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Preliminary Analysis of Electricity Energy Efficiency in SMEs

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Abstract. In general, industrial sector consumes high energy. Therefore, efforts to manage the energy usage in this sector are useful as it can reduce significantly total energy consumption mainly for electricity. This research aims to observe consumers' perceptions and success factors to improve efficiency of electricity energy usage for industry particularly for manufacturing small-medium enterprises (SMEs) in Makassar as a representative big city in Indonesia. A questionnaire for survey is designed to get data from 127 respondents and analysed using statistical approach. Observed variables related to energy efficiency in SMEs include human resources, production technology, rainfall, and tax. Results shown the developed questionnaire is reliable (Cronbach's alpha value exceeds 0.6). Perception of consumers about energy saving is quite good. From aspect of demographic characteristic, there is a difference in users' perceptions on energy saving. Other results show the significant relationship between human resources, production technology, and rainfall condition to the energy efficiency level at SMEs. Knowledge or findings of this study provide valuable information in relation to strategy to improve efficiency of electricity usage in industries.

1. Introduction

Electricity load in many countries increase over the time. To assure the balancing between electricity production and load growth, efforts such as building renewable based power plants at certain times and energy saving are needed. The balancing is an important aspect to keep stability electricity service to consumers in power systems.

As in other places, industrial sector in Indonesia consumes high energy. Based on this, energy saving actions or energy efficiency improvement (EEI) in this sector such as for SMEs is meaningful as a strategy to reduce energy consumption mainly electricity. However, its implementation is not an easy task as several factors can influence the success of energy saving actions or EEI in one place. One of barriers for some consumers to practice energy saving optimally is the lack of information [1]. Therefore, determining the best way to promote energy saving practice for enhancing consumers' knowledge and observing main factors affecting EEI are the challenge for researchers. Consumers that have enough information or have positive perceptions are normally easier to practice energy saving.



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They will utilize energy efficient equipments and use electricity energy wisely in their daily activities as a habit.

There are a number of references which focus on the energy efficiency analysis for different sectors. Barris et al. [2] analyses end user to increase electricity energy efficiency for households in Latvia using logistic regression. The authors perform a survey, and goal-framing theory is adopted to measure the deployment of electricity efficiency concept in society. Rahman et al [3] analyses energy saving potential for households particularly in suburban area in Malaysia. Awareness of consumers and type of electrical appliances are some indicators used in the study to understand factors in reducing energy consumption. Soepardi et al. [4] investigates Indonesian steel industry concerning the barriers to increase energy efficiency. Policy, financial-economic factor, technology and three other variables are examined in relation to EEI. Fleiter et al. [5] analyses factors influencing energy efficiency for SMEs in German. Data from energy audit and statistical approach are used in their empirical analysis. Ackah et al. [6] studies energy efficiency practice of the rural SMEs in Ghana. Product generational dematerialization approach is adopted to investigate electricity and fuel energy consumption. Another reference, by Apeaning et al. [7] for Ghana context observed the barriers to increase energy efficiency especially for large industries. Exploratory and qualitative research are applied to get specific knowledge in enhancing efficiency of energy usage. Recently, study in [8] performs a literatures review on energy policies to increase energy efficiency in SMEs, and in Yonemoto et al. [9], the authors develop physical simulator to assess energy efficiency related to productivity for manufacturing industry.

This study aims to measure perceptions of consumers and to observe factors affecting efficiency of electricity energy usage in industry particularly for manufacturing SMEs in Makassar. For this purpose, survey questionnaire is designed, and regression model is proposed as a tool analysis. In general, increasing efficiency is not only a key strategy to maintain electricity availability for consumers, but also to reduce greenhouse gas emissions in short to medium term or to increase carbon neutral energy system [5][8]. SMEs business avoids lack of energy supply as it may lead to lost profits and customers [10]. However, more advocating of electricity saving is needed as energy efficiency level is not too clear in SMEs, budget for efficiency improvement program is quite low, and often lack of resources which can be an obstacle in adopting innovation [11][12].

To the authors' knowledge, study on energy efficiency for Indonesian SMEs is very limited. This is in line with literature review on energy efficiency reported in [8] which shown no study for Indonesian context. Majority of the studies are from European countries. Therefore, this present work is expected can fill the gap. The structure of paper consists of five parts. After introduction, this paper continues with typical Indonesian SMEs, followed by research methodology and then results. The last part is conclusion including future research.

2. Indonesian SMEs Consumers

Typical industrial consumers in Indonesia are classified into micro, small, medium and large scale which can be grouped into micro-small-medium industry (MiSMEs) and large industry. According to BPS [13], employee number for micro scale is 1 to 4, small scale is 5 to 19, medium scale is 20 to 99, meanwhile for large industry is 100 and above. Among the groups, majority of the consumers is coming from MiSMEs group. Figs. 1 and 2 show Indonesian MiSMEs and their number of employees for year 2012 and year 2014 [14]. As seen from Fig. 1, micro industry is highly dominant compared to other classifications (SMEs). Particularly for SMEs, the number of small and medium sized industries in year 2012 are 602,195 and 44,280, respectively and in year 2014 increased becomes 654,222 and 52,106, respectively. Similar tendency to the number of employees, which is from 3.9 million in year 2012 and becomes 5.5 million in year 2014 for small industry. Meanwhile for medium scale, it is increased from 2.8 million in year 2012 and becomes 3.9 million employees in year 2014. The same

situation in South Sulawesi province which Makassar city is located, the largest consumers group for industrial sector is also coming from MiSMEs.

As Indonesian industries and employee absorption are very high, moreover the number of industries in the future may increase higher which proportional to energy consumption, therefore, it is important to explore industrial characteristic to improve efficiency of energy usage mainly for manufacturing SMEs. This is in line with the concern of Indonesian government to increase SMEs performance.

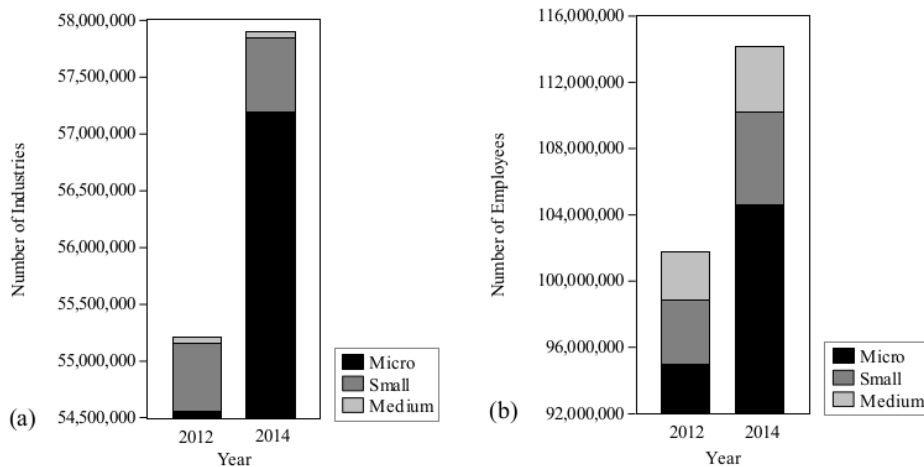


Figure 1 (a)(b) Indonesian MiSMEs and number of their employees for year 2012 and 2014.

3. Research Methodology

The target respondent selected in this study is SMEs particularly manufacturing industry in Makassar area in South Sulawesi province. Required data are collected using a questionnaire survey. The questionnaire is developed based on the related prior studies [15], and it is organized into three main parts, A to C. In Part A is questions about general information of respondents, e.g. age, education level, position in SMEs, and category of industry. Part B is users' perceptions about electricity energy saving, the statements include e.g. "Utilization of low watt electricity equipments in SMEs supports energy saving program in industry", and "Energy saving behaviour can support the sustainability of electricity energy in the future". Meanwhile in Part C is influencing factors related to implementation of energy efficiency. The statements include e.g. "Employees have good enough education", "Used machine is new, it can minimize obstacles in the production process", "Rain with high intensity often occurs in Makassar". Items on the questionnaire is evaluated by using 1 'strongly disagree' to 7 'strongly agree' rating scale (7-point Likert scale).

Purposive sampling technique is used during face-to-face survey that conducted in August to October 2019. The respondents are business owner, manager, or employee who knows energy usage in their organization including electricity equipments and production process. To get more information from collected data after reliability test, perception of consumer is measured using mean score analysis, and regression approach is applied to identify success factors for implementation of energy

efficiency in manufacturing SMEs. Here, the examined factors include human resources, production technology, rainfall, and tax.

4. Results

4.1. Reliability test and validity

For reliability test, Cronbach's alpha value is applied to evaluate items in the questionnaire. Forty respondents are used as a pilot survey. From testing, obtained Cronbach's alpha values are above 0.6 for all dimensions (perception, human resources, production technology, rainfall factor, tax, and efficiency energy). This means items in the designed questionnaire have internal consistency or reliable and it can be used for further analysis (main survey). For validity, this study adopts the expert validity approach.

4.2. Demographic of respondents

Figure 2 shows descriptive statistic for all participants (127 data sample) in this study. The data sample is around 24% of the total number of manufacturing SMEs in the observed area for year 2017. The descriptive data include gender, educational level, age, position of respondents, category of industry, and installed power capacity (IPC). From the figure, 66.14% of the respondents is male and dominantly is business owner (62.2%). Majority of the participants has small industry (92.12%), only 7.87% of them has medium industry. Meanwhile for IPC, 69.3% of respondents have IPC 2,200 – 6,600 VA in their SMEs.

4.3. Perceptions of consumers

Analysis for all participants in this study shown perception of SMEs' consumers concerning energy saving is generally good (5.68 out of 7 Likert scale). Normally, people with good perceptions or have enough knowledge are easier to practice energy saving. They tend to use electricity energy wisely in their daily activities either at home or in workplace.

Further analysis shows a significance difference in the users' perceptions on energy saving from perspective of demographic characteristics, namely based on the category installed power capacity (IPC). The SMEs respondents for IPC 2,200 – 6,600 VA show more positive perception (Mean = 5.76, SD = 0.91) than respondents who have IPC below 2,200 VA (Mean = 5.61, SD = 1.02) and IPC above 6,600 VA in their SMEs (Mean = 4.75, SD = 1.88).

4.4. Success factors of energy efficiency improvement

Regression analysis is performed to examine the relationship between observed variables (human resources, production technology, rainfall, and tax) and implementation of energy efficiency in SMEs as seen in Table 3. From results, variables in the regression model can explain around 42% of the energy efficiency level which well validated. Three of variables in the model namely human resources, production technology, and rainfall have significance at 10% associated with energy efficiency with expected signs. The significance of the variables is indicated by obtained p-value for each variable below 0.1. Among the factors, production technology gives the highest effect associated to EEI in SMEs as indicated by its coefficient value (0.4975) is higher than others.

The result implied that human resources, production technology, and rainfall are some factors to enhance energy efficiency. The better of human resources and production technology, the higher energy efficiency in SMEs. Based on this, efforts include providing information and giving training to increase knowledge of employees including management level are important to implement energy efficiency concept. For production technology, some aspects such as renew production equipments at particular time and utilize efficient-based support devices are useful to achieve optimal efficiency in energy usage. This is in line with previous studies such as in [15]. For rainfall variable, under severe condition such as high intensity rainfall during peak period of rainy season can make consumption higher in SMEs due to additional lighting and the longer production process at certain industries. This can stimulate consumers to use electricity more effective to minimize additional energy consumption.

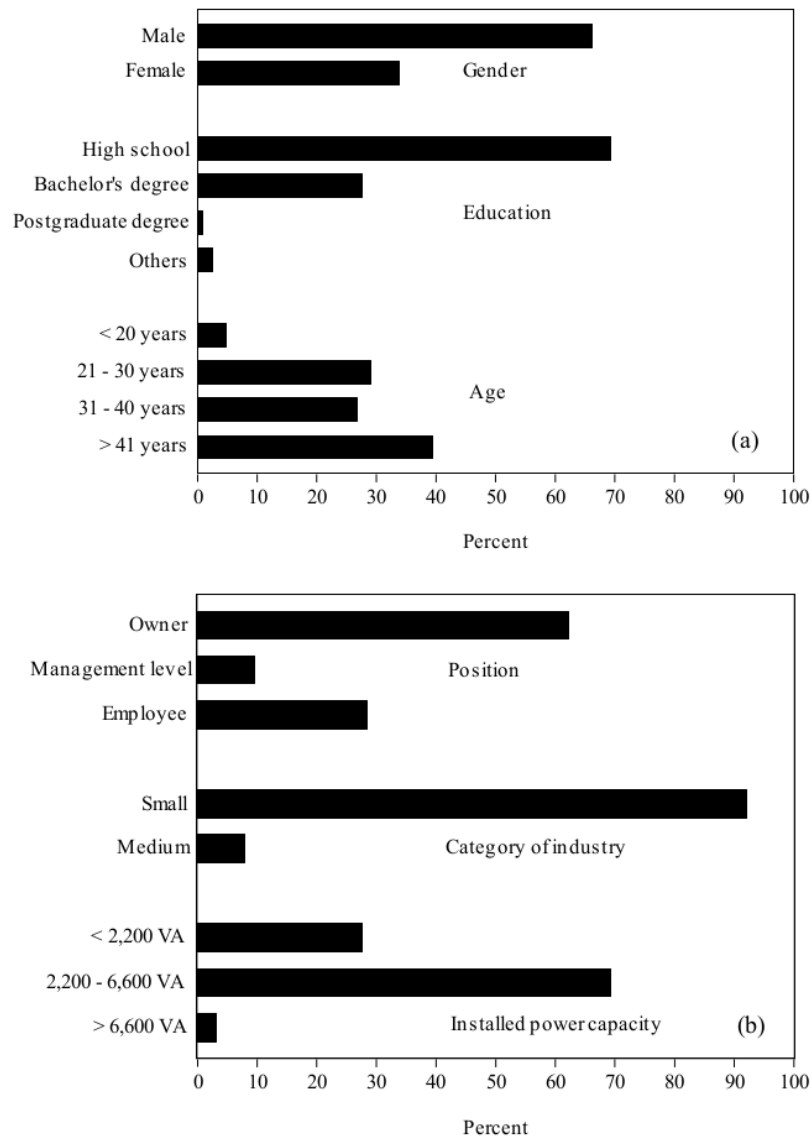


Figure 2. (a)(b) Demographic of respondents

Table 1. Regression result

Variables	Energy Efficiency		
	Coef.	p-value	t-statistic
α_0	1.3473	0.0093	2.6453
Human resources	0.1480	0.0762	1.7886
Prod. technology	0.4975	0.0000	5.6050
Rainfall	0.0957	0.0733	1.8070
Tax	0.0344	0.5693*	0.5705
AR(1)	0.2516	0.0077	2.7124
R^2		0.4392	
R^2_{adj}		0.4158	
Prob. (F-stat.)		0.0000	
Durbin-Watson		2.0464	

*Non significance variable

As implications of the study, policy maker should determine more suitable strategies in promoting EEI to industrial consumers. They can be designed based on the perception level such as by giving priority according to power capacity level in SMEs as IPC affects perceptions of consumers. For example, IPC above 6,600 VA or below 2,200 VA show lower perceptions on energy saving than consumers with IPC 2,200 – 6,600 VA. Similar perspective for designing strategies based on finding for success factors. For example, according to human resources which may refers to educational background of consumers as an indicator. Respondents' background is dominantly junior / senior high school (around 69%). Based on this, education in the form of training or others should more concern to the SMEs consumers.

Enhancing energy efficiency in industry is a pivotal aspect to increase SMEs performance, and it is more important in global competition era. Concerning this, industry business in all scales should implement more energy efficiency concept for effectiveness and competitiveness.

5. Conclusions

This study observed consumers' perceptions and success factors for electricity energy efficiency in industry particularly for manufacturing small-medium enterprises (SMEs) in Makassar. A questionnaire for survey is designed to get data from consumers and analysed using statistical approach. From analysis, it is concluded that the developed questionnaire is reliable. Perception of consumers on energy saving is generally good. Based on the demographic characteristic, there is a difference in users' perceptions on energy saving. Other results show strong relationship between human resources, production technology, and rainfall condition to the energy efficiency level at SMEs. It is expected information from this study can contribute in relation to strategy to improve efficiency of electricity usage in industries. Future research will observe other variables to get more detail information regarding success factors of energy efficiency for industry in Indonesia.

Acknowledgments

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