A Data Envelopment Analysis Approach for Assessing the Efficiency of Sub-sectors of Creative Industry: A Case Study of Batik Enterprises from Semarang, Indonesia

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A Data Envelopment Analysis Approach for Assessing the Efficiency of Sub-sectors of Creative Industry: A Case Study of Batik Enterprises from Semarang, Indonesia

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Abstract. The creative industry (CI) is considered to promote human development while promoting the economic growth. It maintains and protects historical and cultural heritage, improve cultural capital, and foster communities as well as individual creativity. Although there is widespread classification of the CI, the Ministry of Tourism of Indonesia has classified CI into 16 sub-sectors, i.e., (1) advertising, (2) architecture, (3) interior design, (4) product design, (5) craft, (6) visual communication design, (7) fashion, (8) film, animation, and video (9) photography, (10) application and game developers, (11) music, (12) performing arts, (13) publishing, (14) fine arts (15) TV and radio (broadcasting), and (16) gastronomy/culinary. The creative industry is an industry that originates from the use of creativity, skills and individual talents to create prosperity and employment by generating and exploiting the individual's creative and creative power. Batik industry is one of Creative Industry in Indonesia which plays an important role in the economic development. However, the Batik are facing difficulties in many areas, especially in spending their scarce resources efficiently. A case study to assess the efficiency of the Batik enterprises has been conducted by applying the data envelopment analysis in Semarang, Indonesia. The results show that from ten assigned Batik enterprises, there are nine enterprises' that are considered efficient, while the rest are regarded as inefficient. This research is expected to give some advantages to the Batik enterprises' regarding how to use their limited resources in an efficient way.

INTRODUCTION

Small and medium enterprises (SMEs) are broadly acknowledged to have a vital role in the economic development. Both developed and developing countries believe that they could bring huge economic benefits by contributing to the entrepreneurship, employment creation, as well as income generation [1-3]. Particularly in the developing countries, the SMEs are considered as important not only since they create the employment but also because they employ unskilled workers who are abundant in such countries [4]. The SMEs gave big contributions to the employment growth and gave steady decline in poverty rate. Beyond the dark year, the SMEs even contributed more to economic growth compared to big enterprises due to their dependency towards formal markets and credits [5]. In fact, the SMEs represent more than 99% of the total number of enterprises in Indonesia and employ more than 97% of the entire workforce [6-7]. In addition, the SME sector exported as of 16% of total non-oil exports, and accounted for 57.94% of total gross domestic product (GDP) at current prices [7].

The creative industries refer to a variety of economic activities related to knowledge and data generation or exploitation. It may also be referred to differently as the cultural sectors [8] or the creative economy [9]. Howkins' creative economy comprises advertising, architecture, art, crafts, design, fashion, film, music, performing arts, publishing, R&D, software, toys and games, TV and radio, and video games [9]. The definition of CI refers to industry which has its origin in individual creativity, skill and talent, and which has a potential for wealth and job creation through the generation and exploitation of intellectual property [10].

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The Indonesian Ministry of Trade states that the creative industry is an industry that originates from the use of individual creativity, skills and talents to create prosperity and employment by producing and exploiting creative and creative power. The creative industry was first used by Australia in the early 1990s, but was developed rapidly by the British government in the late 1990s [11]. The growth of the creative economy industry is considered capable of driving Indonesia's economic growth. According to the results of research conducted by the Creative Economy Agency (BERKRAF) with the Central Statistics Agency (2016), the creative economy industry in 2015 contributed 852 trillion to the national gross domestic income (GDP) and in 2016 reached 922.58 trillion with the value of contributions to National GDP of 7.44%. In 2017, Indonesian Creative Economy Agency (BEKRAF) established Fashion as the leading creative industry sector in Semarang, especially in the creative industries of batik [12]. The process of making batik in the city of Semarang still uses traditional equipment that allows inefficiency due to wasteful use of raw materials, additives and production processes. Therefore, this study intends to analyze the efficiency of batik production in the city of Semarang.

RESEARCH METHODS

Production efficiency is defined as the ratio of inputs and outputs associated with achieving maximum output with a number of inputs, if the ratio of inputs and outputs is large then the efficiency is high. If the ratio of input and output ratio produces a value of 100% or 1, then the condition is declared ideal. That is, the use of minimal input produces a certain maximum output. In reality this condition is difficult to achieve, so the term relative efficiency arises.

Relative efficiency is the efficiency of relative value among the observed units. A unit is said to have relative efficiency if the unit has better efficiency than other units. The relative efficiency value ranges from 0 to 1. A unit is said to be efficient if its efficiency value reaches 1, which means its efficiency value is better than other units. Calculation of relative efficiency is carried out using the Data Envelopment Analysis (DEA) method. DEA is a method of measuring efficiency based on linear programming which will result in the relative efficiency of a Decision Making Unit (DMU) [13]. The DEA method was developed by [14]. DEA identifies the frontier where the relative performance of all Decision Making Units (DMUs) is compared to the benchmark which is the best DMU value. This allows the best relationship between several outputs and inputs to be estimated [15]. DEA categorizes DMU into two, namely as an efficient and inefficient DMU, where an efficient DMU shows a relative efficiency value of 1 and an inefficient DMU of less than 1 [16]. DEA is a non-parametric approach to evaluating the performance of a collection of homogeneous entities called the Decision Making Unit where there are many inputs and outputs, each of which has different weights [17]. Measurement of efficiency by using the DEA method not only produces efficiency values from each DMU, but also shows units that are references for inefficient units. The DEA model is divided into two namely:

- CCR model (Charnes, Cooper, and Rhodes)
  DEA CCR model is the most basic model of the DEA concept proposed by [14]. This model assumes that the ratio between the addition of input and output is the same or often called the Constant Return Scale (CRS). This means that if there is an additional input of x times, the output will also increase by x times. Another assumption used by this model is that each DMU operates at an optimal scale. The objective function of the CCR model is to maximize the output of the units to be measured [18].
- BCC Model (Banker, Charnes, and Cooper)
  The BCC model was developed by Banker, Charnes, and Cooper in 1984 and is a development of the CCR model. The assumption of this model is that the company does not or has not yet operated at an optimal scale. Another assumption used is the ratio between the addition of input and output is not the same (variable return to scale), meaning that the addition of input x times will not cause output to increase by x times, can be smaller or larger than x times. Increasing the proportion is increasing return to scale (IRS) and can also be decreasing return to scale (DRS) [18].

In this study there were 15 batik creative industries that were used as DMUs. The model used is the CRS (Constant Return to Scale) model because it is assumed that the ratio between the addition of inputs and outputs is the same. The orientation used is output oriented to maximize output variables. Based on preliminary studies and literature reviews, there are several input and output factors that influence the inefficiency of batik production, namely: 1. Fabric. The main raw material in making batik is fabric. The type of fabric used to produce batik is cotton cloth. Generally, this fabric material is obtained from areas around Central Java such as Solo and Pekalongan. 2. Paraffin. In addition to fabric, paraffin is also an important raw material in batik production. The paraffin used in the batik process is the paraffin that has been thawed. The different types of paraffin have an impact on the results and the quality of the batik fabric made. 3. Dye. Dyes are also an important raw material in making batik. There are two types of dyes in batik namely natural batik dyes and synthetic batik dyes. The batik industry in the city of Semarang chooses to use synthetic dyes because it is easily available and has many color choices. 4. Fuel. The fuel used in the process of producing batik in the city of Semarang is LPG. LPG is used to melt paraffin or paraffin used in batik. 5. Water. The use of water in the batik process is also important. Water is used in the process of dyeing and dyeing or waxing from fabric. 6. Manpower. Manpower influential in the process of batik production. That is because the batik process is still done manually which is done directly by human hands. 7. Products. The final product from the production process will be output and will be measured in pieces. Input and output variables in the measurement of the efficiency of the batik creative industry are presented in Table 1.

TABLE 1 Input and Output Variable of DEA

	Variable	Unit
Input	Total manpower	man
	Amount of fabric	meter (m)
	The amount of paraffin	gram (gr)
	Amount of dye	gram (gr)
	Amount of fuel	kilogram (kg)
	Amount of water	liter (l)
Output	Number of batik fabric produced (per month)	piece

RESULT AND ANALYSIS

The selection of the Decision Making Unit (DMU) is the initial step for the DEA method. In this research, the DMU is the batik industry, especially the stamped batik industry in Semarang City as presented in Table 2. Through in-depth interviews with the owners of the batik industry, the data are then grouped into input and output variables. Recapitulation of input and output data is presented in Table 3.

TABLE 2 Data Decision Making Unit

DMU	Batik SMEs
1	Batik Semarang Indah
2	Batik Arjuna
3	Griya Batik Semarang
4	Utomo Batik
5	Batik Aster
6	Batik Aris
7	Batik Pasha
8	Batik Bu Tatik
9	Batik Martha
10	Zie Batik
11	Salma Batik
12	Elly Batik
13	Java Batik
14	Batik Tobong
15	Batik Ana

TABLE 3. Recapitulation of Input and Output Variable Data

DMU	***OUTPUT***	***INPUT***					
	Product (*pieces*)	**Cloth (m)**	**Paraffin (gr)**	**Dye (gr)**	**LPG (kg)**	**Water (l)**	**Manpower (man)**
1	1000	2000	150000	40000	102	30000	20
2	800	1700	100000	30000	84	30000	17
3	750	1400	150000	25000	69	25000	13
4	150	300	25000	10000	15	4500	3
5	300	600	50000	20000	30	8000	5
6	100	200	20000	10000	12	3000	3
7	800	1600	150000	25000	81	27000	16

TABLE 3. continued

DMU	*OUTPUT*	*INPUT*					
	Product (*pieces*)	Cloth (m)	Paraffin (gr)	Dye (gr)	LPG (kg)	Water (l)	Manpower (man)
9	150	300	20000	15000	18	5000	4
10	500	1000	100000	20000	51	20000	12
11	250	500	40000	10000	24	15000	5
12	300	600	60000	15000	33	10000	6
13	200	400	25000	15000	21	6000	4
14	300	600	60000	20000	30	8000	5
15	100	200	25000	7000	12	4000	3

Calculation of relative efficiency is done using SIAD software. The calculation results are presented in Table 4. Based on the calculation results, there are six inefficient batik industries, namely Utomo Batik, Aris Batik, Martha Batik, Zie Batik, Elly Batik, and Ana Batik. This inefficiency is indicated by a TECRS value of less than 1.

TABLE 4. Calculation Results Using SIAD Software

DMU	TE_{CRS}	*Benchmark*	Ket.
1	1	-	efficient
2	1	-	efficient
3	1	-	efficient
4	1	-	efficient
5	1	-	efficient
6	1	-	efficient
7	1	-	efficient
8	1	-	efficient
9	1	-	efficient
10	0.993	0.020 (Griya Batik Semarang) 0.680 (Java Batik)	inefficient
11	0.990	0.062 (Griya Batik Semarang) 0.093(Batik Aster) 0.218 (Batik Bu Tatik)	inefficient
12	0.974	0.052 (Griya Batik Semarang) 0.052 (Batik Aster) 0.158 (Batik Tobong)	inefficient
13	0.951	0.311 (Griya Batik Semarang) 0.222 (Batik Aster) 0.044 (Batik Bu Tatik)	inefficient
14	0.945	0.041 (Batik Semarang Indah) 0.583(Griya Batik Semarang) 0.250 (Java Batik)	inefficient
15	0.933	0.142 (Griya Batik Semarang)	inefficient

Based on the inefficient 4MU results, a proposed improvement is developed. The proposed improvement calculation is done to achieve the ratio of virtual output to input. The change in the number of variables aims to enable each input output variable to reach the targeted value ie achieving efficient criteria. Calculation of input variables and output variables is obtained through the calculation of slack movement and radial movement. The target values of the input and output variables to increase efficiency for the DMU inefficient are shown in Table 5.

Previous research has measured the efficiency of the batik industry by using the DEA method. The results obtained are in line with this study where there is a batik industry that is still inefficient. In this study it was found that out of 15 DMUs there were 6 DMUs which were inefficient, whereas in previous studies obtained from 35 DMUs there were 22 inefficient DMUs. Previous research shows that the number of batik industries that are more inefficient. The inefficiency of the batik industry is caused by wasteful use of inputs. There are differences in the input variables used in this study and previous studies. This study uses 6 input variables namely fabric, paraffin, dye, fuel, water, and manpower, whereas in previous studies only used 4 input variables namely fabric, paraffin, dye, and manpower. The efforts to improve the efficiency of the Batik industry are by calculating the target value of input and output used.

After the target value is obtained, then the actual value is adjusted to the target value that has been obtained, in order to improve the efficiency of the batik industry.

TABLE 5. Calculation of Target Value

DMU	Variable	Actual	Radial	Slack	Target
Utomo Batik	Fabric	300	0	0	300
	Paraffin	25,000	0	0	25,000
	Dye	10,000	0	2,187.50	7,812.50
	Fuel	15	0	0	15
	Water	4,500	0	0	4,500
	Manpower	3	0	0	3
	Product	150	1	0	151
Batik Aris	Fabric	200	0	0	200
	Paraffin	20,000	0	0	20,000
	Dye	10,000	0	4,473.68	5,526.32
	Fuel	12	0	2	10
	Water	3,000	0	0	3,000
	Manpower	3	0	1	2
	Product	100	2	0	102
Batik Martha	Fabric	300	0	0	300
	Paraffin	20,000	0	0	20,000
	Dye	15,000	0	4,300	10,700
	Fuel	18	0	2	16
	Water	5,000	0	420	4,580
	Manpower	4	0	1	3
	Product	150	1	0	151
Zie Batik	Fabric	1,000	0	0	1,000
	Paraffin	100,000	0	0	100,000
	Dye	20,000	0	0	20,000
	Fuel	51	0	1	50
	Water	20,000	0	2,666.67	17,333.33
	Manpower	12	0	2	10
	Product	500	29	0	529
Elly Batik	Fabric	600	0	0	600
	Paraffin	60,000	0	0	60,000
	Dye	15,000	0	1,888.89	13,111.11
	Fuel	33	0	3	30
	Water	10,000	0	0	10,000
	Manpower	6	0	0	6
	Product	300	15	0	315
Batik Ana	Fabric	200	0	0	200
	Paraffin	25,000	0	3,571.43	21,428.57
	Dye	7,000	0	3,428.57	3,571.43
	Fuel	12	0	2	10
	Water	4,000	0	428.57	3,571.43
	Manpower	3	0	1	2
	Product	100	7	0	107

Recommendations for improvement that can be given to the six batik creative industries that have not been efficient can be seen from the results of the calculation of the target values for each input and output variable. At Utomo Batik it is necessary to reduce the use of dye by 2187.50 grams. Batik Aris needs to reduce the use of dye, fuel and Manpower. Dye needs to be reduced by 4473.68 grams, fuel (LPG) needs to be reduced by 2 kg, and manpower must be reduced by one person. Batik Martha needs to reduce the use of dye, fuel, water, and manpower. Dye needs to be reduced by 4300 grams, fuel by 2 kg, water by 420 liters, and manpower needs to be reduced by one person. Zie Batik must reduce the use of fuel, water and manpower. Fuel is reduced by 1 kg, water is reduced by 2666.67 liters, and manpower needs to be reduced by two people. Elly Batik needs to reduce the use of dye and fuel. The use of dye needs to be reduced by 1888.89 grams and fuel 3 kg. Batik Ana must reduce the use of paraffin, dye, fuel, water and manpower. The use of paraffin needs to be reduced by 3571.43 grams, dye 3428.57 grams, fuel 2 kg, water 428.57 liters, and manpower needs to be reduced by one person.

CONCLUSION

The measurement of relative efficiency was carried out in 15 batik creative industries in the city of Semarang. The calculation results show that 9 creative batik industries have been efficient with an efficiency value of 1 namely Batik Semarang Indah, Arjuna Batik, Griya Batik Semarang, Aster Batik, Pasha Batik, Batik Bu Tatik, Salma Batik, Java Batik, and Tobong Batik. While 6 other batik creative industries are still inefficient (inefficient). The creative industries of batik are Utomo Batik, Aris Batik, Martha Batik, Zie Batik, Elly Batik and Ana Batik. Recommendations for improvements are made in the creative industry of batik which is not yet efficient. Utomo Batik needs to reduce the use of dyes. Batik Aris needs to reduce the use of dyes, fuel, and labor. Batik Martha needs to reduce the use of dyes, fuel, water and labor. Zie Batik needs to reduce the use of fuel, water and labor. Elly Batik needs to reduce the use of dyes and fuels. Batik Ana needs to reduce the use of paraffin, dyes, fuel, water and labor.

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