Environmental Innovation as Mediation: Knowledge Management and Firm Performance

Eka Ratnasari Sulistio[a], Wiwiek Dianawati[b*], [a,b]Department of Accountancy, Faculty of Economics and Business, Universitas Airlangga, Indonesia, Email: [b*]wiwiek.dianawati@feb.unair.ac.id

This study aims to examine the relationship between knowledge management and firm performance as mediated by environmental innovation. The research sample used manufacturers listed as firms on the Indonesia Stock Exchange (IDX) for a 5-year period from 2013 to 2017. This study uses path analysis by linear regression. The research result shows that knowledge management has a positive relationship to firm performance. Meanwhile, environmental-based innovation does not mediate the relationship between knowledge management and firm performance. This study is vital to providing information for a firm to continuously work to improve their environmental-based innovation and participate in diminishing the effect of global warming.

Key words: *knowledge management, firm performance, environmental innovation.*

Introduction

Global warming disrupts ecosystem equality when there are increases in the earth's atmosphere, sea, and land temperature. The cause of the global warming phenomenon is closely related to human activity. It started from the industrial revolution in the 18th century, with the development of power generation, transportation and agriculture (Rennings & Rammer, 2011). According to the National Oceanic and Atmosphere Administration (NOAA) in the United States, 2017 was the warmest year followed 2016 and 2015. The temperature is rising worsened by the human habit of mis-managing our use of resources from the natural environment; thus, the global warming trend has become an issue of most significance for contemporary society (Nasih et al., 2019). Based on National Geographic Indonesia, China deposits 187.2 tonne of waste per year into the sea and Indonesia is the second largest depositer of waste in the world into the sea after China (Mills & Smith, 2011). Unmanaged waste is one of the most significant contributions to global warming. Each tonne of solid waste produces 50 kg of methane gas. As Indonesia's population continuously grows,

it is estimated that in 2020 the waste produced will be approximately 500 million kilograms per day or 190 tonnes each year. Awareness of this waste phenomena in Indonesia is needed, especially for business practitioners.

The industry is called by research to actively participate in decreasing the effects of global warming. Providing fresh innovation to address environmental concern with the firm's available resources is ideal (Hamid et al., 2019). One way is by using knowledge management to disseminate environmental awareness. This refers to a set of business processes that have been developed within the organisation to create, keep, transfer, and implement the knowledge (Laudon & Laudon, 2014). Darroch et al. (2002) argues that knowledge management is a management function that creates or positions the knowledge, and manages the knowledge flow inside the organisation, ensuring that knowledge shared is effective and efficient for long-term objectives.

The firm's competitive advantages depend on valuable, hard to imitate, scarce, and irreplaceable resources (Barney, 1991). Furthermore, intangible resources such as knowledge, drive the firm to obtain sustainable competitive advantages (McEvily & Chakravarthy, 2002; Rakino et al., 2019). Grant (1996) highlights that environmental activities are regarded as competitive advantage sources, especially if the related firm has an intellectual asset in line with environmental activities. Based on this explanation, it can be concluded that environmental activity in terms of environmental innovation becomes a firm's long term competitive advantage if it is supported by sufficient knowledge disemination, which is 'knowledge management'.

Environmental innovation, according to Porer and Van Der Linde (1995), is regarded as a vital method for achieving better ecological, financial, and economic status with the least cost. Nadja et al. (2019) explained that a development strategy will need information technology for marketing and improving coordination between stakeholders. Kemp (2000) describes 'environmental innovation' as the practice, method, system, and introduction of new or modified products to replace the business activity that is not efficient and to decrease environmental damage. Becherra-Fernandez and Sabherwal (2001) found that Chain Steel Corporation, a firm that has implemented environmental knowledge circulation processes, improved their environmental and financial performance through environmental knowledge creation. They accumulated and shared knowledge of environmental innovation internally. Furthermore, Branzei et al. (2002) found that specific knowledge being shared relating to environmental management improves a firm's environmental innovation in three distinct national contexts – Canada, Japan, and China. Stanovcic et al. (2015) also found that knowledge management improved a firm's environmental innovation and business performance. This result shows that knowledge management is a vital source of

environmental innovation. Knowledge management improves the firm's environmental innovation, which in turn implicates a firm's business performance.

This study aims to examine the relationship between knowledge management and firm business performance in relation to the use of environmental innovation by a company. This study is based on the premise that environmental innovation gives the firm a competitive advantage that will in turn influence firm performance. To create an environmentally innovative business that is efficient and adequate, it needs a tool to manage the knowledge (knowledge management) (Stanovcic et al., 2015). This research proposes that indirectly, knowledge management has a relationship to firm performance, through environmental innovation. We use manufacturers listed as firms on Indonesia Stock Exchange (IDX) for the period 2013 to 2017.

This study results showed that knowledge management has a statistically significant and positive relationship to firm performance. This result indicates that firms have successfully positioned themselves in the market at a higher value generated by competitive advantage and will be appreciated and obtain loyalty from the market. Thus, it will improve firm performance. Further, the result shows that environmental innovation did not mediate the relationship of knowledge management to firm performance. This study contributes to the firm by providing information for the firm that will improve their environmental innovation strategies – participating in decreasing the negative impact of humankind on global warming. The result of this study also offers research for consideration by the government to compose laws in favour of maintaining ecosystem health in the natural environment.

The rest of this study is organised as follows: Section 2 contains the research hypothesis development; Section 3 explains the research variable, sample, and model; Section 4 discusses the empirical analysis and the hypothesis test and; Section 5 provides a research conclusion, including suggestions for future studies.

Literature Review

Institutional Setting in Indonesia

The Ministry of Environment has set the measuring instrument for firms to be more environmentally responsible. It is called the Program of Performance Assessment Rank (PROPER). The PROPER assessment is selective for the industries that cause an explicitly significant impact on the environment and for where there is substantial awareness of the firm's image or reputation. PROPER has been drawing on society and the market to put pressure on the manufacturing industry to improve its environmental performance (Nasih et al., 2019). Society and the market are empowered by the disclosure of credible information.

The manufacturing industry's attention to PROPER creates a decent firm image and reputation (Kemp et al., 2009).

PROPER rank is categorised by colour - gold, green, blue, red, and black. These categories show how sincere the firm has been in committing to maintaining the natural environment's condition. Gold rank is for the best- firm while the black rank is for the worst-acting firm. The firm that obtained a gold rank in environmental performance has implemented the eco-efficiency concept. Eco-efficiency is a concept that forms more products and services while only using fewer resources and, at the same time, generating less waste and pollution (Angelia & Suryaningsih, 2015).

As global warming issues are raised in discussion and maintaining the natural environment's condition as a campaign rises in intensity, society becomes more aware and selective and opts to select products and services that the firm produces (Marchi, 2012). As to whether the company is responsible for its environment is becoming a significant consideration and some firms in Indonesia are beginning to campaign and are framing themselves as 'go green' firms. They uphold their intentions for natural environment management beside their products or services quality (Sigalingging et al., 2019; Syahri et al., 2019). In framing themselves as an eco-friendly firm, they consistently educate the society through various channels such as mass media, and in turn secure official websites that package eco-friendly products (Stanovcic et al., 2015). This will result in increases in society's trust toward that firm, which impacts with a higher amount of sales. The implementation of environmentally-based innovation, also minimizes costs. Thus, this of economic and ecological benefit as a combination have a positive relationship to firm performance (Angelia & Suryaningsih, 2015).

Relationship between Knowledge Management to Firm Performance

According to a resource-based view, firstly introduced by Barney (1991), the firm's competitive advantage dependis on valuable, scarce, hard to imitate, and irreplaceable products. In general, resources are classified into two classifications, which are tangible assets and intangible assets. Knowledge management in this study is an *intangible asset* of the firm. Knowledge management itself is a process where knowledge is stored, managed, spread, and implemented, so in the future, it is utilised effectively and efficiently by the organisation (Laudon & Laudon, 2014).

Andreeva and Kianto (2012) explain that Human Resource Management (HRM) and Information and Communication Technology have a statistically significant relationship with financial performance and a firm's competitiveness. Kusuma and Devie (2013) also explain that knowledge management has a statistically significant and positive relationship with a

firm's competitive advantage, which, in the end, those competitive advantages will improve firm performance. Stanovcic et al. (2015) also argue that knowledge management can drive environmental-based innovation, which will improve firm performance.

Therefore, if an organisation in this contest is a firm that can effectively utilise knowledge management as its asset, then it will create a competitive advantage for a firm (Kemp et al., 2009). Harymawan (2019) states that a firm that has a particular competitive advantage will implicate the firm with performance improvement. A firm that has a higher value in the market as its competitive advantages will be more appreciated by the market (Pekovic, 2010). With appreciation given, it will raise loyalty from the market and apply it to the firm's goods or services. With the emergence of loyalty, the sale of the firm's goods or services will also increase. The increasing sales of the firm's goods or services increase the profit of the company that will further affect the company's financial performance. Thus, the hypothesis proposed is:

H1: Knowledge management has positive relationship to firm performance

Relationship between Knowledge Management to Environmental Based Innovation

One of the utilisations of knowledge management by the firm is the creation of innovation, primarily environmental-based innovation. Environmental-based innovation is an innovation process that contains systems, practices, and new or modified products with an aim to decreases the firm's environmental damage (Horbach, 2013). Environmental-based innovation emerges as there are pressures from society that have begun to show awareness of environmental health and know global warming to be a significant issue. These pressures will make the firm strive to its fullest possible potential to meet the social demand, so legitimacy is maintained (Bruton et al., 2010).

Stanovcic et al. (2015) examine the relationship of knowledge management to environmental-based innovation. The research result shows that knowledge management drives environmental-based innovation. Arfi et al. (2017)'s research produced an empirical result that shows that not all types of external knowledge outputs amount to green innovation. They are not all the same. The success of green innovation is introducing a more substantial capacity for an organisation's absorption of external knowledge in order to transform its internal capability.

Knowledge management is one of a firm's management tools used to maintain their existence. A fully utilised knowledge management by the firm will trigger fresh innovations that hope to become the solution to maintain their existence. Utilising knowledge management as a trigger base for environmental-based innovation, hopefully, in the future,

the firm will achieve efficiency in its operational activities and obtain appreciation from the market. In the end this will hopefully influence the firm's existence. Based on this explanation, we hypothesised that:

H2: Knowledge management has a positive relationship to environmental-based innovation

Relationship between Environmental-based Innovation to Firm Performance

The institutional theory states that an institute is driven based on external factors compared to internal factors (Zahra, 2013). Thus, a firm will strive to meet those demands to exist and maintain their legitimacy in the market. If the firm correctly implements environmental-based innovation, society will trust this will be increased (Angelia & Suryaningsih, 2015; Septiriana, 2016). As society's trusts it is increased, the sales volume will also be increased. It will also indirectly make the firm's business process more efficient as it implements innovation that decreases environmental damage.

Eiadat et al. (2008) documented a positive and statistically significant environmental-based innovation implementation in relation to firm performance. Ar (2012) also stated that green product innovation has had a positive and statistically significant relationship to firm performance and firm competitiveness. Thus, we hypothesised that:

H3: Environmental-based innovation has a positive relationship to firm performance

Relationship between Knowledge Management to Firm Performance as Environmental-based Innovation as Mediation Variable

Prior studies document knowledge management has a positive and statistically significant relationship to firm performance. Besides, there is a positive relationship between environmental-based innovation to firm performance (Amores-Salvadó et al., 2014; Inkinen, 2016). Thus, it can be concluded based on the previous explanation that there is a positive relationship between knowledge management and firm performance through environmental-based innovation. Studies by both Andreeva and Kianto (2012) and Kusuma and Devie (2013) state that knowledge management has a positive relationship to firm performance. A firm that correctly implements its knowledge management will improve its competitive advantages. As the firm's competitive advantages were firm, it will automatically implicate higher firm performance. Eiadat et al. (2008) and Ar (2012) also argue that environmental-based innovation has a positive relationship with firm performance. A firm that successfully implements the environmental-based innovation will obtain loyalty and appreciation form the market, which in the end, will boost the firm performance.

Environmental-based innovation creation occurs by using tools called knowledge management. A firm that properly utilises knowledge management will likely create an innovation that ceases environmental damage. Thus, knowledge management has an indirect relationship to firm performance through environmental-based innovation. Thus, our hypothesis is:

H4: Environmental-based innovation mediates the relationship between knowledge management and firm performance

Research Methodology

Sample and Data Source

The sample used in this study is the manufacturing firms listed on the Indonesian Stock Exchange (IDX) for the period 2013 to 2017. The research data sources are annual reports and sustainability reports obtained from the IDX website and secure official website. This study examines the manufacture firms as one of the most significant contributors to waste, both hazardous waste and waste from the firm's package product bought by the consumer. The waste materials can be in the form of a carton of paper, which is easy to decompose to the use of plastic as its material, which it is hard to decompose. The total population of the manufacturing firms is 713 firm-year observations. Table 1 provides the sample selection criteria based on a non-probability sampling method. Based on the sample selection criteria, the final sample is 145 observations.

Table 1: Sample Selection Criteria

No	Criteria	Year				
		2013	**2014**	**2015**	**2016**	**2017**
1	Manufacture listed firm in Indonesia Stock Exchange (IDX) for period 2013-2017	135	141	143	144	150
2	Delisted manufacture firm	(2)	(0)	(2)	(0)	(2)
3	Missing data	(105)	(115)	(112)	(111)	(116)
Total Observation		**25**	**26**	**29**	**33**	**32**

Variable Operationalisation

The dependent variable in this study is the firm performance measured using the return on assets (ROA) by divide the firm's net profit by an average total asset of the firm. Next, knowledge management is independent. Darroch et al. (2002) explain that knowledge management is a management function that creates the knowledge, manages the knowledge flow within the organisation, and ensures the knowledge utilisation is effective and efficient

for the organisation's long term benefits. This research measures knowledge management using proxy based on Stanovciv et al.'s study (2015), which is KM_General, KM_Policy, and KM_Culture, where the dummy variable presents these three proxies.

KM_General indicates that within observation years, the firm introduces a knowledge management system, or implements a major change in their knowledge management system. KM_General is measured by a dummy variable, which is valued 1 if a firm implements a new system or improves the knowledge management system and 0 if they not. The KM_Policy indicates that within observation years, the firms have written regulations related to knowledge management. This variable has value 1 if the firm has written regulation related to knowledge management and 0 if they not. KM_Culture explains that within observation years, the firms have a culture that drives management knowledge shares and distributions. KM_Culture has value 1 if the firm has a culture that drives management knowledge distributions or 0 if they do not.

After classifying the observation based on classification standards that have been explained before, the KM_General, KM_Culture, and KM_Policy have been standardised to obtain the value of knowledge management (KM), by deflating the total value from KM_General, KM_Culture, and KM_Policy by three.

The mediation variable in this study is environmental-based innovation. Kemp et al. (2009) explain that environmental-based innovation is an innovation that diminishes the environmental damage from firm business activities. In this study, the environmental-based innovation measured by energy efficiency is using the formula as follows:

$$\text{EEU} \ = \ \frac{\text{Current Year Energy Cost} - \text{Previous Year Energy Cost}}{\text{Asset Turnover}}$$

Methodology

The research uses path analysis by sequential linear regression to predict the relationship between knowledge management and environmental-based innovation to firm performance, with the software SPSS 20. Path analysis is a regression analysis to examine the causality relationship between variables that are included in the research model based on the theory used from Ghozali (2016). The first sequence of path analysis is calculating the research variables on each sample. Then, formulating the appropriate regression equation used by path analysis is as follows:

$\text{ROA} \ = \alpha + B_1 \text{KM} + \varepsilon$
(1)

EEU $= \alpha + B_1 KM + \varepsilon$
(2)
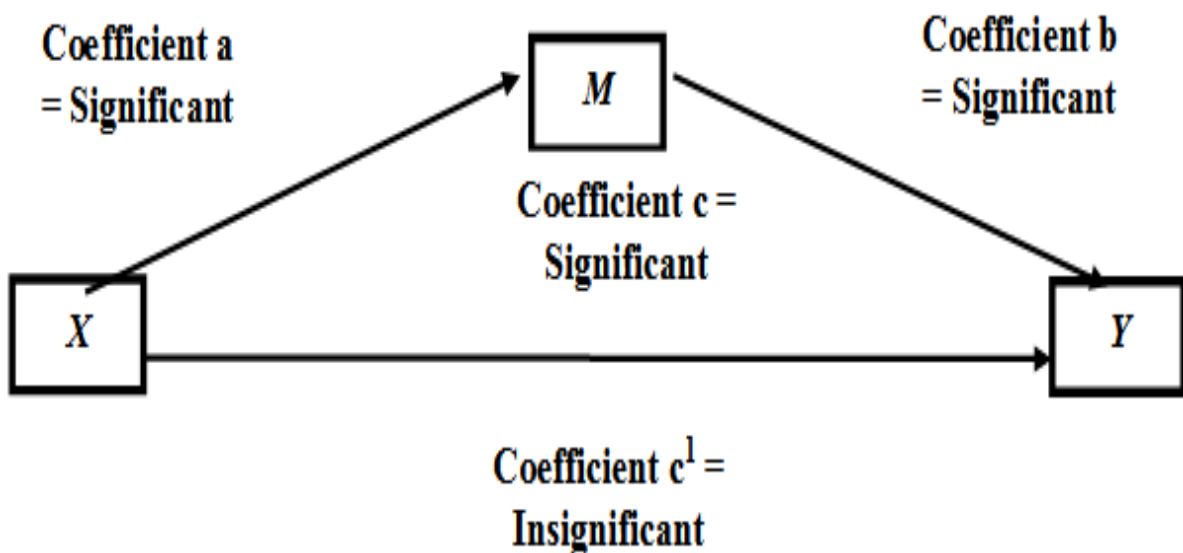ROA $= \alpha + B_1 EEU + \varepsilon$
(3)
ROA $= \alpha + B_1 KM + B_1 EEU + \varepsilon$
(4)

To examine the indirect relationship, we used a Sobel test, where there are some criteria that must be fulfilled (Baron & Kenny, 1986). Figure 1 shows requirements that must be fulfilled by a Sobel test.

Figure 1. Sobel Test Requirements

Result and Discussion

Descriptive Statistics

Table 2 provides the descriptive statistical analysis result. Based on the result, the ROA average is 0.0451083, and the standard deviation value is 0.06279229. The average knowledge management variable is 0.6436782, and its standard deviation is 0.15543235. The efficiency of energy usage variable (EEU), as a proxy of environmental-based innovation has the average value 0.0003974 with a standard deviation of 0.00165108.

Table 2: Statistic Descriptive Analysis

	Minimum	Maximum	Mean	Std. Deviation
ROA	-0.14000	0.31000	0.0451083	0.06279229
KM	0.00000	1.00000	0.6436804	0.15543358
EEU	-0.00476	0.00547	0.0003974	0.00165108

Main Analysis

To examine the direct relationship between an independent variable to the mediation variable, and the mediation variable to the dependent variable, and the indirect relationship between the independent variable to the dependent variable through the mediation variable, we used path analysis. This study used clausal step and product of coefficient steps.

Table 3: Linear Regression Analysis Result

| Equation		Unstandarized Coefficients		*t*	Sig.
		B	**Std. Error**		
1	**X → Y**	0.126	0.032	3.921	0.000*
2	**X → M**	-0.002	0.001	-1.936	0.055
3	**M → Y**	-3.051	3.170	-0.962	0.337*
4	**Total Model**	0.124 (X)	0.033	3.798	0.000
		-1.188 (M)	-1.188	-0.387	0.699

Note * for level significance 5%

Table 3 provides that in equation 1, the knowledge management (X) coefficient is 0.126 and has a positive value and significance level between 0.000 and 0.05. It can be concluded that knowledge management has a positive and significant relationship to firm performance (Y), then H1 is not rejected. Besides, it also is known that if knowledge management increases, then it will increase ROA significantly. In equation 2, it can be seen that the coefficient value of knowledge management (X) is -0.002 with significance level 0.055, which is more than α = 0.05. It can be concluded that knowledge management has no statistically significant relationship to environmental-based innovation (M). Based on this result, the second hypothesis is rejected. The environmental-based innovation (M) coefficient that is proxied by EEU is -3.051 with a significance level 0.337, which is more than α = 0.05. Thus, it can be concluded that environmental-based innovation has a statistically significant relationship to firm performance (Y). Based on this result, the third hypothesis is rejected.

To examine how environmental-based innovation mediates the relationship between knowledge management and firm performance, then needs to examine if there is a direct and

indirect relationship between its variables, according to Sobel test requirement based on Baron and Kenny (1986). The path diagram in Figure 2 explains the causality relationship between variables. Figure 2 shows that the relationship between knowledge management to environmental-based innovation (coefficient a) is not a statistically significant relationship with coefficient value -0.002 and standard error (Sa) 0.001. The relationship between environmental-based innovation to firm performance (coefficient b) is not statistically significant, with coefficient value -3.051 and standard error (Sb) 3.170. Lastly, the direct relationship between knowledge management to firm performance (coefficient c1), was significant and positive.

Figure 2. Path Diagram
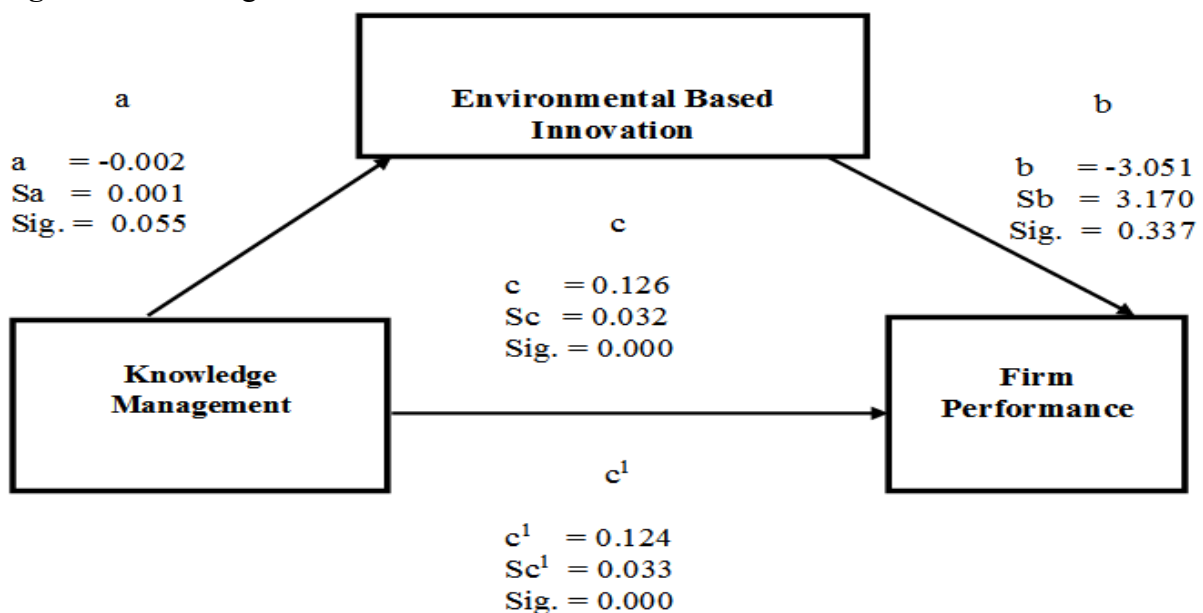
Sobel Test

Table 4: Sobel Calculator Result Analysis

Input		Test Statistic	Std. error	P-value
a	-0.002			
b	-3.051	0.86726371	0.00703592	0.38579754
Sa	0.001			
Sb	0.337			

To examine the indirect relationship between knowledge management and firm performance, based on path analysis model, Table 4 provides the Sobel test result using Sobel calculator. Based on the test result in Table 4, it is shown that the p-value is 0.385, which its more than the required significant level of 0.05. This result implies that the environmental-based innovation has not statistically significant, mediating the relationship between knowledge

management to firm performance with a t value that is positive. From this explanation, it can be interpreted that environmental-based innovation is not mediating the relationship between knowledge management and firm performance; thus, the fourth hypothesis is rejected.

Coefficient Determinant Test

Table 5: Coefficient Determinant Test Result

Model	R	R-*Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.312[a]	0.097	0.091	0.05987454
2	0.160[a]	0.026	0.019	0.00163555
3	0.080[a]	0.006	-0.001	0.06280835
4	0.313[a]	0.098	0.085	0.06005337

Coefficient determinant (adjusted R2) is used to measure the model's ability to explain the dependent variable variation, which then will decide how the independent variable correlates to the value changes of the dependent variable. Table 5 provides the result of the coefficient determinant of the regression model. The results show that the adjusted R square value is 0.091 for the first model, which means that knowledge management explains the dependent variable, which ROA for 9.1%. In contrast, 90.9% is explained by other variables that are not included in this research regression model. Adjusted R square value from the second model is 0.019 and indicates that knowledge management explains environmental-based innovation for 1.9%. In contrast, the rest (98.1%) is explained by other variables that are excluded in this research regression model. For the third model, the adjusted R square is -0.001, which means that the EEU variable does not explain the firm performance variable at all. As for the last model, the fourth mode, the adjusted R squared, is 0.085, which means the KM and EEU explain ROA for 8.5%, while other variables explain 91.5 %.

Research Result Discussion

Based on the research result, it is known that knowledge management has a positive relationship with firm performance. Therefore, if knowledge management increases, then it will likely improve firm performance. Based on institutional theory, the firm will maintain the legitimacy and their position by following and complying with the organisation's environmental norm such as public opinion and local regulation (Meyer & Rowan, 1991). Knowledge management itself as a management function is useful to create knowledge, manage knowledge flow within the firm, and ensure that knowledge utilisation is effective and efficient for the substantial long-term benefits (Darroch et al., 2002). The market will appreciate a firm that successfully positions itself as having a value from its competitive advantages. This appreciation from the market will generate market loyalty in whatever the product or service that the firm offers. Higher loyalty will improve the sales and profit, which

in the end results in higher firm performance (Andreeva & Kianto, 2012; Barney, 1991; Inkinen, 2016).

The research result also has shown that knowledge management has no relationship to environmental-based innovation. This result indicates that if the firm improves its knowledge management, then the firm will not generate environmental-based innovation and so a firm will tend to generate another type of innovation. This research result is similar to the findings of Arfi et al. (2017) which documented that not all types of external knowledge produce the same output in the form of green innovation. Besides that, Baron and Kenny (1986) also explain that knowledge management is not able to drive environmental-based innovation.

Furthermore, the research result shows that environmental-based innovation has no relationship to firm performance. It means every increase in environmental-based innovation does not correlate with firm performance. The research result is driven by a greater presence of a population that increases the energy cost; thus, resulting in the diminishing of firm performance. As the firm profit decreases it increases energy usage (Angelia & Suryaningsih, 2015). Therefore, as it has already been explained before, the environmental-based innovation is a firm response toward global warming issues that is currently being raised by society. Amores-Salvadó et al. (2014) also argued that green innovation products do not have a relationship to firm performance.

Lastly, this research shows that environmental-based innovation does not mediate the relationship between knowledge management to firm performance. This result shows that the firm implements environmental-based innovation to fulfill the market demands, to keep maintaining its legitimacy. In other words, the implementation is not maximized. According to institutional theory, a firm trying to fulfill market demands in order to keep viable, maintains its existence and legitimacy. Thus, if a firm has sufficient resources to conduct innovation, then environmental-based innovation may not be one of their alternatives selected as the environmental-based innovation does not have a positive relationship to firm performance. In this context, the firm is only framing itself to show that the firm is aware of the environmental issue, and will "go green" to obtain sympathy and appreciation from the market. This action was completed having been compelled by-laws and market pressure via an environmentally caring community that are starting to criticise environmental violation that is conducted by firms.

Conclusion

This study aims to examine knowledge management and its relationship to firm performance through environmental-based innovation. The research sample is manufacturing firms listed on the Indonesian Stock Exchange (IDX) for the period 2013 to 2017. The research result

shows that knowledge management has a positive relationship with firm performance. This result implies that a firm successfully positioned in the market as having value-added from competitive advantages will obtain appreciation and loyalty from the market; thus, it will increase in firm performance. Furthermore, environmental-based innovation is not mediating the relationship between knowledge management and firm performance.

This practical study contributes to a firm by providing considerations for firms to continuously improve their environmental-based innovation and participate in diminishing their effect on global warming. This study also adds to the academic literature in relation to environmental-based innovation, where it makes a firm's operations more efficient. Environmental-based innovation can also improve a firm's image in the social context. The results of this research provide a consideration for the government to look to when devising laws that regulate the natural environment.

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