

Research and Development (R&D), Environmental Investments, to Eco-Efficiency, and Firm Value

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Abstract: *This study aims to determine the relationship between research and development (R&D) investment and environmental investment to eco-efficiency and firm value in manufacturing, plantation and mining companies listed on the Indonesia Stock Exchange (IDX) in 2013-2017. The results of this study show research and development (R&D) investment has a positive and significant correlation to eco-efficiency and firm value it shows that research and development (R&D) investment is significant to improve eco-efficiency and firm value. In contrast, environmental investment does not correlate with eco-efficiency and firm value. Also, this study shows that there is no relation between eco-efficiency and firm value. Based on this result, it is known that investment in the environment has not been a concern for entrepreneurs and investors. Therefore strict regulations for business people are needed to preserve the environment. Meanwhile, accounting standards are needed following Indonesia's conditions, which require companies to disclose financial statements related to the environment transparently.*

Keywords: *Research and development (R&D) investment; environmental investment; eco-efficiency; ISO 14001; firm value.*

Abstrak- *Penelitian ini bertujuan untuk mengetahui hubungan investasi research and development (R&D) dan investasi lingkungan terhadap eco-efficiency dan nilai perusahaan pada perusahaan manufaktur, perkebunan, dan pertambangan yang terdaftar di Bursa Efek Indonesia (BEI) pada tahun 2013-2017. Hasil dari penelitian ini adalah investasi research and development (R&D) memiliki hubungan yang positif dan signifikan terhadap eco-efficiency dan nilai perusahaan hal ini menunjukkan bahwa investasi research and development (R&D) merupakan hal yang sangat penting untuk meningkatkan eco-efficiency dan nilai perusahaan, sedangkan investasi lingkungan tidak berhubungan dengan eco-efficiency dan nilai perusahaan. Selain itu, hasil penelitian juga menunjukkan bahwa tidak ada hubungan antara eco-efficiency dengan nilai perusahaan. Berdasarkan hasil penelitian, diketahui bahwa investasi dibidang lingkungan belum menjadi perhatian bagi para pengusaha dan investor, sehingga diperlukan peraturan terkait pelestarian lingkungan yang mengikat bagi para pelaku usaha. Selain itu, dibutuhkan standar akuntansi yang sesuai dengan kondisi di*

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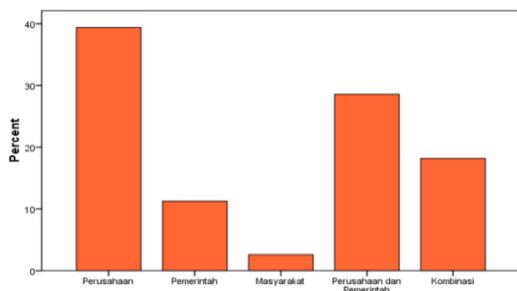
Indonesia untuk pengungkapan laporan keuangan yang berkaitan dengan lingkungan secara transparan.

Kata kunci: investasi research and development (R&D); investasi lingkungan; eco-efficiency; ISO 14001; nilai perusahaan.

1. Introduction

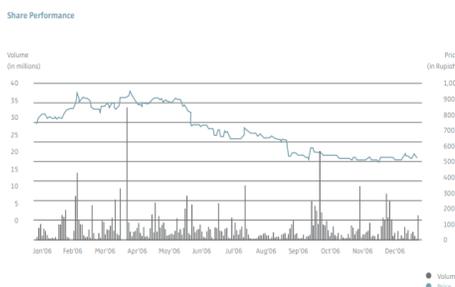
Environmental pollution is an issue that is currently being a public concern. The environmental activist organization, Wahana Lingkungan Hidup Indonesia (WALHI) in 2012, stated that the highest environmental damage actors were companies, especially the mining and plantation sectors. Second is the government. Third, a combination of companies and government, and the last position in society.

Figure 1
Actors of Destruction of the Environment
Persada



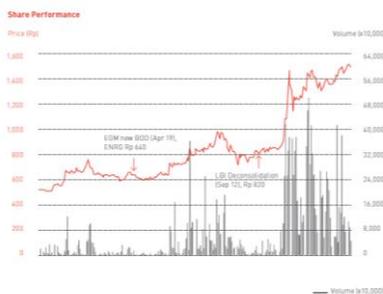
Source: WALHI,2012

Figure 2
Share Performance PT. Energi Mega



Source: Annual report PT. Energi Mega Persada 2006

Figure 3
Share Performance PT. Energi Mega Persada



Source: Annual report PT. Energi Mega Persada 2007

The Issues regarding of environment become one of the most popular issues in accounting because the information disclosed by the company will affect the reputation and sustainability of its business in the future (Ziegler *et al.*, 2011; Griffin and Sun 2012). The phenomenon of the spurt of hot mud at the drilling site Lapindo Brantas Inc. on May 29, 2006, showed that their stock price was a decline after the phenomenon (see figure 2), that evidenced showed that the stock price of PT. Energi Mega Persada, as a company whose most substantial shareholding in Lapindo Brantas, is affected because of its business activities that disrupt the sustainability of the environment. However, in 2007, their stock price was rise although their problem not yet clear (see figure 3). The evidence showed that the business activities that disrupt the sustainability of the environment were not the only key for the investor to made investment decisions.

Issues regarding the environment have attracted many researchers to examine the relationship between environmental performance and firm value. Utomo *et al.* (2017) found that there was a positive influence between environmental performance and firm values measured using Tobins'Q. Anggraeni (2015) found that disclosure of greenhouse gas (GHG) emissions and environmental performance had a positive effect on firm value. There was much research related to environmental performance, and company value attracts the interest of researchers to find out what factors can affect environmental performance and firm value. Some studies have found that innovation in the form of R&D and investment in environmental conservation efforts are factors that can affect environmental performance and firm value. The company's ability to develop and exploit its innovative capabilities is widely recognized as a determinant of the company's value and the company's competitive advantage (Bettis and Hitt, 1995; Helfat and Peteraf, 2003; Voss, 1994). Carvalho *et al.* (2018) found the results of the observation that the concept of innovation and environmental conservation is very dependent and very important for sustainability. Their awareness also motivates the increasing concern of the company towards environmental problems that these natural resources are limited. Therefore, it is essential to carry out more effective and efficient

management of natural resources in the company's business processes (eco-efficiency) in order to maintain their sustainable business life cycle (Anggaraeni, 2015).

The research conducted by Liang et al. (2015) about the effect of technological innovation on eco-efficiency in large industries in China: a) In the Eastern region, independent technology innovation has a significant positive effect on improving eco-efficiency. Improving the ability of independent technology innovation and increasing independent research and development efforts are effective ways to improve the eco-efficiency of industrial enterprises in the Eastern region. b) In the Central region, although independent technology innovation is not significant. c) In the Western region, independent technology innovation has a negative but insignificant effect, possibly due to a lack of funding for independent technology innovation in this region.

With the motivation of increasing discussion regarding the company's investment in environmental conservation and operational efficiency (eco-efficiency), Kuo et al. (2010) conducted a study to provide further empirical evidence through the Japanese case related to relations in environmental conservation with operational efficiency. Based on the analysis of Kuo et al. (2010), there is a positive and significant correlation between the cost of conserving the company's environment, net income, and economic benefits from environmental preservation. It shows that the implementation of the company's long-term environmental conservation has a positive effect on corporate profits in the Japanese case between 2001 and 2006. The relationship between the cost of conserving the company's environment and CO2 emission reduction is positively correlated but not significant, which means that spending on environmental preservation of the company has an impact on reducing CO2 emissions, but that effort is still not enough. Also, the results of the study of Kuo et al. (2010) also shows a positive correlation between the cost of environmental conservation and total CO2 emissions.

Research conducted by Hyo (2017) states that environmental preservation costs negatively affect the three measures of eco-efficiency (environmental intensity, carbon productivity, and return on carbon). Based on the explanation above, this research was conducted to confirm the results of previous studies related to the relationship between

research and development (R&D) investment and environmental investment to firm value and eco-efficiency. This research is also expected to provide practical benefits to the industrial world in terms of increasing the value of the company through eco-efficiency, which is influenced by investment and development (R&D) and environmental investment.

2. Theoretical Framework and Hypothesis Development

2.1. Eco-efficiency

Eco-efficiency according to the environment dictionary and the Ministry of Environment of the Republic of Indonesia is defined as an efficiency concept that includes aspects of natural resources and energy or a production process that minimizes the use of raw materials, water, energy and the environmental impact per unit of product. According to Hansen and Mowen (2007), eco-efficiency means that organizations can produce goods and services that are more profitable while at the same time reducing environmental impacts, resource consumption, and costs. Eco-efficiency can be measured in several ways. The World Business Council For Sustainable Development (2000) measures eco-efficiency by dividing the value of goods or services on environmental impacts. Sinkin et al. (2008) provide alternative measures of eco-efficiency. Sinkin et al. (2008) use ISO 14001 to assess whether companies implement eco-efficiency. In this study, the measurement of eco-efficiency using ISO 14001 certificates, which refers to the research of Marshall and Brown (2003), Al Najjar and Anfimiadou (2011), and Panggau dan Septiani (2017).

2.2. Firm Value

Noerirawan (2012) explains firm value is the value of the company is a condition that has been achieved by a company as an illustration of public trust in the company after going through a process of activities for several years, ie, since the company was founded until now. Firm value can be measured in several ways. In this study, the measurement of firm value using Tobin's Q, which refers to the research of Bharadwaj et al. (1999), Al-Saidi and Al-Shammari (2015), and Utomo et al. (2017).

2.3 Relationship between Research and Development Investment with Eco-efficiency

Innovation is crucial for companies because innovation includes activities to create new products or processes. Increasing R&D activity is the key to innovation (Ehie and Olibe, 2010). R&D investment is often used as an index that can measure the level of innovation of a company (Lee and Min, 2015). Innovation has become a relevant subject for the concept of sustainability because it is defined based on optimizing the use of natural resources, which are translated into systems that result in low environmental damage; saving on natural resource consumption; and reduction of waste and detailed environmental protection rules (Sachs, 1993) in Carvalho *et al.* (2018).

Carvalho *et al.* (2018) found the results of the observation that the concept of innovation and environmental conservation is very dependent and very important for business sustainability. Lee and Min (2015) obtained observations that R&D investment can reduce carbon emissions and increase firm value. Based on the description above, the hypothesis that can be used is:

H₁. *R&D investment is related to eco-efficiency.*

2.4. Relationship between Environmental Investment and Eco-efficiency

According to the Indonesian Ministry of Industry, the green investment must-have aspects:

1. Use of environmentally friendly input materials;
2. Low input material intensity;
3. Application of the concepts of reducing, reuse, recycle, and recovery;
4. Low energy intensity;
5. Human resources who have a level of competence in their field and have insight into the environment, especially resource efficiency;
6. The volume of water used is lower and meets environmental quality standards;
7. Low carbon technology;
8. Use of alternative energy;

Based on the description above, it can be concluded that with the presence of environmental investment, it will encourage the creation of eco-efficiency. In Environmental Management Accounting (EMA), each production process has the potential to produce two types of output, namely product output (PO) and non-product output (NPO). Waste & emission classified as NPO, which are minimized as much as possible because waste is part of production output that has absorbed various types of costs (directly or indirectly) in a production process. One way to reduce NPO or waste is to invest in the environment (Tambunan, 2007). The research conducted by Liang et al. (2018) found that eco-efficiency in eastern China is superior to in western regions. With economic development and environmental investment, eco-efficiency in the region is superior.

The relationship between the costs of corporate environmental conservation and CO₂ emission reductions is also explained by Kuo et al. (2010). According to Kuo *et al.* (2010), the cost of conservation of the company's environment and CO₂ emission reduction are positively correlated but not significant, which means that spending on environmental preservation of the company has an impact on reducing CO₂ emissions, but that effort is still not enough. Based on the description above, the hypothesis that can be used is:

H₂. *Environmental investment relates to eco-efficiency.*

2.5. *Relationship between Research and Development Investment and Firm Value*

Han (2001) in Huang and Liao (2005) states that when facing a highly competitive economic environment, companies must have the ability to innovate, quality, and speed to produce competitive abilities. Therefore, devoting resources to accumulating innovation investments has a positive impact on company performance. In the 21st century, the speed and quality of innovation are used to maintain growth and to produce competitive advantage, and knowledge resources are needed to produce innovations for better performance.

According to the theory of company growth, higher investment in innovation and R&D activities leads to the acquisition of competitive advantage, and superior business.

The innovation efforts made by the company can be seen from the company's commitment to funding/investment in the field of research and development. Furthermore, Artz *et al.* (2010) stated that R&D had a positive effect on products that were announced and patented. Announced products have a positive relationship with firm value. Belderbos *et al.* (2004) state that R&D is very influential in the growth of company productivity. Ghazi and Rim support this (2014) stated that R&D investment is very important in creating firm value. Based on the description above, the hypothesis that can be used is:

H₃. *R&D investment is related to firm value.*

2.6. Relationship between Environmental Investment and Firm Value

The company's activities in producing goods and services can have consequences on the environment, such as environmental pollution. Environmental pollution caused by company operations can cause harm to the community, the environment, and also the sustainability of the business of the company itself. Based on legitimacy theory, companies will get recognition from the public if the company has a good image for the surrounding community. The environmental investment will encourage companies to become green industries.

Along with the increasing debate over the company's investment in environmental conservation and operational efficiency, Kuo *et al.* (2010) conducted a study to provide further empirical evidence through the Japanese case related to relations in environmental conservation with operational efficiency. Based on the analysis of Kuo *et al.* (2010), there is a positive and significant correlation between the cost of conserving the company's environment, net income and economic benefits from environmental preservation, which reveals that the implementation of the company's long-term environmental conservation has had a positive effect on corporate profits in the Japanese case between 2001 and 2006. Nakamura (2011) also found a relationship between environmental investment and company performance and showed a significant influence on the relationship. Furthermore, the research conducted by Paramita and Chariri (2013) found that there was a positive and significant influence between

environmental investment and company performance that was proxied by ROA. Based on the description above, the hypothesis that can be used is:

H₄. *Environmental investment is related to firm value.*

2.7. Relationship between Eco-Efficiency and Firm Value

In legitimizing company activities in the eyes of the public, companies tend to use environment-based performance and disclosure of environment-based information. That is because the company wants to show that while running its business activities, the company has tried to preserve the environment and not harm the surrounding community. The company always strives to adhere to the norms in the community and anticipates the occurrence of the legitimacy gap so that the company will survive (Panggau and Septiani, 2017). Companies that have good environmental performance are good news for investors and potential investors. Companies that have a high level of environmental performance will be responded positively by investors (Titisari dan Alviana, 2012). At present, the company is required not only to pay attention to the interests of management and capital owners, but also employees, consumers, and the public. The company has a social responsibility towards parties outside of management and capital owners, including maintaining the environment.

Utomo *et al.* (2017) also found that there was a positive influence between environmental performance and company value measured using Tobins'Q. Anggraeni (2015) found that disclosure of greenhouse gas (GHG) emissions and environmental performance have a positive effect on firm value. Panggau and Septiani (2017) mention that eco-efficiency has a positive and significant influence on firm value. Jacobs *et al.* (2010) disclose that environmental awards and certifications (EAC) that provide information about the recognition given by third parties, especially for environmental performance such as ISO 14001, associate positive and significant market reactions. This means that companies that adopt the concept of eco-efficiency have higher corporate value and can generate profits in the future than companies that do not adopt the concept of eco-efficiency. Based on the description above, the hypothesis that can be used is:

H₅. *Eco-efficiency is related to firm value.*

3. Research Method

3.1. Research samples

The population in this study were companies listed on the Indonesia Stock Exchange (IDX) during the study period, namely 2013-2017. The samples used in this study were manufacturing, mining, and plantation companies listed on the Indonesia Stock Exchange during 2013-2017. For companies that report financial statements with USD in the study sample using the assumption that the rate of 1 USD = 14,000 IDR.

Table 1.
Number of Samples

Keterangan	2013	2014	2015	2016	2017
Companies whose share are listed on the Stock Exchange	483	506	525	560	555
Manufacturing companies disclosed environmental investments.	49	49	49	49	49
Plantation companies disclosed environmental investments.	7	7	7	7	7
Mining companies disclosed environmental investments.	12	12	12	12	12
Amount of the sample	340				

3.2. Variables

The variables in this study are firm value, eco-efficiency, R&D investment, and environmental investment. The measurement of firm value variables in this study uses Tobin's Q, which refers to the study of Bharadwaj *et al.* (1999), Al-Saidi, and Al-Shammari (2015), and Utomo *et al.* (2017). The formula for measuring the value of Tobin's Q, according to Al-Saidi and Al-Shammari (2015) as below.

$$\text{(Market value of shares + Total debt) / Book value of total assets of the firm}$$

The eco-efficiency variable is measured using the ISO 14001 certificate, and this assessment is used because the purpose of eco-efficiency is related to the objectives of

ISO 14001. This measurement is the same as that used by Marshall and Brown (2003), Al Najjar and Anfimiadou (2011), and Panggau and Septiani (2017).

Table 2.

The definition of variables

Variable	Symbol	Variable Measurement
R&D investment	R&D	R&D expenditure / Total sales
Environmental investment	Environmental	The amount of funds issued by the company to support environmental conservation program
Firm Value	<i>Tobin's q</i>	Total aset
<i>Eco-efficiency</i>	ECO	ISO 14001

The R&D investment variable is measured using the value of the R & D intensity, as was done in the studies of Amin and Aslam (2017), Ghazi and Rim (2014), and Lee (2015). Where the value of the R&D intensity is obtained by dividing the number of funds issued by the company for R&D activities with the total amount of the extension. The environmental investment variable is measured by using the number of funds issued by the company to support environmental conservation programs, as done in the study of Nakamura (2011). Based on the explanation above, the definition of variables used in this study as Table 2.

4. Results and Discussion

The results of this study indicated that the R&D investment and environmental investment has a positive and significant relationship to the eco-efficiency that is peroxided with ownership of the ISO 14001 certificate. Furthermore, this study indicated that R&D investment has a positive and significant relationship to the firm value, which is peroxided by Tobin's Q. In contrast, environmental investment and Eco-efficiency have a negative relationship with the firm value, which is peroxided by Tobin's Q.

Table 3.
Descriptive Statistics of Variables Studied

	N	Minimum	Maximum	Mean	Std. Deviation
R&D	340	.00	.10	.0080	.01381
Environmental	340	.00	.09	.0065	.01143
ECO	340	.00	1.00	.6000	.49062
Tobins'Q	340	.50	23.29	2.0231	2.85758
Valid N (listwise)	340				

Based on the results of the Spearman (Rank-Spearman) rank correlation test in table 4, it can be explained that R&D investment has a positive and significant relationship to the eco-efficiency that is proxied with ownership of the ISO 14001 certificate. This means that the increase in R&D investment is effective enough to improve the eco-efficiency that is proxied with the ownership of ISO 14001 certificates. While environmental investment has a positive relationship with eco-efficiency, but the strength of the relationship is very weak. This shows that an increase in environmental investment is still not effective enough to improve the eco-efficiency that is proxied with ownership of the ISO 14001 certificate. The results of this study are consistent with previous studies showing that R&D investment has a positive and significant relationship to the eco-efficiency (Carvalho *et al.*, 2018; Lee and Min, 2015).

Table 4.
Relationship between Research and Development (R&D) Investment and Environmental Investment to Eco-Efficiency

		ECO	RnD	Environmental
	Correlation Coefficient	1.000	.303**	.004
ECO	Sig. (2-tailed)	.	.000	.944
	N	340	340	340

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Processed data SPSS 20, 2019

Based on the results of the Spearman (Rank-Spearman) rank correlation test in table 5, it can be explained that R&D investment has a positive and significant relationship to the firm value which is proxied by Tobin’s Q. Further, environmental investment has a negative relationship with the strength of a very weak and insignificant relationship to firm value which is proxied by Tobin’s Q. Eco-efficiency proxied with ISO 14001 certificate ownership has a negative relationship with the strength of a very weak and insignificant relationship to the firm value which is proxy with Tobin’s Q. The results of this study are consistent with previous studies showing that R&D investment has a positive and significant relationship to the firm value of the company (Belderbos *et al.*, 2004; Ghazi and Rim, 2014).

Table 5.
Relationship between Research and Development (R&D), Environmental Investment, and Eco-Efficiency to Firm Value

		<i>Tobin's q</i>	ECO	RnD	Envi
	Correlation Coefficient	1.000	-.003	.123*	-.020
<i>Tobin's q</i>	Sig. (2-tailed)	.	.962	.024	.716
	N	340	340	340	340

*. Correlation is significant at the 0.05 level (2-tailed).
 **. Correlation is significant at the 0.01 level (2-tailed).

5. Conclusion, Implication, and Limitation

5.1. Conclusion

Based on the results of the study, it can be concluded as follows: (1) R&D investment has a positive and significant relationship to eco-efficiency, (2) Environmental investment has a positive relationship with the strength of a very weak and insignificant relationship to eco-efficiency, or in other words, environmental investment is not related to eco-efficiency, (3) R&D investment has a positive and significant relationship to firm value in the following year, (4) Environmental investment has a negative relationship with the strength of a very weak and insignificant relationship to the value of the firm in the following year, or in other words, environmental investment is not related to the value of the firm in the following year, (5) Eco-efficiency has a negative relationship with the strength of a very weak and insignificant relationship to the value of the firm

in the following year, or in other words, eco-efficiency is not related to the value of the firm in the following year, and (6) Based on the results of the research, it is known that research and development (R&D) investments are crucial things to improve eco-efficiency and firm value.

5.2. Implication and Limitation

This study also has several limitations in the research process, among others, as follows: (a) This study only covers five years so that many companies do not disclose the variables desired by researchers or companies that have just registered on the Indonesia Stock Exchange, (b) This study only uses the ownership of the ISO 14001 environmental management certificate as a proxy for the eco-efficiency variable, (c) This study uses several variables that have a low relationship. That is, there are still many other factors outside the variables in this study, (d) This study only uses samples of manufacturing, plantation, and mining companies listed on the Indonesia Stock Exchange, (e) The data in this study are abnormally distributed, (f) This research was conducted before the enactment of the Financial Services Authority Regulation (POJK) number 51 / POJK.03 / 2017 concerning the Implementation of Sustainable Finance for Financial Service Institutions, Issuers, and Public Companies, so that companies that disclose the investment in environmental conservation are still few, and (g) This research is limited to testing relationships between variables.

5.3. Suggestions

In future research, several things need to be considered, including, for example: (a) The next researcher should increase the scope of the longer research period so that the sample remains sufficient with the variable data value not 0 (zero) and provide better and more significant research results, (b) Further, researchers should add research variables in order to produce high relationships between variables, such as foreign ownership, company size, EPS, and other variables, (c) Future researchers should add research samples in order to provide better research results (d) Further, researchers should use other, more relevant measures to proxy the eco-efficiency variable in

addition to the ISO 14001 certificate, such as the eco-efficiency measure submitted by the World Business Council for Sustainable Development (WBCSD) in order to provide better research results, and (f) Further researchers should research the Financial Services Authority Regulation (POJK) number 51/POJK.03/2017 concerning the Implementation of Sustainable Finance for Financial Service Institutions, Issuers, and Public Companies is officially enacted, to see better results.

5.4. Implications

This research has the following implications: (a) Based on the results of the study, investment in the environment has not been a concern for entrepreneurs and investors, so that regulations are needed regarding binding environmental preservation for business people and (b) For IAI, accounting standards are needed following the conditions in Indonesia to require companies to disclose financial statements related to the environment transparently in the context of full implementation of integrated reporting.

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