determine the level of efficiency of some creative industries subsectors in East Java.

Conclusions are a series of processes that have been described in previous chapters accompanied by the success of the research process in achieving the objectives set at the beginning of the process.

Suggestion is a recommendation that will be given regarding the possibility of further research starting from the weaknesses and difficulties in carrying out this research.

4. COLLECTING AND PROCESSING DATA

4.1. Collecting Data

The data collection method used is document review (analysis of the contents of official documents issued by the government). The data used are quantitative data related to the input and output variables forming the efficiency values for each object being compared or Decision-Making Units (DMUs), which were published in the last five years period, 2011-2015. Furthermore, theoretical indicators relating to input and output variables on industrial performance in East Java are further examined for their relevance to the reality of the object of research.

4.1.1 Input and Output Indicators

Penelitian ini menggunakan empat variabel input dan satu variabel output. Cakupan pada variabel-variabel tersebut adalah sebagai berikut:

- *Output* 1 : Gross Regional Domestic Product (GRDP)
- *Input* 1 : Number of Companies
- *Input* 2 : Labor
- *Input* 3 : Input or Intermediate Costs (includes: raw materials, fuel, electricity and gas, building rent, machinery and equipment, and non-industrial services)
- *Input* 4 : Labor costs

4.2 Processing Data

The input and output data that has been collected is then processed and calculated to produce efficiency values from industrial sectors based on the 2009 Indonesian Business Field Standard (KBLI), which eventually formed 16 Large and Medium Industry (IBS) sectors as DMUs. Calculation of engineering efficiency with DEA uses four input variables and one output variable. The performance of the creative industries in East Java will be analyzed based on the results of data processing that has been done with MaxDEA software. These results are obtained through data calculations in the 2011-2015.

Data analysis in the period 2011 to 2014 was carried out by taking into account the results of data processing consisting of CRS, VRS technical efficiency values, and Scale Efficiency values. However, for the final analysis period of 2015, the analysis was carried out with regard to the results of data processing consisting of CRS, VRS, Scale Efficiency technical efficiency values and determination of

peer groups and improvement targets for each subsector going forward.

5. ANALYSIS AND DISCUSSION

Efficiency assessment to see the performance of the industrial subcategory in East Java is carried out in several stages, namely: calculating the value of Technical Efficiency (CRS and VRS), Scale Efficiency, determining peer groups (CRS and VRS), and setting improvement targets for DMUs that are not yet operational optimal or still inefficient.

The TE_{CRS} and TE_{VRS} values will be analyzed as a whole in the 2011-2015 period. Meanwhile, peer groups and improvement targets are analyzed only in the final calculation period (2015) which can be used as a reference for improvement in the years ahead.

5.1 Technical Efficiency Constant Return to Scale (TE$_{CRS}$)

From calculations done with the MaxDEA 7 Basic software, the results show that the value of technical efficiency (TECRS) from year to year over a five-year period (2011-2015) continues to experience fluctuating changes as shown in Figure 4.
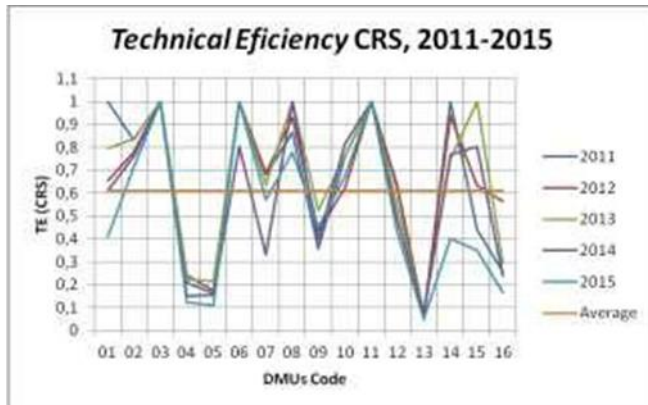

Figure 4. *Technical Efficiency* CRS f 2011-2015.

Based on the CRS technical efficiency (TE$_{CRS}$) calculation shown in Figure 5.1 above, it can be seen that over a five-year period (2011-2015) there were two industries that had successively reached the level of technical efficiency or optimal TE, namely subcategory 03 (tobacco processing industry) and subcategory 11 (basic metals industry). Meanwhile, as many as 14 industrial subcategories fluctuated with efficiency over a period of five years.

From the calculation of the CRS technical efficiency values for five years (2011-2015), changes in the technical efficiency of several DMUs occur every year.

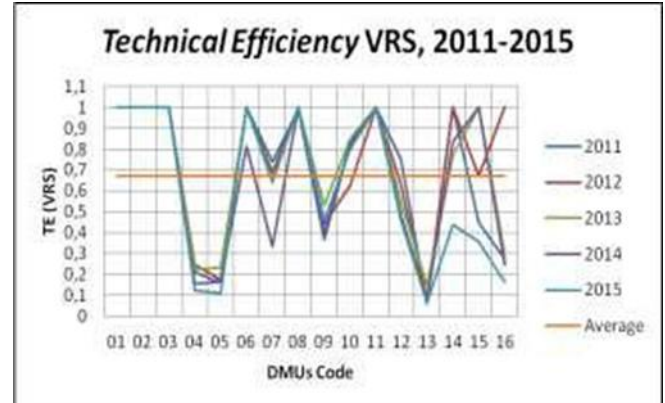## 5.2 Technical Efficiency Variable Return to Scale (TE$_{VRS}$)

Figure 5. *Technical Efficiency* VRS for 2011-2015.

Based on the results of the Technical Efficiency VRS (TE$_{VRS}$) calculations shown in Figure 5, it can be seen that over a five-year period (2011-2015) there were four industries that had successively reached the level of technical efficiency or optimal TE (efficiency value 1), namely subcategory 01 (coal industry and oil refining), 02 (food and beverage industry), 03 (tobacco processing industry) and subcategory 11 (basic metal industry). Results Meanwhile, as many as 12 industrial subcategories fluctuated with efficiency over a period of five years.

From the calculation of VRS technical efficiency values for five years (2011-2015), changes in the technical efficiency of several DMUs occur every year.

5.3. Scale Efficiency of DMUs for 2011-2015

Based on the scale efficiency calculations in tables 4.6 and 4.7 that have been carried out in the previous chapter, the number of industrial subcategories is obtained with decreasing return to scale (DRS) scale, constant return to scale (CRS), and increasing to scale (IRS) for each year during the period 2011-2015 written in Table 1.

Table 1. Scale of Efficiency of Industrial Subcategory, 2011-2015

Years	RTS			Total Sub-Industries
	DRS	CRS	IRS	
2011	9	5	2	16
2012	4	3	9	16
2013	3	5	8	16
2014	1	3	12	16
2015	6	3	7	16
Total Sub-Industries	23	19	38	65

5.4. Peer Groups of CRS for 2015

DEA identifies peer groups for inefficient DMUs. Peers is an industrial subcategory with technical efficient that can provide a reference for the operationalization of efforts to

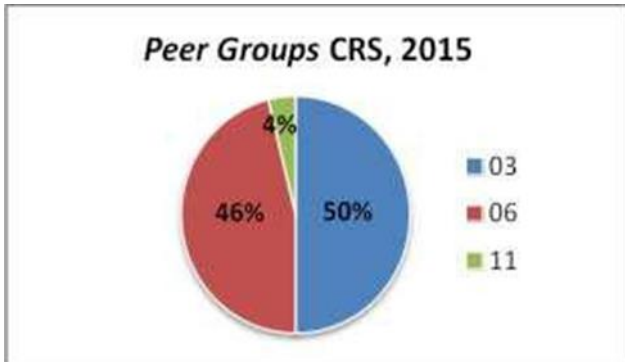increase its efficiency. The determination of Peer Groups is

Figure 6 Percentage of CRS Peer Groups in 2015.

carried out on two CRS and VRS models, which refer to an increase in output or output oriented values. In addition, the focus of determining peer groups is also based on the efficiency values of DMUs in the last period of observation (2015), shown in Figure 6.

5.5. Peer Groups of VRS for 2015

Percentage of weighted DMUs that became peer groups in the last period of 2015 (in percent), using the VRS calculation shown in Figure 7.
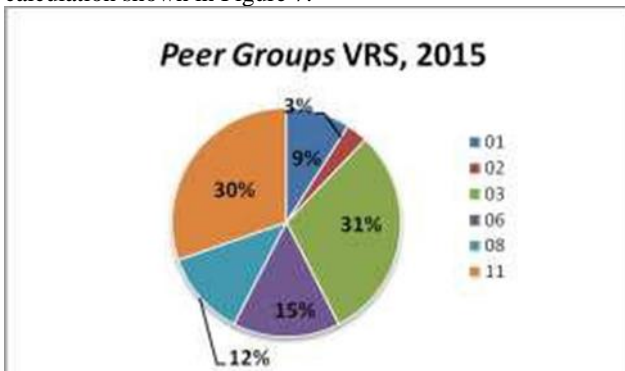

Figure 7 Percentage of CRS Peer Groups in 2015.

5.6. Output Increase Targets for 2015

CRS improvement target analysis is based on calculations in 2015, this is because this period is the last period of observation. Analysis of improvement targets is given for all industry subcategories that are inefficient by looking at current input and output values, improvement targets, and strong or weak projections that show new input and output values when applying improvement targets. Thus, there are two options as alternatives that can be used to improve the performance of each DMUs which is considered inefficient. Based on the calculation of CRS efficiency values that have been done previously, the results show that DMUs that do not have optimal performance are 13 DMUs. Therefore, the analysis of CRS improvement targets for inefficient DMUs

with output oriented is carried out on a number of inefficient DMUs, namely 13 DMUs. Meanwhile, the analysis of the target of improving VRS for inefficient DMUs with output oriented is carried out on a number of inefficient DMUs, namely 10 DMUs.

6. CONCLUSION

The DEA calculation results, dividing the conclusion into two parts, are:

a. Technical Efficiency CRS (TE$_{CRS}$) show that in the last five years (2011-2015) there were two achieving a stable level of technical efficiency namely subcategory 03 (tobacco processing industry) and subcategory 11 (base metal industry). In 2015, there were only 3 subcategories that reached the optimal TE (CRS) consisting of 3 subcategories (03, 06 11) and 13 subcategories (01, 02, 04, 05, 07, 08, 09, 10, 12,13, 14, 15, and 16) are inefficient.

b. Technical Efficiency VRS (TE$_{VRS}$) show that over a five-year period (2011-2015) there were four subcategories that achieved a stable level of technical efficiency, namely subcategory 01 (coal industry and oil refining), 02 (food and beverage industry), 03 (tobacco processing industry) and subcategory 11 (basic metals industry). In 2015, there were 6 subcategories that achieved optimal TE (VRS) consisting of 3 subcategories (01, 02, 03, 06, 08, and 11) and 10 subcategories (04, 05, 07, 09, 10, 12,13, 14, 15, and 16) are inefficient.

Suggestions for further research, namely to renew the comparing industry. Not limited to the dominant subsector of the creative industry. And, can compare the level of efficiency of the industrial subsector in each region in East Java (38 regencies / cities).

APPENDIX

A. Classification Data of Industrial Subcategories

Code	Industrial Subcategory
1	Manufacture of Coal Products and Petroleum Refineries
2	Food and Beverage Industry
3	Tobacco Processing Industry
4	Textile and Apparel Industry
5	Leather Industry, Leather Goods and Footwear
6	Timber, Wood and Cork Industry (Excluding Furniture) and Woven Goods from Bamboo, and Rattan
7	Paper Industry and Paper Products; Printing and Reproduction Media Recording Industry
8	Chemical Industry and Articles of Chemicals; Manufacture of Coal Products and Petroleum Refineries
9	Rubber Industry, Rubber and Plastic Products
10	Non-Metal Mining Industry
11	Basic Metal Industry

12	Metal Industry, Not Machines and Equipment; Computer, Electronic and Optical Goods Industry; Electrical Equipment Industry
13	Machinery and Equipment Industry; Motorized Vehicle Industry, Trailers and Semi-Trailers
14	Other Transportation Equipment Industry
15	Furniture Industry
16	Other Processing Industries; Repair and Installation Services of Machinery and Equipment

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