

The Effect of ESG on ASEAN Public Companies' Green Innovation per 2021

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Abstract: The aim of this study is to test the effect of ESG on ASEAN public companies' green innovation per 2021. By doing a directed content analysis combined with the assistance of autocoding through machine learning, evidence shows that ASEAN companies were still slow in terms of adapting several green innovation dimensions. Furthermore, we do an OLS regression analysis that includes several financial control variables to determine the effect of the ESG score on the ASEAN firms' green innovations. In conjunction with that we also run robustness checks by using robust OLS regression and the result is aligned with the common OLS regression. Finally, this article summarizes that there is a significant effect of the ESG score on ASEAN companies' green innovation and hopefully the investors can rely on the ESG score to interpret the green innovations done by the companies.

Keywords: ESG for non-finance companies, sustainability, green innovation, ASEAN companies, content analysis

1. Introduction

The majority of sustainable and responsible investors rely heavily on the ESG ratings provided by sustainability rating organizations that have been created in the market as intermediaries since they are unable to independently assess the sustainability of companies on their own. (Drempetic, Klein, & Zwergel, 2020). The validity of the ESG rating is still a complex debate and the implications have a very broad impact (Tan & Zhu, 2022). In contrast, sustainability rating organizations gather information from the society and directly from businesses to produce ESG scores with precise and advanced technique (Drempetic et al., 2020). ESG can be interpreted as environmental, social, and governance, thus the ESG score itself means high or low support and/or company participation in environmental, social and governance aspects (Fernando, Nurcholifah, & Pulunga, 2022).

With regard to the ESG ratings, green innovation is now a crucial tool for businesses looking to increase their market share and last over the long term. (Karimi Takalo, Sayyadi Tooranloo, & Shahabaldini Parizi, 2021). Green innovation significantly improves business performance and in essence, low-level green product innovation is simpler and less expensive (Tang, Walsh, Lerner, Fitza, & Li, 2018). Technology innovation that complies with eco-economic development standards in order to protect the environment and conserve resources is known as "green innovation". (Eiadat, Kelly, Roche, & Eyadat, 2008). However, the research and development of green innovation practices are still in their early stages (Zhang, Zhao, Cui, & Wu, 2020). Furthermore, the research focus in the field of green innovation in the past has

been on the industry or national level, which is a highly complex area associated with numerous issues (e.g. measurement of economic benefits, comparison of alternatives, etc.) (Schiederig, Tietze, & Herstatt, 2011). Having said that we conclude if the ESG score is interpreted as the contributions to the environment, social, and governance, we believe that they must be carrying out green innovations and state the activities in the sustainability report or other publications. We prefer to use ASEAN member state public companies because we see a huge increasing trend of ESG scoring by Thomson Reuters-Refinitiv. In conjunction with that, we found the total of ESG-rated companies have grown more than 202% since 2018 as stated in Table 1. Due to limited research that uses ESG scores and disclosure as fundamentals as well as research materials, this time we will discuss their impact on green innovation practices and be more comprehensive by using content analysis combined with digital possibilities on companies registered as members of ASEAN. This is aligned with the statement from Adams (2004) and Huguen et al. (2014) in Pratama et al., (2022) that the substance of comprehensive corporate reporting, including sustainability reports or sustainable development reports, will minimize asymmetric information and the disclosures of the information will be advantageous for several parties.

Table 1. Total ESG-rated companies in ASEAN done by Thomson Reuters

Year	Total
2018	215
2019	328
2020	406
2021	650

This research has two objectives (1) Analysing green innovation companies using content analysis and enhanced with digital possibilities based on the sustainability or annual report extraction and mapping them into twelve dimensions that have been defined according to various previous research. (2) Finding out the influence of ESG scores on the green innovation practices in ASEAN public companies by using a regression method. Additionally, this study can also benefit several parties. Investors might gain better insight and rely on the ESG score to improve their judgement before investing in the respective companies. Investors also may greatly value the disclosure of information to learn about the companies' contributions to green innovation practices which will improve their evaluation of their investments. For companies, this research could provide an overview of the disclosure components in the sustainability report that necessary to be improved. The rest of the paper is divided as follows: section 2 presents a brief literature review; section 3 describes the research method; section 4 provides the research results, implications and discussions; and section 5 concludes the article.

2. Literature Review

2.1. Disclosure of Information and ESG Rating

Information is essential for assessing a company's sustainability, just as it is when assessing its risk. (Drempetic et al., 2020). It makes sense that more businesses are publishing voluntary sustainable reports as a result of the desire for openness. According to Bartels et al., (2016) in Drempetic et al., (2020), a country may have a variety of reporting tools that are aimed at different kinds of businesses. If CSR reporting improves company reputation, as previously demonstrated, we can draw the conclusion that businesses anticipate greater financial performance in conjunction with an improvement in reputation among stakeholders. (Q.

Wang, Dou, & Jia, 2016).

Freeman (1984) defines a stakeholder as any organization or person that can have an impact on how a company achieves its goals, hence this includes creditors, employees, customers, suppliers, public interest organizations, and governmental agencies. Freeman (1983) conveyed that the dynamics of stakeholders influence the firms' decisions. As the level of stakeholder power increases, the importance of meeting the stakeholder's expectations increases too (Roberts, 1992). As stated by Roberts (1992) social responsible activities are important and useful in fulfilling the satisfaction of the stakeholders. Consequently, a strategy plan for managing stakeholder interactions includes creating a corporate reputation as being socially responsible through implementing and publicizing social responsibility initiatives. According to Chakravarthy (1986) in Roberts (1992) that well-adapted firms or firms that have excellent strategic management performance realize that the cooperation of a firm's multiple stakeholder groups is a must condition for supremacy. By compiling all of those literatures, we believe that a sophisticated collaboration should be made between firms and stakeholders to achieve organisational goals.

2.2. Green Innovation

For several years, the importance of management's green innovation is growing in practice and academia likewise. The literature on green innovation has developed and grown over the past few decades as a result of its numerous and vital applications (Karimi Takalo et al., 2021). Green innovation, also known as eco-innovation, is a process that helps develop new goods and technology with the goal of lowering environmental risks including pollution and the adverse effects of resource extraction (Castellacci & Lie, 2017). Eco-innovation can be categorized based on its aim (products, processes, marketing techniques, organizational structures, and institutions), its methodology (modification, redesign, alternatives, and creation), and its influence on the environment (Kemp & Pearson, 2007). The focus of eco-innovation can generally be determined by whether it is technological or non-technological: eco-innovation in products and processes tends to rely heavily on technological development, whereas eco-innovation in marketing, organizations, and institutions tends to rely more on non-technological changes (Kemp & Pearson, 2007).

Driessen and Hillebrand (2022) provide a very pragmatic definition of "green innovation" to explain what it is and how it differs from other types of innovation in that it can be created without reducing environmental burden yet has considerable environmental advantages. The multiple concepts in the literature review which are green innovation, eco-innovation, environmental innovation and sustainable innovation having said that they are used synonymously in various previous research (Schiederig et al., 2011). Therefore, green innovation is an important tool that can help society, organizations, and companies to achieve environmental sustainability and plays an important role in achieving competitive advantage (Chu, Wang, & Lai, 2019). Hence, the effect of green innovation was agreed with the stakeholders concept especially when there are adversarial groups or special interest groups concerned with social issues (Roberts, 1992).

2.3. Measuring Green Innovation

Numerous research have employed the environmental innovation idea, however its main tenets are still vague and variable depending on the situation (Farza et al., 2021). Some of the research still follows the respective measurement of green innovation by using patent analysis, documentary analysis, survey analysis or even a combination of them.

In this literature, we would like to perform a digital and documentary source analysis.

According to the majority of studies, innovation can only be achieved by a new product or process entering profit-oriented use. This idea has important ramifications for how innovation is measured. It implies that the preferred innovation indicator would be based on a systematic and direct monitoring of such output occurrences and that this type of data is freely accessible. Compared to measuring R&D (an "input" indicator of knowledge activity) or counting patents (an "intermediate" signal of innovative activity), these metrics are very different. However, compared to the use of upstream input or intermediary metrics, the use of output events as an innovation indicator is significantly less developed. There is a lot of evidence to suggest that research involving patent processes and applications is a bad indicator of genuine innovative activity. Additionally, in this context, prior research efforts in business, environmental, and economic literature have been concentrated on attempting to measure and analyze eco-innovation implementation levels to learn how environmental actors can minimize their detrimental environmental impacts, comply with green requirements, and be more effective to ensure the welfare of the present and future generations (García-Granero, Piedra-Muñoz, & Galdeano-Gómez, 2018). Since there is no one perfect approach or indication, it will be best to choose a variety of combinations of measurements of green innovation (García-Granero et al., 2018).

Based on the introduction and literature review above, the development of the hypothesis as follows:

H₁: ESG score has a significant positive effect to the firm's green innovation.

3. Research Methods

The data in this paper includes ESG scores from ASEAN public companies in 2021 rated by Refinitiv – Thomson Reuters as well as green innovation dimensions performed by the companies. The population of the data is 650 companies whilst using the purposive sampling method, hence, the total of the sample is 381 companies. A directed content analysis will be applied to determine the green innovation dimensions and frame a pattern with a total of 10% of the samples. In conjunction with that, the particular data on companies' green innovation obtained from sustainable reports/annual reports will be extracted further with the assistance of autocoding through machine learning using artificial intelligence (Nvivo). Hence, an autocoding matrix will be generated and transformed into a percentage to calculate the total dimensions applied. After getting the full set of green innovation data, a regression analysis will be performed to test the empirical model with several control variables including return on assets, leverage, and size of the companies.

3.1. Content Analysis

Researchers presume that content analysis is a flexible method for analyzing text data (Cavanagh, 1997). Content analysis refers to a group of analytical techniques that includes strict, systematic textual analysis as well as impressionistic, intuitive, and interpretive approaches (Rosengren, 1981). Researcher's theoretical and practical objectives, as well as the phenomenon being examined, substantially influence the particular type of content analysis approach they choose (Weber, 1990). Meanwhile, this kind of flexibility has brought content analysis useful for lots of research, the lack of absolute definition and precise procedures has probably limited the implementation of content analysis (Tesch & Beaudry, 1990). The main variation of content analysis is commonly limited to classifying it as primarily a qualitative versus quantitative research method (Hsieh & Shannon, 2005). According to Hsieh (2005), there are 3 distinct approaches which are conventional, directed, and summative content

analysis. All of the three approaches are used to interpret and understand text data. Hsieh (2005) portrayed analytic procedures specific to each approach mentioned and addressed trustworthiness with hypothetical examples from end-of-life care research.

The dimensions of green innovation are obtained from various previous research and theories. According to Zhang et al., (2020), the literature research and theories are not limited by time and space so we can summarize and draw conclusions from previous research results. Even though, we also can use the Global Reporting Initiative (GRI) Index to support the evidence. Another research was conducted by Papoutsis and Sodhi (2020) they were using combinations of standards from previous literature, the GRI, the KLD index, and the UN global compact sustainability reporting guidelines. The details of the dimensions are shown in table 2.

Table 2. Summary of Green Innovation Dimensions

Dimensions	References
Green technology (D1)	Kemp and Pearson (2007)
Materials (D2)	GRI 301
Energy (D3)	GRI 302
Water (D4)	GRI 303
Environmental management system (D5)	Winter and Lasch (2016)
Cooperation (D6)	GRI 308
Waste (D7)	GRI 306
Product (D8)	Kemp and Pearson (2007)
Green finance (D9)	Kemp and Pearson (2007)
Green office (D10)	Eichholtz (2010)
Supply chain (D11)	Laari et al. (2017)
Green activities (D12)	Kemp and Pearson (2007)

3.2. Extract the Criteria of Green Innovation Practices

According to the dimensions, the relevant criteria are taken from the releases of public firms that have green innovation data and applied to the data. There are three steps: download the modules that will serve as evidence, software upload of the company's publications, and data encoding.

Due to the significant linguistic, cultural, and other variations among ASEAN public enterprises used as research objects, it is difficult to collect the desired data. While this is happening, their publications arrive in a variety of formats, and the data on green innovation logically grow disorganized. To ensure the orderly progression of the research, we would want to establish the following requirements as necessary:

- 1) through the researcher's network environment, the company's website provides access;
- 2) English is the primary language used to deliver content on the company's official website;
- 3) Separate publications, such as CSR reports, sustainable development reports, sustainability reports, or annual reports, are available on the company's official website.

Secondly, we mainly used the sustainability report as the fundamental source of data to obtain the green innovation practices conducted by the companies.

Apart from the sustainability report, the main source of data is the annual report published on the website. According to Kent and Chan (2003) in Siregar and Bachtiar (2010) several reasons why it is justified to use the annual report:

- 1) companies frequently utilize their annual reports to reveal their social initiatives to

- stakeholders as a major channel of corporate communication;
- 2) including both financial and non-financial information in a single document is one method of reducing disclosure costs;
 - 3) an annual report is also the module of information that is actively sought by pressure groups;
 - 4) disclosures through other media or perhaps press release are subjected to the risk of multi interpretations and distortions, and disclosure through the annual report are completely handled by the internal management.

Thirdly, we need to encode the data that we obtain from various reports of the firms. According to the purpose of this research, the company data are imported into the software for coding with the dimensions as the first-level nodes. We will use the manual coding by reading paragraphs resulting from the data extraction in the second step and conduct the directed content analysis method until 10% of firms are analysed. The benchmark of 10% was suggested by the Nvivo software to analyze the respective trend. These are two examples of manual coding that we conduct as below:

- 1) *The Company also uses cardboard as the outer packaging material and currently unused cardboard packaging or the rest of the production is reprocessed by a third party into new cardboard packaging to be reused as outer product packaging – PT Akasha Wira International Tbk.*
- 2) *Meanwhile, in environment sector, the Company has taken several material approaches to implement energy efficiency, including minimizing the mobility of official travels, maximizing work from home (WFH) policy to reduce the mobility of operational vehicles, encouraging ADHI's employees to ride bicycle as a mode of transportation through ADHIGOS, installing solar panels at main office building as an implementation of green office, planting 7,314 tree seeds, and conserving 80 animals throughout 2021 – PT Adhikarya Persero Tbk.*

From the first paragraph, we conclude that PT Akasha Wira International Tbk. was implementing the cooperation dimension by coordinating some of their activities with intermediaries or suppliers to prevent, mitigate and reduce environmental harm to their supply chain. Meanwhile, from the second paragraph, we conclude that PT Adhikarya Persero Tbk. was implementing the energy and green office dimension since the firm doing the energy efficiency by attaching several solar panels and directly building a green office environment.

In conjunction with the directed content analysis, we use autocoding through machine learning based on 10% human manual coding patterns to fasten the process. Since the purpose of this research is we would like to study the effect of ESG scores on ASEAN member state public companies' green innovation in 2021, then, we collect all of the ASEAN ESG scores from Thomson Reuters – Refinitiv and find 381 firms exclusive from the banking and finance-related industry. Herewith, the respective summary below.

Table 3. Sample Distributions Based on Countries

Country	Number of public companies	%
Indonesia	22	5.77
Cambodia	1	0.26
Malaysia	172	45.14
Philippines	16	4.20
Singapore	63	16.54
Thailand	92	24.15
Vietnam	15	3.94

Country	Number of public companies	%
Total	381	100

3.3. Empirical Model

After finishing the directed content analysis as well as the autocoding processes, we would like to run a multiple linear regression and include several control variables in the model. This research uses one dependent variable which is the ESG score. While for the independent variable consist of green innovations carried out by the companies. As mentioned previously, we use several control variables such as; return on assets, leverage, and firm size. According to Tan & Zhu (2022), these three control variables were valid and may impact green innovations.

We employ the model and variable descriptions as detailed below:

$$GI_i = a + ESG_i + ROA_i + LEV_i + SIZE_i + e$$

Table 4. Brief Descriptions of the Variables

GI	The sum of green innovation dimensions applied by the respective companies. If a company applied more than one practice in a dimension, the value will be still 1. The maximum dimensions are 12 equivalent to 100%
<i>a</i>	Constant
ESG _i	ESG score based on Refinitiv-Thomson Reuters per 2021 on firm's <i>i</i>
ROA _i	Return on assets (nett profit divided by total assets) on firm's <i>i</i>
LEV _i	Leverage (the total liabilities are divided by the total assets) on firm's <i>i</i>
SIZE _i	The natural logarithm of total assets on firm's <i>i</i>
<i>e</i>	Other variables that are not stated in the research

4. Results and Discussion

4.1. Content Analysis Results

Table 5. Content Analysis Results

Country	Count of Company	Cooperation	Energy	EMS	Green Activity	Green Finance	Green Office	Green Tech	Materials	Product	Supply Chain	Waste	Water
ID	22	11	14	11	13	1	7	9	5	7	6	13	12
KH	1	0	1	1	1	0	0	1	1	0	1	1	1
MY	172	27	152	141	161	35	19	96	108	41	146	144	134
PH	16	8	15	16	16	8	5	10	11	3	16	15	16
SG	63	9	58	54	60	15	15	42	25	7	59	53	56
TH	92	35	89	81	90	46	20	69	66	42	79	85	85
VN	15	0	13	9	14	6	3	5	7	5	7	6	13
Grand Total	381	90	342	313	355	111	69	232	223	105	314	317	317
%	100	23,62	89,76	82,15	93,18	29,13	18,11	60,89	58,53	27,56	82,41	83,20	83,20

After conducting a directed content analysis, we use a feature from Nvivo software called autocoding with the existing pattern which adapting from the summative content analysis theory. Furthermore, an autocoding matrix will be formed automatically and can be used based on the researcher's needs. Before the results above were done, the result of the autocoding matrix transformed into a dummy variable in which if the firm is applying the respective dimension, then we will input "1" for "Yes" and otherwise will be inputted "0" for

“No” and we will calculate the total of the applied dimension in percentage. Moreover, since the imperfect qualitative data is captured by machine learning, it is a must we need to do data cleaning to furnish the results of the autocoding matrix generated by Nvivo.

Based on Table 5 above, it turns out that 89.76% of public companies in ASEAN have practised green innovation in the energy dimension. This is mostly done by saving energy, installing solar panels, and building investments in renewable energy. Furthermore, green activities are also conducted by most of the firms based on the sample by investing in research and development and training for employees that increase employee competency and reduce environmental harm. However, only 18.11% of companies adopt a green office, where companies are still quite conventional in developing office building designs, office green areas, open space, and reducing paper and office building materials used that have no guarantee of traceability. Hence, only 27.56% of samples applied the product dimension, meaning that most of the ASEAN companies were not disclosing eco-innovative products in their reports. Thus, it can be concluded that on average 381 public companies listed according to the samples adopt 60.98% of the predetermined dimensions.

4.2. Analysis of Regression Results

Table 6. Regression Analysis Results

Variable	Unstandardized Coefficient Regression	Sig.	Conclusion
Constant	0.575574	0.0031	-
ESG	0.004470	0.0000*	Significant
ROA	0.145276	0.1105	Not significant
SIZE	-0.006127	0.3749	Not Significant
LEV	-0.014345	0.7785	Not significant

*sig at 5%

Table 7. Model Summary

n	F	Sig.	R ²	Adjusted R ²
381	20.75521	0.000000*	0.180865	0.172151

*sig at 5%

From the results of multiple linear regression analysis as shown in Table 6, the multiple linear regression equations formed are as follows:

$$GI = 0.575 + 0.004ESG + 0.145ROA - 0.006SIZE - 0.014LEV$$

The number of samples observed is 381 public companies in ASEAN in 2021. In the t-statistic as shown in the table above, only the ESG score has a significant partial effect on green innovation. Meanwhile, those control variables (ROA, size, and leverage) do not have a significant partial effect on green innovation. This is evident from the probability value > 0.05 for each variable.

The ESG score regression coefficient is 0.004 and is positive, so it can be interpreted that the effect exerted by the ESG score variable on green innovation is positive. This condition means that if the other independent variables are held constant, then every 1% increase in the ESG score will increase the company's green innovation by 0.004%. Then, as seen from the table above, the coefficient of determination (adjusted R-squared) is 0.172 or 17.21%, this

means 17.21% of green innovation variation which can be explained by variations of one independent variable, namely the ESG score. While the other 82.79% is explained by other causes outside the regression model. These results are partially in line with research by Tan and Zhu (2022) where ESG rating scores have a significant effect on green innovation in terms of the quality and quantity of companies as measured by patent analysis. The ESG scores used in this study were taken from SynTao Green Finance Agency in China from 2010 to 2018. Some control variables (ROA, leverage, size) were also processed together with the regression model by Tan and Zhu (2022), but only the size of the firm shows a partial significance to green innovation. The rest of the control variables in the previous research did not show a significant effect on green innovation.

4.3. Robustness Checks

Table 8. Results of Robustness Checks

Variable	Unstandardized Coefficient Regression	Sig.	Conclusion
Constant	0.466798	0.0154	-
ESG	0.004431	0.0000	Significant
ROA	0.158082	0.0806	Not significant
SIZE	-0.002029	0.7678	Not Significant
LEV	-0.024119	0.6347	Not significant

*sig at 5%

Table 9. Model Summary of Robust Statistics

n	R ²	Adjusted R ²
381	0.162316	0.153404

It is necessary to check the robustness of the empirical model. This robustness check is one of the methods of OLS regression which is not really sensitive to outliers. Based on Table 7, the result shows that all of the three control variables remain not significant to green innovation. It is proved by the probability of the three control variables being > 0.05 . Furthermore, the ESG score remains significant and the coefficient is 0.004 and is positive, so it can be interpreted that the effect exerted by the ESG score variable on green innovation is positive. Consecutively, our analysis concludes that the results of the OLS regression are similar to the robust OLS regression analysis.

5. Conclusion

ESG ideas are gaining ground and extending globally under the guidance of the United Nations and other organizations. The adoption of the ESG score assists companies in changing their business practices from profit-driven to sustainable development, which is a crucial step toward protecting the environment and attaining green development. The use of ESG scores and their connection to corporate green innovation in underdeveloped nations, however, is the subject of sufficient research. Consequently, this research adds to the body of knowledge on sustainable development and responsible corporate environmental investment.

This study chooses 2021 data on Refinitiv-Thomson Reuters for ASEAN public listed businesses as the study dataset and uses the ESG score as an entrance point. The information

about green innovation, on the other hand, has been taken from business periodicals using content analysis and merged with digital possibilities using machine learning. The qualitative information reveals that ASEAN public companies favour developing green energy sources and environmentally friendly initiatives that advance science and benefit society. However, ASEAN companies are still slowly adapting the green office and space concept and are complex in terms of inventing eco-innovative products. The empirical results show that the ESG score has a significant effect towards green innovation performed by the companies. Subsequently, the empirical results remain significant and credible when subjected to robust testing by using the robust OLS regression. Since the ESG score is significant to green innovation, we can conclude that investors can rely on ESG score data to interpret green innovation activities performed by companies. Hence, it will reduce difficulty on the investor's and/or stakeholders' judgement pertaining to the green innovation dimensions. Furthermore, this research did not find any significant effect from several financial control variables towards green innovation.

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