



# The Influence of Board's Green Education on Green Innovation: The Case of Mining, Quarrying, and Extraction of Oil and Gas in Indonesian Public Companies

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**Abstract**—This study investigates the effect of green education of the board of directors and board of commissioners on green innovation in Mining, Quarrying, and Extraction of Oil and Gas in Indonesian Public Companies. Based on the panel data test of 105 observations on Mining, Quarrying, and Extraction of Oil and Gas companies listed on the Indonesia Stock Exchange for the period 2017-2021, we used the ordinary least squares regression method to investigate the proposed hypothesis. The findings show that the green education of the board has a positive and significant impact on the implementation of green innovation, both the green training that comes from the board of directors and the board of commissioners. Overall, this study provides important implications that green education through green or environmental-based training will encourage green policy making so that it can contribute to the achievement of sustainable development goals in Indonesia.

**Keywords**—board of director's green education, board of commissioner's green education, green training, green innovation

## I. INTRODUCTION

Indonesia's commitment to realizing the 2030 sustainable development goals implies the need for industrial involvement as an economic organ that makes important contributions both economically, socially and environmentally. The mining, quarrying, and oil and gas extraction activities are related to the discovery, mining (excavation), processing, utilization, and sale of minerals (minerals, coal, geothermal, oil and gas). In carrying out its business activities, the mining, quarrying, and oil and gas extraction industry is not only considered to have a positive impact on company performance through indicators economy but is also considered one of the industries that have a big impact on the environment [6].

Corporate stakeholders have taken notice of the business methods used by the mining, quarrying, and oil and gas extraction industries with regard to environmental

sustainability. Previous research by [11] and [5] demonstrated that stakeholder involvement in promoting sustainable practices in the mining industry is a positive and beneficial commitment that can be developed through multiple processes such as dialogue/communication, networking, and collaboration. The emphasis on sustainability from a stakeholder perspective is not only related to economic sustainability but also social and environmental sustainability. The management of the mining industry is required to carry out strategic innovations to reduce the consequences of mining operations on local communities and the surrounding environment. Innovation that is environmentally oriented and provides added value to the organization can be achieved through implementing green innovation. Green innovation is often associated with its benefits to the environment [2, 3]. The practice of green innovation is believed to be a solution that can realize stakeholder expectations for mining, quarrying, and oil and gas extraction activities that have an environmental impact.

Top management plays a crucial role in formulating policies and guiding the firm towards success and sustainability. According to upper echelons theory, organizational performance is a reflection of top management [8]. As a key organ of the organization, the executive has the authority to implement a variety of strategic policies that contribute to the organization's long-term viability, including decisions about green innovation. The core tenet of the upper-echelons theory is that the personal traits of executives are the primary determinants of the strategic decisions they make [7]. In several studies, education is one of the personal characteristics that is frequently employed as a variable representing personal executives and relating to organizational success.

Prior research has connected top management educational traits with innovation choices. As an illustration, [9] found that director education influenced innovation decisions through firms' R&D investment and proposed that higher director education leads firms to increase R&D investment.

Furthermore, related to environmental innovation, a study by [12] found that CEO education plays a role in promoting corporate environmental innovation to encourage corporate green research and development investment and environmental responsibility.

Evidence from prior empirical investigations demonstrates that executive education promotes company innovation. To the best of our knowledge, however, no research has investigated the relationship between environmental education received through training on environmental themes and green innovation. Therefore, by using content analysis, this study aims to examine whether the environmentally oriented training held by the board of directors and the board of commissioners has an impact on the implementation of green innovation, particularly in the mining, quarrying, and oil and gas extraction industry listed on the Indonesia Stock Exchange.

## II. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### A. Green Innovation in Mining

Green innovation refers to the innovation of green methods to preserve and maintain environmental sustainability as a result of a company's commercial operations [2, 3]. As part of the business innovation model, green innovation entails the implementation of a variety of green strategies in all business processes, products, and management. Green innovation in the mining, quarrying, and oil and gas extraction industry may involve recycling techniques, waste management and reduction, energy conservation, and the use of technology that contribute to the mining tailings decontamination process [1]. Moreover, green innovation entails three primary activities, namely (i) preventing pollutants and decreasing pollution generated by industrial process activities; (ii) controlling pollutants by minimizing pollution released into nature; and (iii) focusing on reducing ecological damage caused by operations and restoring the environment [13].

### B. Green Education and Green Innovation

Upper echelons theory proposes that company performance is influenced by the personal characteristics of its top managers [8, 7], including strategic decisions related to company innovation [9]. Among these personal characteristics is Education. Education is the acquisition of knowledge, abilities, attitudes, beliefs, and habits [10]. There are numerous ways to gain an education, including through training.

Previous study indicates that CEO education has a role in fostering corporate environmental innovation in order to drive business investment in green research and development and environmental responsibility [12]. Education involves a learning process to improve personal knowledge, skills and abilities. Because training is part of education, additional insight related to the environment is needed to improve environmental performance. A study by [4] found that green training is one of the most effective practices in developing human resources (HR), which helps develop green behaviour, which in turn has an impact on organizational sustainability performance.

The annual report for the mining, quarrying, and oil and gas extraction business mentions that the board of directors and commissioners are developed through numerous seminars/

workshops/ trainings. Among the pieces of training are environmental/green related training such as energy, climate change, environmental conservation, risk management, environmental, social and governance (ESG), digitalization, technology, reporting and other sustainability themes. On the basis of these reasons, we hypothesize:

H1a. Green education of the board of directors has a positive and significant impact on the implementation of green innovation.

H1b. Green education of the board of commissioners has a positive and significant impact on the implementation of green innovation.

## III. RESEARCH METHOD

This study uses companies in the mining, quarrying, and oil and gas extraction industry group. Based on the Osiris database, the number of companies incorporated in the mining, quarrying, and oil and gas extraction industry is 55 companies. Based on this number, we use 21 companies with the consideration that these companies have sufficient information related to green innovation. The sample was analyzed with the 2017-2021 observation period so that the panel data used to test the hypothesis were 105 firm years. Data was collected through several sources. First, data related to green innovation was collected by employing content analysis in annual reports and other supporting documents covering activities related to green process innovation and green product innovation. Second, data associated with the green education of the board of directors and the board of commissioners were collected through content analysis of the annual report by identifying the members of the board of directors and the board of commissioners who attended training with the theme of environment/green/sustainability.

Furthermore, it is given a score of "1" if members of the board of directors or board of commissioners have attended green training and "0" if no members of the board of directors or board of commissioners have participated in green training. To check the validity of the green training data, we also open the websites of each company and activity to support scoring and ensure that the training activity materials are related to the environment /green /sustainability. Third, data related to control variables, namely firm size, firm age, ownership, leverage and ROA, were obtained through the Osiris database.

Our research model is described in Fig. 1 as follows.

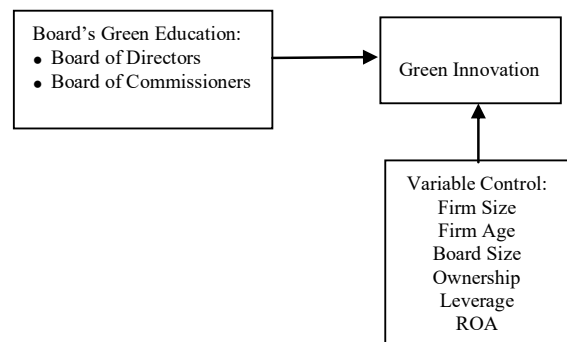


Fig. 1. Conceptual framework

Based on fig. 1, we formulate the equation modeling in this study are:

- Equation (1):

$$GI_{it} = \alpha_0 + \alpha_1 Dir.GrEdu_{it} + \alpha_2 FS_{it} + \alpha_3 FA_{it} + \alpha_4 BS_{it} + \alpha_5 Own_{it} + \alpha_6 Lev_{it} + \alpha_7 ROA_{it} + \epsilon_{it} \quad (1)$$

- Equation (2):

$$GI_{it} = \alpha_0 + \alpha_1 Comm.GrEdu_{it} + \alpha_2 FS_{it} + \alpha_3 FA_{it} + \alpha_4 BS_{it} + \alpha_5 Own_{it} + \alpha_6 Lev_{it} + \alpha_7 ROA_{it} + \epsilon_{it} \quad (2)$$

Notes:

- GI = Green innovation
- Dir.GrEdu = Board of director’s green education
- Comm.GrEdu = Board of commissioner’s green education
- FS = Firm size
- FA = Firm age
- BS = Board size
- Own = Ownership
- Lev = Leverage
- ROA = Return on Assets
- $\epsilon$  = Error

**IV. RESULTS AND DISCUSSIONS**

**A. Descriptive Statistics**

Table 1 shows that the average sample companies have implemented the GI with a value of 0.83. Furthermore, the average value of Dir.GrEdu is 0.73, and the average value of Comm.GrEdu is 0.59. This indicates that, on average, the majority of the sampled companies have directors or commissioners with green training.

TABLE I. DESCRIPTIVE STATISTICS

Variables	N	Min	Max	Mean	Std. Deviation
GI	105	0.40	1.00	0.83	0.158
Dir.GrEdu	105	0	1	0.73	0.444
Comm.GrEdu	105	0	1	0.59	0.494
FS	105	11.82	25.41	15.84	4.063
FA	105	10	53	30.67	12.393
BS	105	3	11	5.29	1.742
Own	105	0	1	0.19	00.395
Lev	105	8.80	96.13	48.44	24.379
ROA	105	-19.89	60.54	12.07	14.579

**B. Statistical Test Results**

Equation (1). The information in Table 2 pertains to the findings of the regression test of equation (1), which examines the effect of the board of director’s green education on green innovation. The p-value ( $p < 0.01$ , = 0.143) indicates that the green education of the board of directors has a positive and significant effect on the implementation of green innovation. This means that green

training attended by members of the board of directors in mining, quarrying, and oil and gas extraction companies has a role in driving green innovation strategies in order to achieve company sustainability.

TABLE II. REGRESSION TEST RESULTS FOR EQUATION (1)

Variabel	GI		
	B	t-value	P> t
Dir.GrEdu	0.143	4.59	0.000
FS	0.002	0.74	0.463
FA	0.002	1.43	0.156
BS	-0.007	-0.74	0.462
Own	0.041	1.02	0.311
Lev	-0.001	-1.56	0.123
ROA	-0.002	-2.07	0.041
Number of Obs	105		
Prob > F	0.000		
R <sup>2</sup>	0.340		
Adj R <sup>2</sup>	0.292		

Equation (2). Table 3 provides information related to the results of the regression test of equation (2), which examines the effect of the board of commissioners' green education on green innovation. The p-value ( $p < 0.01$ , = 0.085) indicates that the green education of the board of commissioners has a positive and significant effect on the implementation of green innovation. This means that green training attended by members of the board of commissioners in mining, quarrying, and oil and gas extraction companies has a role in driving green innovation strategies to achieve company sustainability

TABLE III. REGRESSION TEST RESULTS FOR EQUATION (2)

Variabel	GI		
	B	t-value	P> t
Comm.GrEdu	0.085	2.66	0.009
FS	0.003	0.82	0.416
FA	0.003	1.73	0.086
BS	-0.011	-1.19	0.238
Own	0.037	0.85	0.398
Lev	-0.001	-1.85	0.067
ROA	-0.002	-2.03	0.045
Number of Obs	105		
Prob > F	0.000		
R <sup>2</sup>	0.252		
Adj R <sup>2</sup>	0.197		

**V. CONCLUSION AND IMPLICATION**

Environmental sustainability is an ecological responsibility that must be considered, especially in mining, quarrying, and oil and gas extraction companies whose operating activities have the potential to harm the environment. An environmentally-oriented innovation strategy through the implementation of green innovation is an innovation that applies green principles in business practices that are expected to provide added value for the company economically, socially, and environmentally. The role of the board of directors and the board of commissioners is a critical factor in implementing the company's sustainability strategy.

The results of statistical testing utilizing two equation models indicate that the role of green education through

training with environmental/green/sustainable themes has a positive and statistically significant effect on the adoption of green innovation in mining, quarrying, and oil and gas extraction businesses. The results of this study are expected to provide implications related to the commitment to building the capacity of the board of directors and the board of commissioners to participate in a variety of training programs that provide additional knowledge and skills, especially those related to environmental/green/sustainable themes.

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