The Impact of Environmental Regulation Implementation: A Meta-Analysis

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[2] Department of Law, Universitas Muhammadiyah Kudus, Kudus 59316, Indonesia
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ABSTRACT

Effective environmental regulations are crucial for biodiversity preservation and fostering innovation to mitigate environmental damage. The aim of this research is to set the groundwork for further research into the substantial role of environmental regulatory policies in promoting pro-environmental innovation. This research employs a meta-analysis approach, focusing on correlational studies published between 2001 and 2021 in English. Inclusion criteria for data selection consisted of articles addressing environmental regulations and their implementation. Correlation analyses were conducted using JASP software. The findings indicate a significant relationship between environmental regulations and their implementation, with a correlation coefficient of 0.28. With a 95% confidence interval, the estimated true score range lies between 0.14 and 0.41. Bias testing was performed using the trim and fill method, and no evidence of publication bias was found, supporting the validity of the meta-analysis results. Thus, it can be concluded that environmental regulations play a significant role in encouraging pro-environmental innovation and urging governments in each country to provide certainty about their pro-environmental policies.

1. INTRODUCTION

The issue of environmental damage is becoming increasingly evident. This is evidenced by the efforts made by several people to conduct environmental studies [1]; these studies have resulted in several programs and concepts such as Sustainable Development, Millennium Development Goals, and Sustainable Development Goals [2, 3]. The impact caused by environmental damage has been felt by all humans living on earth [4]. Food scarcity and global warming are proof of that [5]. Food scarcity and global warming affect several countries where the human population is constantly increasing, such as Bangladesh [6, 7], Yemen [8, 9], and several African countries. An increase in population that is not matched by the ability to manage nature properly will become a problem for future generations. The role of the state is crucial in balancing the preservation of nature with economic growth and population increases. The state can control the preservation of nature from threats through environmental regulations and enforcement in the field, such as making special regulations to protect river areas, protect sea areas, and protect water from pollution. Regulation is one of the instruments that can be used by the state to support environmental protection. Regulations are born from a legislative process that has been mutually agreed upon by the community and the government. Countries that have created and implemented effective environmental regulations, like Japan and Finland [10], are now reaping the benefits. These regulations foster an attitude of environmental stewardship

[11].

Environmental regulations are indeed not the main instrument in protecting the environment from damage. According to Lawrence Friedman, three elements are needed to create a law-abiding and obedient society: legal substance, legal culture, and law enforcement [12]. However, within the context of these three elements, legal regulation serves as an instrument that can compel individuals or companies to preserve the environment. Environmental regulations form a small part of the regulations established by a country [13]. On the other hand, each country's interests in protecting and managing the environment are always different. Take Indonesia, for example, which possesses various natural resources but continually faces political interests in managing them. Consequently, Indonesia's natural resources are depleting, impacting food reserves and resulting in the loss of some ecosystems. Moreover, several indigenous groups in Indonesia reject the new policies that introduced the latest environmental regulations, specifically Law Number 11 of 2020 concerning Job Creation, as they believe these are detrimental to their local environment [14]. Groups aware of the importance of a healthy environment continue to advocate for robust environmental regulations, recognizing their potential for significant positive impact. This is evident in countries that prioritize carbon reduction and climate protection, where the development of environmentally friendly product innovations is actively encouraged to enhance the effectiveness of environmental regulations.

Environmental conflicts continue to occur in several

countries. Therefore, this meta-analysis research aims to provide a new perspective on environmental regulations, which have the benefit of measuring the success of implementing these regulations in supporting environmental protection in each country included in the analysis. The analysis of forest plots and funnel plots is enhanced by the inclusion of moderator variables chosen by the authors: the targets of environmental regulations and their origins. These two criteria indicate that environmental regulation has become a primary agenda in every country.

Some meta-analytic articles investigate the application of environmental regulations, discussing their impact on the development of innovations, product innovations, and the performance of environmentally friendly companies. The research concludes that environmental regulations do influence the future of the environment. Threats of environmental damage and climate change can be reduced by the presence of such regulations [15]. Another meta-analytic study posits that environmental regulations also affect international trade, then set standards related to innovative products produced [16]. Meanwhile, Cohen's research argues that environmental regulation must be conducted in various parts, not only within the scope of the country, as it can also significantly impact areas with environmental regulations [17].

Based on these three studies, it can be said that measuring the relationship with the meta-analysis method provides a new perspective. Conducting studies on environmental regulations and their impacts will yield valuable results for future studies. Given the current environmental conditions, we have concluded that the environmental conditions on earth are deteriorating, and issues such as global warming, water pollution, and flooding have become real threats to human life and future generations. This study aims to determine and quantify the strength of the relationship between environmental regulation and its implementation. This objective is beneficial for understanding how the presence of environmental regulations in a country influences their importance for the residents and companies within.

2. METHODOLOGY

The method used in this study is a correlational meta-analysis, which aggregates and concludes results from different researchers studying the same theme. The meta-analysis results yield global conclusions drawn from studies conducted by previous researchers. This study collects quantitative data and employs statistical analysis to help derive global conclusions. The theme of this research is the relationship between environmental regulations and their application. Environmental problems faced by several countries can be overcome by law enforcement, but this also requires a strong legal basis. It is hoped that the presence of environmental regulations can stimulate the innovation process and the creation of innovative products to improve the performance of countries or companies in environmental protection.

The data analyzed in this study are the results of research conducted by previous researchers. The data pertains to environmental regulations and their implementation. Researchers followed PRISMA reporting guidelines for data search and selection from January 2023 to March 2023 (Figure 1). Based on PRISMA reporting, researchers determined four

steps: 1) defining eligibility criteria; 2) analyzing sources and information; 3) study selection; and 4) data collection.
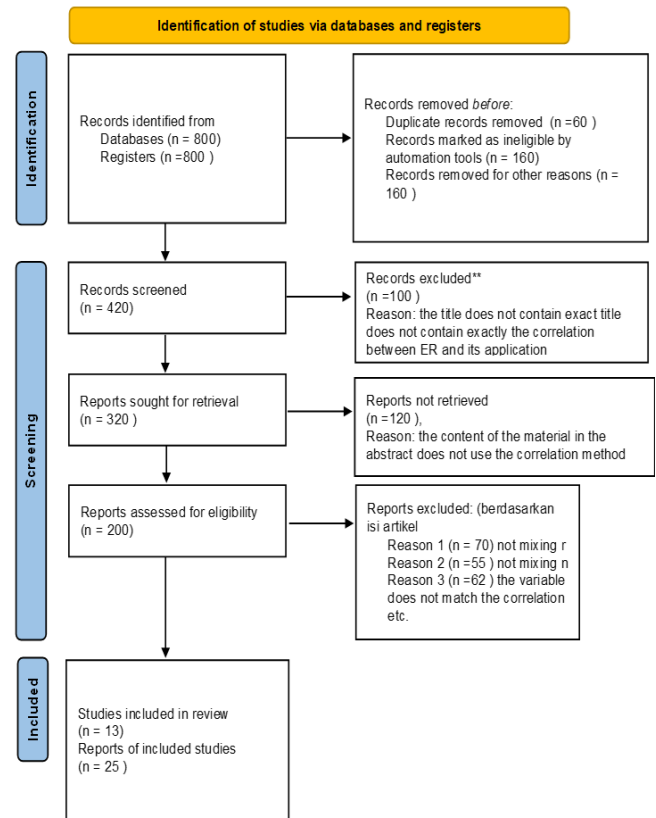

Figure 1. Prisma flow cart

The data in this study are the results of research conducted by previous researchers related to the relationship between cognitive aspects of a person's behavior toward the environment. In determining the data, there are inclusion criteria in Table 1.

Table 1. Aspects and criteria of collecting data

Aspect	Inclusion	Exclusion	Information
Time	From 2012 to 2021	Other	the year range used in searching for articles
Language	English	Other	The language used in the article
Data Type	Quantitative	Other	data research
Data	Contains an r (reliability index) and an n (sample size)	No r or n found, which means not having (reliability index) or (sample size)	The sample size used in the article data must have a correlation index to find the effect size and standard error
Theme	Correlation of environmental regulations with implementation	other	Specification of the theme considered in data collection

The collection of articles will be used as data through several processes, then 800 articles are obtained according to keywords, titles, and themes. However, out of 800 articles,

only 13 articles containing 25 data met the inclusion criteria and were eligible for analysis. While articles that do not meet the criteria are excluded.

In the 13 articles that served as data, there were several studies with complex themes that made it possible to carry out more than one analysis. An example is the article by Feng et al. [7] which has two analyses that can be used as data, namely the country's performance in making environmental regulations and encouraging it to implement innovations for environmental sustainability. Another example is an article by Meng et al. [18] which has 4 different data points worth analysing: the state encourages companies to increase innovation, the state encourages companies to green development, and increase in enterprise intelligence and environmental dynamism with companies.

The random effect model is used in this study because it aims to produce generalizable conclusions. In analysing the random effects model, evidence that heterogeneity is needed. The value in heterogeneity can be seen from I^2, a data is included in the heterogeneity category if $I^2 > 25\%$ [19].

The correlation method is a type of meta-analysis used in this study. Correlation is used to find out about the relationship between environmental regulation and product innovation, innovation process, and performance. In sequence, the process of finding a correlation mental analysis begins with an analysis looking for effect sizes and standard errors. In meta-analysis research, it is necessary to have a fisher transformation, especially for the correlation index (r) which is an effect [20] to use the formula for calculating the standard error and effect size using JASP software to display the final pot and forest plot.

The division of research roles was carried out in this study. roles are divided proportionally. The first researcher has the task of managing the team and describing the flow of the research. The first researcher has another task, which is to collect data according to the inclusion and exclusion criteria. The fifth researcher was in charge of verifying the data and making analysis tables. The fifth researcher then analyses based on the special rules of meta-analysis. The second researcher has the task of translating the results of the data entered into the analysis table and fulfilling the requirements of the fourth and third researchers. The last step was carried out by the first researcher by compiling a report on the results of the analysis of this study.

2.1 Findings

Climate change and global warming are environmental problems that the earth is currently facing [21]. This is due to an increase in industrialization in every country [22]. Climate change is a change in temperature that has an impact on food security in the world [23]. These problems can be reduced by making decisions in the form of environmental legislation that are appropriate to the problems in each country. Environmental regulations are useful as a legal basis that regulates and directs communities and companies in acting to protect the environment. From the several articles analyzed, we found a correlation between environmental regulation and process innovation, product innovation, and performance improvement of society and companies.

The indicators in this study are symbolized by the correlation index (r) and the number of samples in the study (n) and then find the effect size (z) and (SEz) standard error indicators. To find out the total number of effect sizes and

standard errors of each study will be shown in Table 2 below.

Table 2. Aspects and criteria of collecting data

No	Researcher	t	n	z	SEz
1	[24]	0.055	35	0.055	0.177
2	[24]	0.534	35	0.596	0.177
3	[24]	0.479	35	0.522	0.177
4	[25]	-0.175	520	-0.177	0.044
5	[26]	0.332	355	0.345	0.053
6	[26]	0.347	355	0.362	0.053
7	[27]	0.872	398	1.341	0.050
8	[28]	0.241	30	0.246	0.192
9	[28]	0.491	30	0.537	0.192
10	[29]	-0.076	100	-0.076	0.102
11	[29]	-0.087	100	-0.087	0.102
12	[30]	0.017	213	0.017	0.069
13	[30]	0.344	213	0.359	0.069
14	[30]	0.344	213	0.359	0.069
15	[31]	0.550	100	0.618	0.102
16	[32]	0.235	305	0.239	0.058
17	[32]	0.14	305	0.141	0.058
18	[32]	0.154	305	0.155	0.058
19	[32]	0.146	305	0.147	0.058
20	[33]	0.0486	34074	0.049	0.005
21	[33]	-0.023	34074	-0.023	0.005
22	[34]	0.12	297	0.121	0.058
23	[34]	0.13	297	0.131	0.058
24	[35]	0.39	28	0.412	0.200
25	[36]	0.706	25	0.879	0.213

Notes: the letter r is the correlation index, the letter z is the effect size, the letter Sez is the symbol for the standard error and the letter n is the number of respondents studied.

The selection of the data above is based on the problems to be analyzed, namely the relationship between environmental regulation and its implementation. After being analyzed, it shows a correlation value that varies in eating and answering question [37], as well as the standard error value. The next step is to perform an analysis using the homogeneity of the data. The process of data homogeneity will be carried out at an early stage before the correlation-type meta-analysis is carried out, the purpose of data homogeneity is to prove the data. In this heterogeneity test the estimation used with parameter I^2. The results of the heterogeneity test will be displayed in Table 3.

Table 3. Residual heterogeneity estimates

	Estimate
I^2 (%)	99.509

Table 3 above is made to show supporting data and not with directly selected analysis, the homogeneity test is carried out to assess differences [2]. Then the results of the analysis will be analyzed based on the distribution of data in the forest plots. A forest plot, also known as a blobbogram, is a visualization of effect sizes and standard errors for each study. This visualization shows the trend of the data thereby helping us to see the global conclusions of the many studies analyzed. The following is a forest map of the relationship between one's knowledge and attitude toward the environment. According to Hu et al. [17], the understanding of meta-analysis of environmental regulations is still global and cannot be specific, so conducting a study on the correlation of environmental regulations needs to be carried out more deeply and can better describe the urgency of implementing environmental regulations. Hu et al. [17]'s opinion can indeed be

synchronized with the environmental damage experienced by several countries that have abundant natural resources [17]. On the other hand, several countries produce environmental regulations, but environmental regulations generate new problems, for example, Law No. 11.

The next step is to carry out an analysis using forest patches on the distribution of the data. On the other hand, the terms forest map is also known as blobbogram and bloblogram, which are descriptions of the standard errors and effect sizes to be explained in each study. The data description shows the global conclusions seen from the trend of the data so that it makes it easier to see the overall conclusions from the several studies that have been analyzed. In the pictures below is a forest map about the relationship between environmental regulations and their implementation.

The data displayed in the forest plots are very diverse, the results show that there is a low correlation, a strong correlation, and a negative correlation. In the conclusion effect, the results show the number 0.28. These results show that the general correlation value between environmental regulations and their application to generate innovation in protecting the environment is 0.28.

The assumed value shown in the JASP software is 95%, in the average forest plot results it is known that the displayed value is 0.14 to 0.4. So based on these values, it can be concluded that there is a correlation although not too strong between environmental regulations and their application in encouraging the birth of innovations for environmental protection. The values generated by the forest plot above allow for further analysis. This analysis is used to determine the depth of values displayed by the forest plot (Figure 2).

Encouraging the formation of environmental regulations is an effort that must be carried out by every country to create a good environment for environmental protection. With the existence of environmental regulations, it is hoped that it will provide a guarantee for a good future for the human future.

In the process of conducting a meta-analysis, what is needed by the researcher is to confirm data bias. This can be done in several ways, including using the trim and fill method which uses iterative procedures that can function to reduce or eliminate small data or eliminate large errors in the funnel plot and produce an adjusted effect size by recalculating the effect size. So, researchers can analyze and detect changes. So, the process of doing meta-analysis can help researchers to analyze and detect shifts in magnitude and changes in data that are not included in the analysis. The funnel plots below show how the trim and fill method detects publication bias.

The image in the funnel plot above shows that no open points are found because all dots are black. This situation explains that all the studies selected to be analyzed in the meta-analysis have all been published and there are no signs indicating that any research has been omitted. So, the potential for bias in this study has been proven with a value of 0.28 and this also proves a positive correlation between environmental regulations and their application. To clarify this assessment, Figure 3 will be compared with a forest plot derived from the trim and fill method. This comparison results in the exact same distribution being displayed by both forest plots so that there are no signs indicating differences in the magnitude of the standard error and the effect size, as a result, the shift in values is not displayed. The conclusion from the funnel plot visualization strengthens the analysis of publication bias of the data analyzed. The value of 2933 obtained from the fail-safe N method is a confirmation of publication bias. This value

indicates N fail-safe > 5K+10 = 135, so the conclusion of publication bias in meta-analytic studies can be concluded that there is no problem.
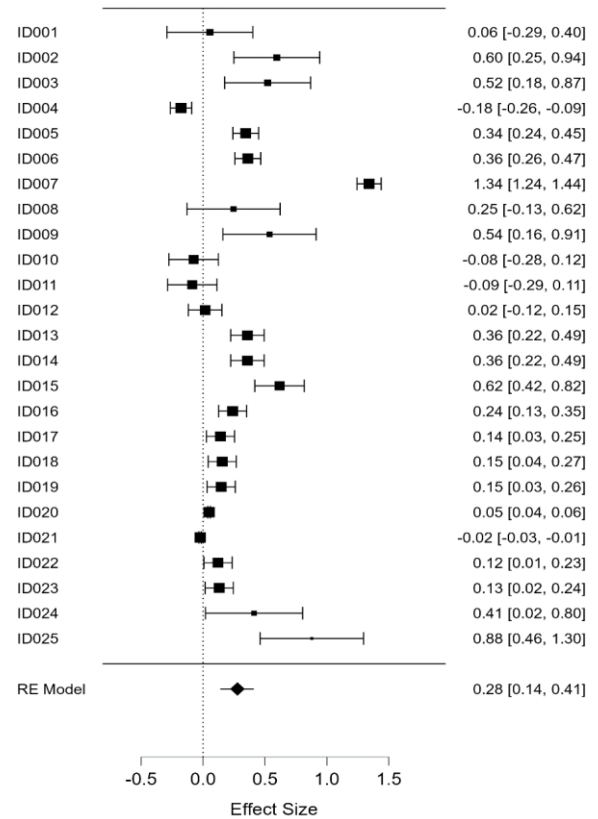
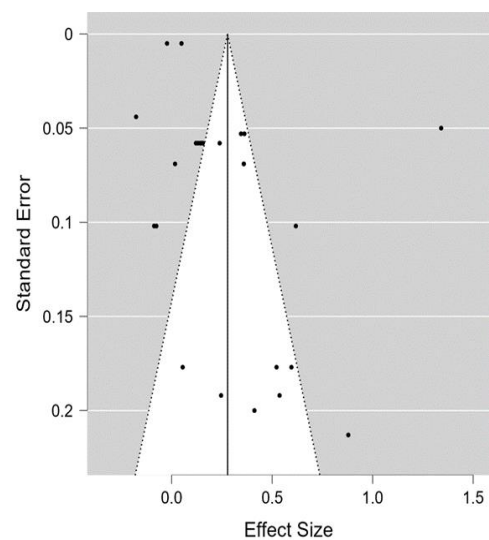

Figure 2. Forest plot

Figure 3. Funnel plot output of trim and fill method

Based on this test, shows a correlation value of 0.28 between environmental regulations and their application to produce innovative products and encourage the innovation process is valid. The data collected and analyzed comes from various studies that have different backgrounds, for example, research objects from different countries, and research objects at different times.

The final step is to display the moderator variable. There are two moderator variables that will be displayed. First, moderator variable analysis showed that there was no

difference between the continents of Asia, Oceania and Europe, as indicated by the value of $p = 0.455 > 0.05$ (95% confidence level). This statement refers to the results of the analysis of variance shown in Table 4. Thus, the Effect Size results which indicate a positive correlation between ER and its application occur in all continents where the research is sampled. Based on these findings, it can be recommended that environmental regulations be continued in all countries, because they have a very clear role. For example, in the countries of China and Australia, although in its development in each country environmental regulations have developed into several special rules based on the environmental problems faced.

Table 4. Analysis Data variance by continent

Cases	Sum of Squares	df	Mean Square	F	p
Continent	0.187	2	0.093	0.817	0.455
Residuals	2.513	22	0.114		

Note: Type III Sum of Squares

The second moderator variable analysis is based on the type of performance, namely Financial Performance, Process Innovation, Performance and Product Innovation (all meanings are explained). Based on the analysis of variance shown in Table 5, it was found that $p = 0.346 > 0.05$ (95% confidence level), so it can be concluded that there is no difference in the relationship between ER and its application based on the type of performance. Thus, strengthening ER has a positive impact on product innovation performance, process innovation, performance and financial performance. Based on these findings, recommendations emerged regarding the sustainability of environmental regulations which should be implemented properly and correctly according to the conditions of each country, because environmental regulations are actually the main regulations to protect humanity in the future.

Table 5. Analysis data variance by performance

Cases	Sum of Squares	df	Mean Square	F	p
Performance Type	0.386	3	0.129	1.168	0.346
Residuals	2.313	21	0.110		

Note: Type III Sum of Squares

The moderator variable provides a detailed description because forest plots and funnel plots are still global in conducting analysis. Thus, the moderator variable is to provide a specific explanation so it will make it easier to find the weaknesses and strengths of research that correlates, including this research. Because the samples were taken based on continent criteria and objects that will be regulated by environmental regulations.

3. DISCUSSION

Forest destruction experienced by most developing countries is proof that the state cannot exist as a savior of the environment [38]. Starting with forest destruction and then the loss of several species that are currently threatened with extinction, for example, the disappearance of the Javan tiger

species [39], the Balinese tiger in Indonesia [40], and the small population of the northern African white rhino [41]. The human population explosion and the explosion in human needs were the initial triggers for the destruction of nature and the disappearance of some living things on this earth. The increasing number of people also encourages the opening of new jobs which are forced to be opened because humans need money to fulfill their lives. The existence of massive industrialization is a threat to the environment [42].

Some humans have uncontrollable attitudes, resulting in humans continuing to try to maintain their lives in various ways. On the other hand, humans also have an attitude that loves the environment. The two attitudes are indeed contradictory, but these attitudes should indeed be controlled jointly by making a mutual agreement. The collective agreement must be contained in an environmental regulation. Then the regulation must have a binding sanction.

Some countries that have made good environmental regulations have felt the results, such as America, China, Japan, and Finland. An indicator for a country to be a country with good environmental regulations is to occupy the best position in the SDGs ranking determined by the United Nations. So environmental regulations play an important role in protecting the environment from environmental damage and environmental regulations can also encourage countries to do more in encouraging innovation for every company in their country.

The shift from food packaging products that are not easily recycled to food packaging that is easily recycled is small proof that from environmental regulations the world can be saved from damage and global warming slowly. Human lifestyle is the key to implementing environmental regulations. Pros and cons in protecting the environment will indeed continue to occur because conflicts over natural resources are real conflicts and take many lives. Ironically, conflicts over natural resources occur between government organs and the people themselves, an example of this is the forced detention of customary land rights on the Indonesian island of Borneo.

A sense of love and awareness of the environment must indeed be supported by an established environmental regulation. From this feeling, a person will have the urge to protect the future of humanity. Likewise, companies that are supported produce innovative processes, products, and performance improvements in order to protect the surrounding environment. Innovation is indeed part of the way that can be done to prevent environmental damage.

Each continent has different characteristics when viewed from an environmental standpoint. such as the Asian continent which has natural variations, in the southeast which is dominated by tropical rain forests, in the north which is dominated by desert and snow, the African continent which is mostly dominated by deserts, Europe which is dominated by forest variations which are almost similar to America. Various characteristics of the continent have a role in safeguarding the future of humanity. A reciprocal relationship between humans and nature is needed. Therefore, humans have a role to guard not to do damage. Protecting means making rules that apply fairly to nature and humans. Innovation and encouragement of change in innovation can be included in the substance of environmental regulations which will be used as instruments of protection.

Regulation is key in supporting the existence of an order. In the opposite case, irregularity will arise because it is caused by the absence of a rule. This also applies to environmental

regulations, every country that creates environmental regulations has the goal of saving the environment from damage and maintaining the sustainability of the environment. Even though it will have problems in its application, the encouragement to implement environmental regulations in everyday life is an obligation.

4. CONCLUSIONS

Based on the results of the analysis using meta-analysis, it shows that there is a positive correlation between environmental regulations and their implementation so that there is an incentive to produce innovative processes, and products resulting from innovation. Then from the forest plot data it can be seen that there is a general correlation between environmental regulation with its application with a value of 0.28 assuming a 95% confidence level. The value of 0.28 is the displayed value which comes from the score range of 0.14 to 0.41. Although these results are not included in the assessment category that has a high correlation. These results prove that the resulting positive correlation is formed under normal circumstances. The findings in this study confirm that environmental regulations have an impact on environmental protection if properly implemented and used as a legal basis to encourage process innovation and product innovation. The analysis of forest plots and funnel plots is strengthened by showing the moderator variables chosen by the authors, namely the objects that will be regulated by environmental regulations and where these environmental regulations come from. These two criteria can provide that environmental regulation has become the main agenda in every country.

5. LIMITATION

According to the results of our research, we cannot analyze in detail case by case the relationship between environmental regulations and their implementation, because we use analysis of secondary data. Therefore, in our opinion, a more real and in-depth investigation of environmental regulations is needed.

6. RECOMMENDATION

Environmental regulations are very important for every country so that every country needs to have environmental regulations. although not all countries already have environmental regulations, with this research it is hoped that all who read this article will be interested in conducting deeper studies on environmental regulations, for example, the Indonesian state which continues to improve in environmental protection, this is because several environmental experts have studies based on literature and field studies, more in-depth research is needed regarding strategies for implementing environmental regulations that can be understood by everyone and can be applied in all countries, so that it will minimize environmental damage in several countries that have abundant natural resources.

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