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Value-Added, Energy, and Technology-Capital in Central Java Industries

Setyo Tri Wahyudi^{1*} and Darmawan¹**AFFILIATION:**

¹ Department of Economics,
Faculty of Economics and Business,
Universitas Brawijaya, East Java,
Indonesia

***CORRESPONDENCE:**

setyo.tw@ub.ac.id

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Abstract: Nowadays, many industries do not depend on labor intensive, but have transformed to rely on intensive technology. Industry is considered potential strategy to raise value-added for its effort to alter raw or intermediate goods to finished goods. In this study, value-added approach is used to measure the role of technology - capital and energy. A lot of work has been done analyzing restricted variables in single study, but there is still a significant gap where research did not determine differences between measures. This paper aims to discuss the similarities of many technology – capital and energy related variables in Central Java Industries and analyzes their profile change to regional value-added from 2007 to 2017. Data related to technology – capital and energy are collected from Statistics Indonesia (*Badan Pusat Statistik*). The variables are examined using exploration factor analysis, multiple linear regression, and cluster analysis. The result shows that the energy consumption has the greatest effect on value-added rising during the study period, while technology - capital does not. Hence, policymaker should maintain the availability of energy for industries. Then, except for Kudus Regency and Semarang Municipality, policymaker should pay attention to the growth of value-added of the entire regions.

Keywords: Value-Added; Energy; Technology; Capital; Spatial; Industry

JEL Classification: E23, J24

Introduction

It is widely accepted in whole countries that the development in the industrial sector is the potential strategic development. That is because the process raises value-added, converting raw or intermediate materials into finished products. Furthermore, the industrial sector is considered competitive and often associated with rapid economic growth. In Indonesia, not only is the manufacturing industry the main driving force behind the sustainable and rapid economic growth, but also the national economic structure's pillar industry. For example, in 2007, ratio of industrial sector to Gross Domestic Product (GDP) is 27.01 percent and in 2017, the sector of industry contributes 20.16 percent or 13,588.8 trillion to GDP. It is a fantastic percentage. Even in 2015, Indonesia's industrial contribution to GDP was the fourth largest in the world. Hence, the growth strategy of the manufacturing sector must be within a strategy context. It should place the priority of industrial sector growth in a concentrated manner on high productivity and high competitiveness industries (Anggriawan, Maskie, & Syafitri, 2019).

Most industries today do not depend on labor intensive, but they have transformed to rely on intensive technology. The growth brought by technological change is sustainable as technology is focused on innovation, such as scientific development and accumulation of knowledge (Kapelko & Abbott, 2015; Liu et al., 2015) where the rule of decreasing marginal utility does not apply at all. This is also a sign of increased marginal utility. Even though the adoption of digital technology has raised concern about the way it will transform the productivity and employment (Camiña, Díaz-chao, & Torrent-sellens, 2020). There are several benefits obtained by the implementation of technology in industry, particularly advancements from machinery and other equipment. Products can for example be massively produced in a short time. As a result, industries could significantly raise their total value-added. However, there is any interesting finding from the study Muchdie and Nurrasyidin (2019) about the relationship between technological progress and human development. They found that the impact of technological progress on human development is negative, both direct and indirect.

In a transition from labor to capital-intensive Industries, the manufacturing sector has undergone structural change (Whang, 2019). Hamidi and Elida (2018) does research related to value-added and labor. Even though labor is ample physically, it will not be cheap economically. As a result, promoting the growth of labor intensive production would thus be extremely difficult (Grabowski, 2016). Moreover, Al-thani et al. (2018) says that the development of smart technology has contributed to some of the sustainability ideas to be reconsidered. Like low density cities can become both sustainable and livable, providing the framework for a sustainable town.

A different study such Wang et al. (2020) analyzes the driving impact of the industry growth drivers. It shows that the factor of production was the first and foremost driver of growth, but its driving impact was confronted with a rigorous labor driven challenge. The regional factor production offers obvious spatial correlation and heterogeneity without a fairly stable pattern of space. The competitiveness of the industry in all regions is significantly influenced by the economic climate, the structure of industrial organizations and the technological level. The framework of industrial organization exerts the various effects on the productivity of different regions (Chen et al., 2017). Meanwhile, technology somehow is related to energy consumption. Unconventional machining (UCM) processes are typically energy-intensive and used mainly for processing materials with high-quality specifications. In response to the new machining strategy of energy-saving and emission reduction, Zheng et al., (2020) shows that the energy conservation and emission reduction approaches in unconventional machining have focused mainly on machine tool design optimization, process modeling and optimization, and controlling demand.

Geng and Cui (2020) combines the analytical approaches of economics and geography, and takes data from the companies listed in the energy conservation and environmental protection industries. Instead, from the environmental protection viewpoint, they examine the spatial variability of the performance of industrial capital allocation and its motivating factors. The results show that there is a pattern of growing uncertainty in the capital allocation performance of the Chinese energy conservation and environmental protection industry. Environmental regulation and infrastructure have a substantial

positive impact on the efficiency of regional capital allocation, and improve other drivers influence and spatial heterogeneity.

Dilaver and Hunt (2011) forecasts future demand for industrial energy, the relationship between industrial energy use, industrial value-added and electricity prices. The findings indicate that production and real electricity prices and an Underlying Energy Demand Pattern all play an important role in driving the market for Turkish industrial power. While Balogun and Mativenga (2013) track the visibility and process dependence of energy and carbon footprint in machining process through a new mathematical model and logic that predict direct electrical energy requirements in machining toolpaths. Further, Yustisia and Sugiyanto (2014) investigate the existence of Environmental Kuznets Curve (EKC) according to development level and energy orientation, such as consumption of energy, export of energy, import of energy, and share of renewable energy consumption over the period 1991-2010 and found that renewable energy has an important role for sustainable development.

Budzianowski (2012) concludes that the most attractive synergies between energy technologies and value-added management were found in the following area: (i) soil fertilization (sustainable agriculture), (ii) the use of CO₂ to enhance biomass growth, (iii) simultaneous (bio)-chemicals and fuels production and (iv) the enhancement of oil and natural gas recovery. Furthermore, Yao and Cheng (2015) says energy is an important material basis for national economy's sustainable development and raising the living standards of the people. Many researchers try finding a method that is highly accurate in forecasting energy consumption of industry. However, in Indonesia cases, Prishardoyo and Sebayang (2013) examined the relationship between economic growth in Central Java Province with the quality of the environment through people perception. They found that most people are not bothered by the decline in the quality of the environment, especially air quality so that the use of vehicles is increasing. Another finding is that low public participation in managing the environment around where they live, especially for people who are directly affected economy activities.

In accordance with value-added, Kalu et al. (2019) and Abokyi et al. (2018) explores whether there is any relationship between energy consumption and value-added agricultural and industrial sectors as well as the Nigerian economy's overall growth rate. The finding is there is a very strong evidence of the existence of a long-run relationship between energyconsumption and indicators of economic growth. There is clear evidence that economic growth and agricultural value-added respond to the shocks and dynamics of the energy consumption studied, although the value-added of production proved otherwise. Oppositely Ghaderi, Azadeh, and Mohammadzadeh (2006) finds that electricity consumption does not add any value to most industries in Iran.

On the contrary, for Marxists, backwardness emerges failure to apply modernisation theory. The process of development and underdevelopment are purely formal and ahistorical. Future societies will not replicate the paths of other societies in the past. The underdevelopment has taken place within global context of capitalist accumulation and dependence for the periphery economies (Amin, 1975). Furthermore, there is no

presumption that capital goods industries will be capital-intensive. There is no presumption that appropriate products will employ appropriate technology. It may therefore not be possible to classify any particular technique as inappropriate, because it may be appropriate in some respects, inappropriate in others (Stewart, 1978)

Previous research investigates only a limited number of variables in a single study. Budzianowski (2012) as an example, conducts a study in response to energy technology and value added. Hamidi and Elida (2018) provide deep understanding between value-added and labor. In addition, Zheng et al. (2020) reveal related technology to energy consumption. Geng and Cui (2020) examine spatial variability of the industrial capital performance and environmental protection. Camiña et al. (2020) analyze the links between automation technologies, productivity and long-term jobs using a panel of data analysis. Meanwhile, Dilaver and Hunt (2011) forecast future demand for industrial energy by using the relationship among industrial energy use, industrial value-added and electricity prices. Based on the previous research, there is still a large gap where research only use one variable to represent one measure. This paper uses several variables to determine one measure and then examine differences between measures. The measures would be technology - capital and energy. The novelty of the research, this study explores similarities of several variables related to technology - capital and energy in Central Java Industries and analyzes their profile shift to value-added on a regional level from 2007 to 2017. The finding includes significant contributions to the development economics literature and offers valuable information for policymakers.

Research Method

In this study, we use data from Central Java industries on value-added, value of gasoline, value of fuel oil, purchased electricity, purchase/addition and construction/major repairs of land, building, machinery and equipment, vehicles and other fixed capital. Details are taken from publication of Statistics Indonesia-Badan Pusat Statistik (BPS), namely Statistics of Medium and Large Manufacturing Industry in Central Java. We use the data from 2007 and 2017 publications. The cases are based on 35 regions/municipalities in Central Java.

Since there are lots of variables in this study, measurement and interpretation will be more complex than if the variable is less. That's why we are going to simplify the variables in the first place. Then, regarding value-added of Industries in Central Java, we are going to analyze the impact of various factors in 2007 and 2017. Next, value-added spatial mapping relating to both factors is compared between 2007 and 2017. Therefore, this study use statistical measures as follows:

Exploratory Factor Analysis

The factor model is basically inspired by the following argument, namely assuming variables can be grouped by their correlations. That is, assume that all variables within a given group are strongly correlated with each other, but relatively small correlations with

variables in other groups. Factor analysis can be considered an extension of principal component analysis (Johnson & Wichern, 2007).

The main purpose of factor analysis are data summarization and data reduction. Data summarization describes the relationship between variables through a correlation check. If the correlation is made between the variables of the analysis, it is called an analysis of the factor R. Nevertheless, if a correlation is made between respondents or sample analysis, it is called Q factor Analysis, which is often popularly referred to Cluster Analysis. Meanwhile, data reduction means creating a new set of variables called a factor to replace a certain number of variables after a connection is created. Exploratory factor analysis begins with assessing good variables and then factoring and rotating. Once the factors have been rotated and interpreted, we can measure the factor scores, another aspect of the study. Factor scores are linear combinations of the elements and can be used in subsequent research as independent variables (Cleff, 2019; Mooi, Sarstedt & Mooi-Reci, 2018).

Multiple Linear Regression

The numbers in the newly formed factors, namely energy factor as well as technology - capital factor, are a composite of the related origin variables. Hence, those factors can be used in regression analysis to examine the value-added in 2007 and 2017 due to energy as well as technology - capital impact. The equation for each model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$$

where Y = value-added, β_0 = intercept, β_n = regression coefficient of n-th Factor, X_n = summarization of several variable n-th.

To check robustness of multiple linear regression, we conduct the homoscedasticity test and normality test. Homoscedasticity means that the variance of error or disturbance must be the same for each of the explanatory variable value. Violation of homoscedasticity implies that we cannot trust statistical result. Normality has a meaning that residuals are normally distributed. Violation of normal form indicates that there is outlier in residual. In this study, Breusch-Pagan test will check homoscedasticity, while Shapiro-Wilk test will investigate normality in the model.

Clustering with K-Means Method

K-Means is a non-hierarchical data clustering method that attempts to partition existing data into one or more clusters or groups, so that data that has the same characteristics (High intra class similarity) is grouped into one same cluster, and data which have different characteristics (Low inter class similarity) are grouped in other groups. This model provides precise distribution from multivariate perspective (Battisti & Parmeter, 2013). In this study, there are 3 clustered to be determined. We try examining the highest cluster with value-added, the medium cluster of value-added, and the cluster of the lowest one.

Result and Discussion

Modelling Factor

Based on the result obtained from Kaiser-Meyer Olkin measure of sampling adequacy, the existing variables, namely gasoline value, fuel oil value, electricity, purchase/addition and construction/major repairs of land, building, machinery and equipment, vehicles and other fixed capital, are able to be predicted and analyzed by using exploratory factor analysis. The results of the conducted factor analysis by using principal component method confirm that the initial eight items can be reduced without a significant loss of information. Then the mapping result of eigen value vector (y-axis) versus the component associated with it (x-axis) indicates the number of factors can be formed. Figure 1. demonstrates the scree plot suggesting that there are two loading factors should be established. It is shown by how many components located at or above the red line ($\gamma=1$).

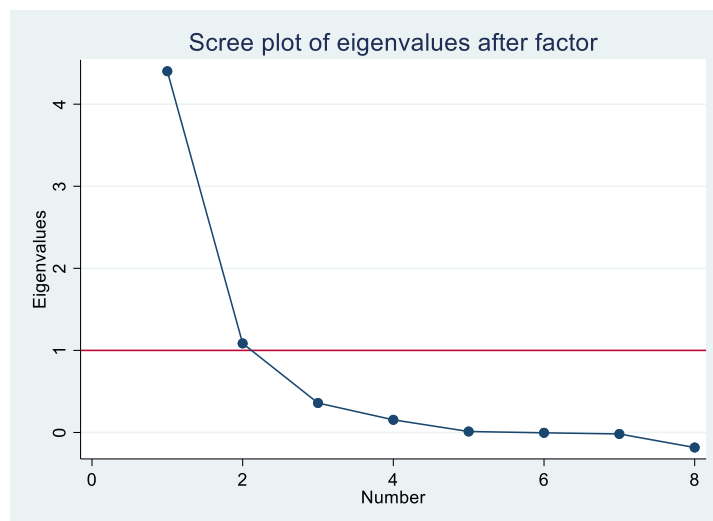


Figure 1 Determining The number of Factor Loading
Source: Data Processed

The component matrix resulting from the rotation process reveals clearer and more significant distribution of variables. It is obvious because there is no noticeable ambiguity between loading factor 1 and loading factor 2. The difference between both factors is obviously seen as rotation converges the forming of factors. The correlation between Gasoline and Factor 2 is 0.62 (strong). Contrastly, the correlation between Gasoline and Factor 1 is weak. As a result, Gasoline is included in Factor 2. Next, Electricity is included in Factor 2 as its loading factor is the largest. Likewise, Fuel Oil is included in Factor 2 because its correlation to factor 2 is the greatest. Meanwhile, other variables such as purchase/addition and construction/major repairs of land, building, machinery and equipment, vehicles and other fixed capital are included in Factor 1 as their correlations are great at Factor 1.

Table 1 Rotated Factor Loadings (Pattern Matrix) and Unique Variances

Variable	Factor 1	Factor 2	Uniqueness
Gasoline	0.1500	0.6156	0.5985
Electricity	0.3376	0.5760	0.5543
Fuel Oil	0.0726	0.6176	0.6133
Machine	0.7504	0.5744	0.1070
Land	0.9827	0.0390	0.0328
Building	0.9840	0.1436	0.0111
Vehicle	0.8379	0.4782	0.0692
Other_fixed	0.6807	-0.1002	0.5266

Source: Data Processed

Hence, the eight variables are grouped into two factors after they have been factored, rotated, and checked. They form two new factors because the covariance relationships among variables in terms of a few underlying, but unobservable, random quantities (Johnson & Wichern, 2007). We call the first factor as Energy Factor, consisting of the value of fuel oil, the value of gasoline, and electricity. While, the second factor is known as Technology-Capital Factor that consists of machine, vehicle, building, land, and other capital. Furthermore, we gain composite score from each factor which is important for subsequent analysis. We are going to use each factor as independent variable in further analysis.

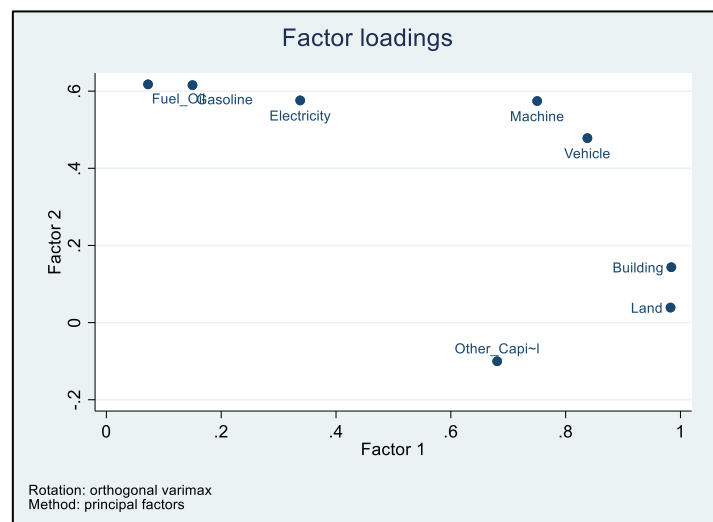


Figure 2 Variables of Industries in Central Java After Factoring and Rotation

Source: Data Processed

Relationship between Value-added, Energy, and Technology- Capital 2007-2017

The values in the newly developed factors, namely energy and technology - capital factor are combination of the associated variables of origin. Furthermore, with these values, we assess the value-added in 2007 and 2017 by regression. The equation is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$$

Both energy factor and technology - capital factor are capable of explaining the value-added variance of Central Java Industries by 24 per cent. It has the meaning that approximately 76 percent variance of value-added is determined by other explanatories beyond the model. The result shows that a rise in the usage of Energy would significantly increase the Central Java's value-added of industries. Meanwhile, technology – capital factor is not significant statistically in the model. Stewart (1978) notes that the underdeveloped industrial sectors are unable to pursue an alternate path. Not only because the world economic facts of life make it impossible, but because the cultural, psychological and economic pressures of dependent relationship have shaped policy makers in third world countries. Hence, they do not wish to follow an alternative strategy.

Table 2 Regression Result (Number of Observation: 70)

Variables	Coefficient	Standard Error	t-statistics	Prob.
cons	20.83381	0.18692	111.45	0.000
TECHNOLOGY_CAPITAL	0.34772	0.18977	1.83	0.071
ENERGY	0.84713	0.20563	4.12	0.000
R-squared		0.2386		
Adj R-Squared		0.2159		
F-statistics		10.500		
Prob. F		0.0001		

Source: Data Processed

Several methods are used to illustrate the assumption behind regression (Table 2), such as homoscedasticity test and normality test. The homoscedasticity test using Breusch-Pagan test is based on residual of regression and independent variable, and the result show that there is considered homoscedasticity in the model (the Prob > chi2 is more than 0.05). It means that data vary within the same range of the average. Next, Shapiro-Wilk test is used to examine normality of data show that the data can be assumed normally distributed (the value of Prob > z, which is more than 0.05). It has a meaning that the mean, median, and data mode are generally the same.

Table 3 Gauss-Markov Condition: Heteroscedasticity and Normality Test

Shapiro-Wilk W test for normal data					
Variable	Obs	W	V	z	Prob>z
Residual	70	0.99218	0.481	-1.590	0.94413

Breusch-Pagan/Cook-Weisberg test for Heteroskedasticity

Ho	Constant Variance
Variable	Fitted values of Ln_ValueAdded
Chi2(1)	1.37
Prob. > chi2	0.2426

Source: Data Processed

Profiles of Central Java's Industries 2007-2017

There are three cluster groupings in 2007. The first group is only composed by Kudus Regency as seen on the graph. This regency has the largest amount of value-added, much

greater than the average value-added in Central Java's Industries. This only Regency often uses energy more than other industries, and even higher than the provincially industrial average consumption. However, this group usage of technology - capital factor is the lowest of two other groups. Interestingly, Kudus does not use much technology - capital value to reach high value-added.

The second group consists of thirty regencies/municipalities. The industries under this category typically have the value-added, technology-capital factor, and energy consumption less than provincial average. Even though these industries utilize technology - capital factor the most among three groups in 2007 the value-added they hit are the least among three groups. Regency of Pati, Regency of Sragen, Municipality of Semarang, and Regency of Pekalongan belong to the third group. Their position in term of value-added as well as the usage of energy factor is in the middle. Meanwhile, their technology - capital factor usage is slightly less than the second group.

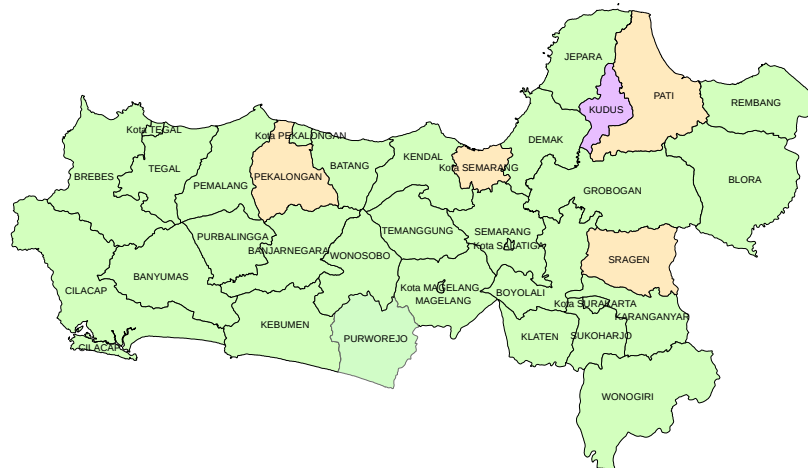


Figure 3 Map of Value-added Clusterisation in Central Java's Industries 2007

Source: Statistics Indonesia-*Badan Pusat Statistik* (BPS)

As for 2017, Kudus Regency still uses low technology - capital factor. Its technology - capital factor is lower than the average provincial industrial usage and also the lowest among other regencies/municipalities. Its consumption of energy is significantly lower than Municipality of Semarang, but slightly higher than that of other thirty-three regions. Kudus regency, however, still persists on attaining the greatest value-added among other regencies/municipalities.

Municipality of Semarang utilizes much more technology - capital factor as well as energy than other regions in Central Java, but its value-added is still far behind Kudus Regency. Semarang Municipality's technology - capital factor and energy level is far more than provincial industry rate and also the highest among other regencies/municipalities in 2017.

Thirty-three regions/municipalities experience the lowest value-added in 2017. All areas in Central Java, except for Kudus Regency and Municipality of Semarang, belong to one

group with the lowest value-added and the lowest factor of energy. Even though these regions have middle technology - capital factor that is higher than Kudus Regency, they can't surpass the value-added of Kudus.

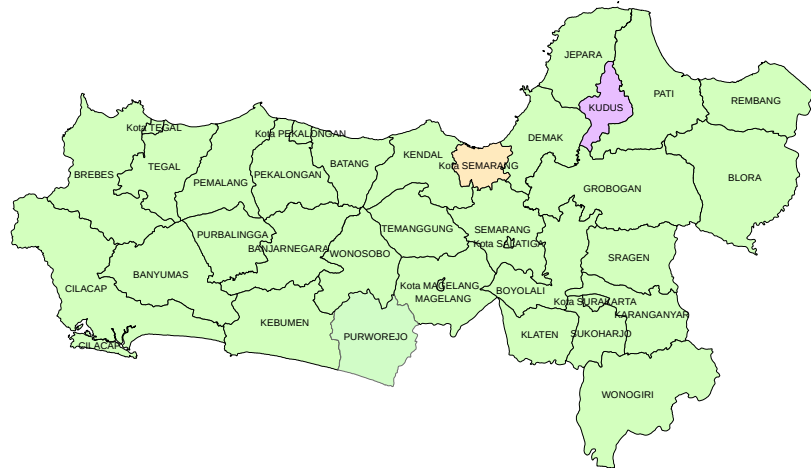


Figure 4 Map of Value-added Clusterisation in Central Java's Industries 2017
Source: Statistics Indonesia-*Badan Pusat Statistik* (BPS)

Past studies did not specify the differences between measures or investigated only a limited number of variables in a single study. The current study employed factor analysis to analyze similarities and variation in the constructs assessed via Statistics of Medium and Large Manufacturing Industry in Central Java. A two-factor solution was defined to be the most appropriate for explaining these constructs, namely energy aspect (explaining the purchase and the use of gasoline, fuel oil, and electricity) and technology - capital aspect (explaining the purchase/addition and construction/major repairs of land, building, machinery and equipment, vehicles and other fixed capital). Therefore, the two factors identified in this paper has a variety of implication practices. We may try to determine the industrial value-added for a wide variety of aspects.

Interestingly, there is a balance, but a gap in Central Java's industry behavior from 2007-2017 in value-added increase. In 2007, value-added of overall industries rely on the consumption of energy and technology - capital use (Abokyi et al., 2018). However, in 2017 energy consumption leads to value-added, but technology – capital does not. It is believed that in 2017, the technology - capital used by industries are typically unconventional machine, hence energy-intensive and used mainly for processing materials with high quality specifications (Zheng et al., 2020). Furthermore from 2007 to 2017, we may analyze the driving factor of the industry value-added drivers. It shows that generally the factor of energy is the first and foremost driver of value-added.

Regionally, factor of energy and factor of technology - capital offer clear spatial correlation and heterogeneity with a relatively stable pattern of space. It is a little bit different with previous study (Chen et al., 2017). Kudus Regency is the area of industries that utilize much energy, but little technology - capital, however has a large amount of

Value-added. This regency still persists in two distinct phases of study, 2007 and 2017. There is no noticeable difference in this region after eleven years.

In comparison, Municipality of Semarang, the Regency of Pati, Regency of Sragen, and Regency of Pekalongan use middle energy and technology - capital in 2007 and reaches middle value-added among Central Java's industries. Next, only Semarang Municipality raises these factors to be the most in 2017. However, the value-added that Semarang Municipality provides is still far from Kudus Regency. Meanwhile, many regencies in 2007 use technology – capital the most, but their value-added are the least ones. Furthermore in 2017, even though these regions utilize technology - capital factor more than Kudus Regency (that reaches the first position in value-added in 2017), the value-added they achieve is still the least.

Conclusion

Past studies did not specify the differences between measures or investigated only a limited number of variables in a single study. The current study employed factor analysis to analyze similarities and variation in the constructs assessed via Statistics of Medium and Large Manufacturing Industry in Central Java. A two-factor solution was defined to be the most appropriate for explaining these constructs, namely energy aspect (explaining the purchase and the use of gasoline, fuel oil, and electricity) and technology - capital aspect (explaining the purchase/addition and construction/major repairs of land, building, machinery and equipment, vehicles and other fixed capital). Therefore, the two factors identified in this paper has a variety of implication practices. We may try to determine the industrial value-added for a wide variety of aspects.

Overall, industries in Central Java rely on the energy consumption instead of technology-capital. The most used energy is from gasoline, fuel oil, and electricity. In order to support industrial process, policy maker should maintain the existence of energy source because it helps industries to raise value-added. The process of underdevelopment of technology-capital use indicates the failure of applying modernization. This situation could result from failure of replicating the paths of other developed economy societies' history or could be caused by strongly dependent relationship of policymaker, so that they do not wish to follow an alternative strategy (Amin, 1975; Stewart, 1978). To this circumstance, industries had better employ appropriate technology to appropriate product (Stewart, 1978).

Even though Semarang Municipality has increased its technology – capital to be the largest, the highest value-added is reached by Kudus Regency with the lowest usage of technology-capital. If Kudus Regency raise its consumption on technology-capital, it might boost value-added much higher. Likewise, despite other regencies (except for Kudus and Semarang) in Central Java experience the highest use of technology – capital, still Kudus Regency with highest usage of energy consumption achieve the largest value-added. If Central Java Province's industrial growth is used as the backbone of its economic development, the measurement of performance in this research has to be focused on its

value added. All regions, except for Kudus Regency and Semarang Municipality need paying attention because their value-added are the lowest. These regencies also utilize small amount of energy consumption, which is below the average. So, policymakers should care of these regions. Conversely, industrial development policies which obviously have no effect on that economic growth need to be checked (Anggriawan et al., 2019).

This study approximates technology-capital by using variables of machinery, equipment, vehicles, building, land, and other fixed capitals. Using exploratory factor analysis, actually we can add many more variables. The same treatment can be applied to energy factor, more variables can be added to load the factor. Furthermore, It is advisable to examine value-added of industries by utilizing other dimensions besides energy and capital-technology. It is also possible to exclude Semarang Municipality and Kudus Regency for future study as both regions have extremely higher value-added than other regions. Thus, study could see what dimension in other regions to be improved to raise industrial value-added.

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