Effect of Top Management Team Characteristics and Green Innovation on Firm Performance in Indonesia: Role of Carbon Emission Disclosure

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ABSTRACT

The purpose of this study is to investigate whether top management team (TMT) characteristics and green innovation (GI) affect firm performance, and if so, whether the effect is mediated by carbon emission disclosure (CED). This quantitative study employs the partial least square structural equation modeling (PLS-SEM) to test the hypotheses. The data were collected from the high-profile companies listed in the Indonesia Stock Exchange (IDX) for the 2015-2019 period. A mediating research framework was developed to explain the association among constructs. Using agency theory and sustainability theory (triple bottom line), the results show the following findings. First, TMT characteristics positively affect firm performance. Second, GI positively affects on firm performance. Third, CED partially mediates the effect of TMT characteristics on firm performance. Fourth, CED partially mediates the effect of GI on firm performance. The current study addresses the existing research gaps and debates in the previous studies in term of proposing a more comprehensive framework by adding CED as a mediating variable. This study also builds a new dataset and focuses on environmental issues in the Indonesian research setting as an emerging country and a two-tier governance system adopter.

Keywords: TMT Characteristics, Green Innovation, Carbon Emission Disclosure, Firm Performance, Economic Growth and Productivity
JEL Classifications: O3, G34, L25

1. INTRODUCTION

Firm performance has a crucial role because it reviews the work of company's management. Companies that want to survive in a competitive business environment have to innovate and maintain performance in all conditions (Taouab and Issor, 2019). A superior performance is a way to satisfy investors and is reflected in terms of profitability, growth, and market value (Cho and Pucik, 2005). Firm performance can be influenced by many factors, one of which is good corporate governance (GCG). In implementing GCG, Indonesia follows a two-tier GCG system which has *Dewan Direksi* (TMT) and *Dewan Komisaris* (Board of Commissioners). *Dewan Direksi* in a two-tier system is identical

to the Top Management Team (TMT) in a one-tier GCG system who is responsible for managing the company. *Dewan Komisaris* acts as the supervisor and advisor to *Dewan Direksi*. The current study focuses on TMT characteristics consisting of the proportion of women, education, size, nationality, and age.

Although some scholars have examined the effect TMT characteristics on firm performance, the results are still inconsistent. Several previous studies have stated that TMT characteristics (proportion of women, education, size, nationality, and age) have a positive effect on firm performance (Nyeadi et al., 2021; Papadimitri et al., 2020; Pucheta-Martínez and Gallego-Álvarez, 2020; Badru and Raji, 2016; Fernández-Temprano and

Tejerina-Gaite, 2020). In contrast, several previous studies have shown that TMT characteristics have a negative effect on firm performance (Aggarwal et al., 2019; Hussain et al., 2018; Khan and Subhan, 2019; Tanikawa et al., 2017). This research gap provides the opportunity to conduct further studies.

In addition to TMT characteristics, another important factor that influences firm performance is green innovation (GI). In the era of sustainability, GI has become a popular concept in the recent years due to the issues of global warming and environmental damage which pose a serious threat to the world population (Miao et al., 2017). GI is a new technology (hardware or software) related to products or production processes that lead to energy efficiency, pollution reduction, waste recycling, environmentally friendly product design, and corporate environmental management (Chen et al., 2006; Zheng et al., 2020). Previous studies by scholars (Huang and Li, 2017; Tang et al., 2018; Xue et al., 2019; Zhang et al., 2019) prove that GI positively affects firm performance. GI can increase market value through production process efficiency (Salvadó et al., 2015). However, Palmer et al. (1995) proved that companies involving in GI could become inefficient and suffer in productivity losses. This gap also justifies further investigations.

The current study argues that the research gaps in previous studies are due to ignoring the notion that TMT characteristics and GI do not directly affect firm performance but through a mediator. Therefore, the current study proposes carbon emission disclosure (CED) as a mediating variable for the following reasons: (1) there are previous studies regarding the effect of TMT characteristics on CED (Al-Qahtani and Elgharbawy, 2020; Kılıç and Kuzey, 2019; Lee et al., 2021; Liao et al., 2015; Nuber and Velte, 2021); (2) the existence of previous studies on the effect of GI on CED (Li and Zeng, 2020; Zhang et al., 2020; Yue et al., 2021); (3) the existence of previous research on the effect of CED on firm performance (Alsaifi et al., 2020; Cucchiella et al., 2017; Hardiyansah et al., 2021; Lewandowski, 2017; Soewarno et al., 2018; Trinks et al., 2020); (4) companies need to disclose environmental information to create a good image for stakeholders, one of which is carbon emission management (Kurnia et al., 2020). According to (Delmas and Nairn-Birch, 2011), the better the CED, the better the company's profitability performance.

This study has two important issues to addresss, namely: (1) investigating the mediating role of CED on the relationship between TMT characteristics and firm performance; and (2) examining the mediating role of CED on the relationship between GI and firm performance. Thus, the current study supports the development of agency theory and sustainability theory in term of proposing a more comprehensive framework by adding CED as a mediating variable, and focusing on environmental issues in the Indonesian research setting as an emerging country and a two-tier governance system adopter. The current study has three research questions, namely: (1) Do TMT characteristics affect firm performance?; (2) Does GI affect firm performance?; (3) Does CED mediate the effect of TMT characteristics on firm performance?; (4) Does CED mediate the effect of GI on firm performance?

This is a quantitative study conducted on the high-profile companies listed in the Indonesia Stock Exchange (IDX) for the 2015-2019 period. It employs the partial least squares structural equation modeling (PLS-SEM) to analyze and test the hypotheses studied. The findings prove that: (1) TMT characteristics positively affect firm performance; (2) GI positively affects on firm performance; (3) CED partially mediates the effect of TMT characteristics on firm performance; (4) CED partially mediates the effect of GI on firm performance.

The current study has theoretical and practical contributions. Theoretically, it provides empirical evidence to the developments on agency theory (Jenson and Meckling, 1976) and sustainability theory. Specifically, it provides empirical evidence of the effect of TMT characteristics and GI on firm performance with CED as a mediating variable in Indonesian high-profile companies. Practically, it provides guidance on how to improve firm performance by properly managing good corporate governance, green innovations and CED. The findings can be a useful reference for further researchers who are interested in studying the characteristics of TMT, GI, CED, and firm performance.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Agency theory by Jenson and Meckling (1976) states that there are differences in interests between principals (shareholders) and agents (management). Those differences potentially lead to agency conflicts that cause agency costs (Bhatt and Bhatt, 2017). According to Fama and Jensen (1983), to align the goals of principals and agents, the agency theory suggests to separate decision-making and to reduce managers' discretion through implementing good corporate governance (GCG). GCG has been proven to reduce agency problems and encourage companies to operate as expected (Terjesen et al., 2014). In implementing GCG, TMT plays an important role (Chari et al., 2019; Schillemans and Bjurstrøm, 2020; Vitolla et al., 2020). TMT is responsible for increasing the company's sustainability following the expectations of shareholders (Nuber et al., 2020; Teece, 2019). This is because TMT is the company's highest decision maker who determines firm performance.

Sustainability theory explains that a balance is needed in managing the environmental, economic, and social issues to achieve sustainability. The concept of Triple Bottom Line (TBL) is introduced by Elkington (1997). According to Székely & vom Brocke (2017), companies need to adopt sustainability strategies into their businesses by implementing new governance and performance strategies that involve their shareholders.

2.1. TMT Characteristics and Firm Performance
Discussions on the role of good governance in improving firm performance relate to agency theory stating that there is a conflict of interest between management and stakeholders (Jenson and Meckling, 1976). The implementation of good governance is expected to minimize the conflict of interest. TMT has a critical role as the key element of good governance structure of a company

because all important decisions relate to TMT. Therefore, TMT characteristics are important in determining firm performance. A study by Fernández-Temprano and Tejerina-Gaite (2020) on 87 non-financial companies in Spain proved that the age diversity of chief executive officer has a positive influence on firm performance. Nyeadi et al. (2021) conducted a study in 720 companies in Ghana and proved that the involvement of women in TMT ranks positively affects company performance. A study by Pucheta-Martínez and Gallego-Álvarez's (2020) proved that board size, board independence, and the involvement of female directors positively affect corporate performance. Thus, the better the good governance structure proxied by TMT characteristics, the better the firm performance. Based on the previous arguments, the first hypothesis is proposed as follows:

H_1: TMT characteristics are positively associated with firm performance

2.2. Green Innovation and Firm Performance

Sustainability theory operationalized by TBL suggests that company's sustainability performance can be achieved if the company has the capability to balance environmental, social, and economic issues. By implementing GI, a company can improve sustainability performance and ecological and energy efficiency (Li et al., 2018). GI is divided into two processes, namely green product innovation (GPI) and green process innovation (GPR) (Wong et al., 2012; Tang et al., 2018). GPI aims to reduce environmental impact during the product life cycle (Christensen, 2011). On the other hand, GPR aims to reduce energy consumption during production or convert waste into valuable goods (Salvadó et al., 2012). According to Xie et al. (2019), these two innovations will drive better competitive advantage and firm performance. A study by Tang et al. (2018) on 188 manufacturing companies in China proved that GPR and GPI have a positive and significant effect on firm performance. Xue et al. (2019) conducted a study on 256 companies in China and proved that GI positively affects operational, financial, and environmental performance. Research by Zhang et al. (2019) on 764 companies in China proved that GI improves sales growth performance. In summary, the better the green innovation the better the firm performance. Based on the previous argument, the third hypothesis is proposed as follows:

H_2: Green innovation is positively associated with firm performance

2.3. Mediating Role of CED on TMT Characteristics-firm Performance Relationship

Agency theory states that to solve conflict of interest between management and stakeholders, a company needs good governance system. The role of TMT is very important in implementing a successful good governance because TMT is responsible for all business processes and decision-making within the organization (Shar Baloch, 2020; Saleh et al., 2020). The decision regarding carbon emission disclosure is also under control of TMT. A study by Al-Qahtani and Elgharbawy (2019) on 165 companies in the UK proved that the representation of female directors on the TMT positively affects the disclosure and management of greenhouse gas information. Kılıç and Kuzey's (2019) conducted research on

154 companies in Turkey and proved that companies with more independent directors are more sensitive in responding to carbon disclosure projects.

Carbon emission disclosure (CED) is a strategy for responding to stakeholders' demands so that companies do not ignore environmental problems in carrying out their operations. Implementing CED is expected to improve the company's reputation and increasing company value (Hardiyansah, 2021). A study by Soewarno et al. (2018) on 87 companies proved that carbon disclosure project positively affects financial performance. A study by Alsaifi et al. (2020) on 350 companies in the UK proved that voluntary carbon disclosure positively affects financial performance. Another study by Trinks et al.' (2020) on 1572 international companies proved that superior financial performance is found in carbon-efficient companies. Based on the previous explanation, the following third hypothesis is proposed:

H_3: CED mediates the effect of TMT characteristics on firm performance.

2.4. Mediating role of CED on Green Innovation-firm Performance Relationship

TBL states that management needs to balance environmental, social, and economic issues to achieve sustainability goals (Elkington, 1997). Green innovation plays a crucial role in firm sustainability. A study by Xu et al. (2021) proved that GI positively affects carbon emission performance in China. Companies with environmentally friendly innovations are driven uncover carbon emission problems in their operational activities. According to Hardiyansah (2021), the increasing public awareness of the importance of environmental sustainability, CED will create a good response from the market and society so that it has a significant impact on firm performance. Based on the previous arguments, the following fourth hypothesis is proposed:

H_4: CED mediates the effect of green innovation on firm performance.

3. METHODOLOGY

3.1. Sample and Data Collection

The data were derived from all high-profile companies listed on the IDX for the period of 2015-2019. The purposive sampling method was employed with the following criteria: (1) the company must be a high profile company listed on the Indonesia Stock Exchange for the 2015-2019 period; (2) the company must publish annual reports and or sustainability reports; (3) the company must disclose carbon emissions in annual reports or sustainability reports. Based on the criteria, as many as 156 firm-year data were obtained.

3.2. Definitions and Measurements
3.2.1. TMT characteristics
Table 1 shows the definition and measurement used in measuring TMT characteristics. Green Innovation (GI) is defined as the formulation and development of operating products, services, and processes that reduce environmental damage with available alternatives. GI consists of two processes, namely green product

Table 1: Definition and measurement of TMT characteristics

Indicators	Definition	Measurement	References
Proportion of female TMT	The proportion of female TMT is measured by the ratio between the number of female TMT and the total number of the entire TMT	The proportion of Female TMT=Number of female TMT/Total ranks of TMT	Pucheta-Martínez and Gallego-Álvarez (2020)
CEO educational background	The educational background of CEO	The bachelor's, master's, MBA, and Ph.D. education levels taken by the president director are given a value of 1. If the CEO does not take the education, it is given a value of 0. *Score=Bachelor+2 x Master+2 x MBA+3 x PhD*	Papadimitri et al. (2020)
CEO nationality	Nationality of the CEO	It is measured by a dummy variable, which is given a value of 1 if the CEO is a foreign national and given a value of 0 if it comes from Indonesia.	Badru and Raji (2016).
TMT size	Total Number of TMT	TMT Size=Σ All members of the TMT	Pucheta-Martínez and Gallego-Álvarez (2020)
CEO age	Age when the CEO in the office.	CEO Age=Year in office – Year of birth	(Naseem *et al*., 2019)

innovation (GPI) and green process innovation (GPR) (Wong et al., 2012; Tang et al., 2018).

3.2.1.1. Green product innovation
Green Product Innovation (GPI) is the improvement of new products or services that do not negatively impact the environment. In the current study, GPI is analyzed using information disclosed in the sustainability report and annual report by assessing it through 12 keywords (environmental, green, sustainable, ecology, clean, cycling, saving, low carbon, emission reduction, energy saving, environmental protection, and environmental, pollution). If there is a disclosure by the company, then a rating of 1 will be given and 0 otherwise. Then, an index is obtained by dividing the total disclosures by 12 as inspired by the studies of Cormier and Magnan (2015) and Li et al. (2016).

Green Product Innovation = Total information disclosed/12.

3.2.1.2. Green process innovation
Green Process Innovation (GPR) is defined as improving the production process and using environmentally friendly technologies to reduce negative environmental impacts. To measure GPR, the current study uses the award from the Ministry of the Environment obtained by each company. The name of the award is PROPER (Firm Performance Rating and Environmental Management Program) which consists of five categories. The assessment score is 5 for companies in the gold category, a score of 4 for companies in the green category, a score of 3 for companies in the blue category, a score of 2 for companies in the red category, a score of 1 for companies in the black category and a score of 0 for companies that are not in the PROPER category.

3.2.2. Carbon emission disclosure
Carbon Emission Disclosure (CED) is one of the environmental information that provides information about carbon accounting from industrial processes, determining carbon reduction targets, reporting systems, and developing carbon reduction programs. Referring to Bae Choi et al. (2013), CED was measured by 18 disclosure indicators which were divided into five categories.

The categories relate to climate change: risk and opportunities, GHG emissions accounting, energy consumption accounting, GHG deduction and cost, and carbon emission accountability. Each indicator is given a score of 1 if it is disclosed, and a score of 0 is given if it is not disclosed. A maximum score of 18 will be awarded when a company discloses all information.

Carbon Emission Disclosure = Information disclosed.

3.2.3. Firm performance
Firm performance describes the company's management ability to manage resources. In the current study, firm performance is measured by financial performance and firm value using the formula presented in Table 2.

3.2.4. Control variables
The current study employs two control variables that affect firm performance. Both variables refer to the previous studies using the firm size and firm age. These variables are presented in Table 3.

3.3. Analysis
To test the hypohesis, the current study employs the partial least square structural equation modeling (PLS SEM). The PLS SEM is suitable for this current study due to the following reasons, namely: (1) its ability to test complex models simultaneously (Sholihin and Ratmono, 2013); (2) its effectiveness to test the secondary data from a measurement theory perspective (Hair et al., 2017); and (3) its ability to produce accurate tests using relatively small data (Sholihin and Ratmono, 2013). The PLS SEM consists of two steps: (1) the measurement model analysis; (2) the structural model analysis.

4. RESULTS

4.1. Descriptive Statistics
Table 4 shows the result of descriptive statistics. Based on the values of standard deviation and mean, the data of proportion of female TMT, ROA, ROE, and Tobin's Q tend to vary. Meanwhile, the data of CEO education, TMT size, CEO age, GPI, GPR, CED,

Table 2: Definition and measurement of firm performance

Variables	Definition	Measurement	Reference
Return on Assets (ROA)	ROA describes how company assets are used to generate profits.	$ROA_{i,t} = $ Net Income/ Total Assets $_{i,t}$	Kyere and Ausloos (2021)
Return on Equity (ROE)	ROE describes the company's ability to generate profits for shareholders by using their own capital.	$ROE_{i,t} = $ Net Income Total Equity i, t $_{i,t}$	Assenga *et al.*, 2018
Leverage	Leverage is used to measure company funding that is financed from debt.	$LEV_{i,t} = $ Total Debt Total Assets i, t $_{i,t}$	Poletti-Hughes and Briano-Turrent, 2019
Current Ratio	The current ratio is used to measure the company's liquidity position.	$CR_{i,t} = $ Current Assets Current Liabilities i, t $_{i,t}$	Vairavan and Zhang (2020)
Tobins' Q	Tobin's Q is used to measure firm value.	Tobin's $Q_{i,t} = $ MCCS $_{i,t+BVLi,t}$ BVTA $_{i,t}$	Pucheta-Martínez and Gallego-Álvarez (2020)

Table 3: Definition and measurement of control variable

Variables	Construct	Description	References
SIZE	Firm Size	Natural logarithm of total assets	Assenga *et al.* (2018)
AGE	Firm Age	Number of years which the firm has been listed.	Harjoto *et al.* (2019)

Table 4: Descriptive statistics

Variable	n	Minimum	Maximum	Mean	SD
Proportion of female TMT (TMT1)	156	0	0.57	0.0853	0.1337
CEO education (TMT2)	156	0	8	2.1987	1.60411
TMT size (TMT3)	156	2	10	5.6026	1.9925
CEO nationality (TMT4)	156	0	1	-	-
CEO age (TMT5)	156	38	70	53.0897	6.23142
Green product innovation (GPI)	156	0.25	1	0.8226	0.16659
Green process innovation (GPR)	156	0	5	2.0321	1.90219
Carbon emission disclosure (CED)	156	1	18	9.4295	4.78453
Return on asset (ROA)	156	−0.58	0.92	0.0637	0.12758
Return on equity (ROE)	156	−0.78	2.24	0.1215	0.2913
Leverage (LEV)	156	0.02	1.9	0.436	0.26109
Current ratio (CR)	156	0.11	8.05	1.7492	1.36854
Tobin's Q (TQ)	156	0.36	14.12	2.5483	2.87319
Firm age (AGE)	156	0	38	18.7949	8.9592
Firm size (SIZE)	156	21.92	33.03	29.7278	2.04216

Leverage, Current Ratio, Firm Age, and Firm size do not tend to vary.

4.2. Pearson Correlation
Table 5 shows the result of Pearson correlation. A value of more than 0.5 indicates a relatively strong correlation, while a value of <0.5 indicates a weak correlation. A positive sign indicates a unidirectional correlation, while a negative sign indicates an opposite correlation.

4.3. Measurement Model Analysis
The PLS-SEM used in the current study consists of measurement model analysis and structural model analysis. The measurement model assesses the relationship between measures and construct by evaluating the reliability and validity of measure of specific construct. It determines the correspondence rules between the measured and latent variables (Hair et al., 2010). The three criteria used to assess each construct in the measurement model consist of composite reliability, convergent validity, and discriminant validity. The current study uses the minimum factor loading value of 0.6 and the composite reliability of more significant than 0.7 (Chin, 1998; Hair et al., 2013). In the first iteration, CEO age is an invalid indicator of TMT characteristics because its factor

loading was 0.524 (<0.6). Therefore, CEO age was omitted from the construct indicator of TMT characteristics in further analysis.

The current study assesses construct validity by evaluating convergence validity and discriminant validity. The average variance extracted (AVE) is used to assess convergent validity. The value of AVE must exceed 0.5 which indicates that each indicator fulfills one part of the variance of its indicators. In discriminant validity, the square root of AVE of a construct must be greater than the correlation between the construct with another construct (Sholihin and Ratmono, 2021). The reliability is assessed using composite reliability (CR) and its value must be greater than or equal to 0.7 (Hair Jr. et al., 2017). Table 6 presents the result of convergent validity test. The AVE values for TMT characteristics, GI, CED, and firm performance are 0.678. 0.664, 0.754, 0.678, respectively. The composite reliability values for TMT characteristics, GI, CED, and firm performance are 0.887, 0.860, 1.000, and 0.912, respectively.

Table 7 presents the result of discriminant validity test. The test ensures that the square root of the AVE shown in the diagonal column must be greater than the correlation between constructs in the same column (Sholihin and Ratmono, 2021). The TMT

Table 5: Pearson correlation

Variables	TMT1	TMT2	TMT3	TMT4	TMT55	GPI	GPR	CED	FP1	FP2	FP3	FP4	KP5	AGE	SIZE
TMT1	1														
TMT2	−0.194**	1													
TMT3	−0.062	0.071	1												
TMT4	−0.122*	0.175**	0.017	1											
TMT5	−0.069	−0.342**	0.07	−0.217***	1										
GPI	−0.155*	−0.034	0.284***	0.063	0.151*	1									
GPR	−0.325***	−0.08	0.226**	0.205**	0.159**	0.508***	1								
CED	−0.345***	0.173**	0.211***	0.191***	−0.162**	0.509**	0.465***	1							
FP1	−0.008	0.059	0.061	0.393***	−0.105	−0.129	0.15*	0.191**	1						
FP2	0.001	0.008	−0.011	0.388***	−0.063	−0.084	0.199**	0.158**	0.846***	1					
FP3	−0.034	0.016	−0.244***	−0.0472	0.064	0.045	0.072	−0.142*	−0.276***	−0.022	1				
FP4	−0.039	0.066	0.068	0.161**	−0.002	−0.157*	0.008	−0.049	0.261***	0.083	−0.539***	1			
FP5	−0.16*	0.062	−0.178**	0.166**	−0.096	−0.342***	−0.059	−0.009	0.38***	0.384***	0.026	0.039	1		
AGE	−0.182**	0.095	−0.171**	0.08	−0.052	−0.13	0.122	0.142*	0.358***	0.404***	0.155*	0.131	0.305***	1	
SIZE	−0.174**	−0.032	0.277***	−0.042	0.065	0.303***	0.331***	0.421***	−0.0003	0.013	−0.025	−0.063	−0.263***	0.108	1

Table 6: Results of convergent validity

Construct	Factor loading	P-value
TMT characteristics		
Composite reliability=0.887; AVE=0.664		
Proportion of female TMT	0.816	<0.001
CEO education	0.858	<0.001
TMT size	0.710	<0.001
CEO age	0.867	<0.001
Green innovation (GI)		
Composite reliability=0.860; AVE=0.754		
Green product innovation	0.868	<0.001
Green process innovation	0.868	<0.001
Carbon emission disclosure (CED)		
Composite reliability=1.000; AVE=1.000		
Carbon emission disclosure	1.000	<0.001
Firm performance		
Composite reliability=0.912; AVE=0.678		
Return on asset	0.647	<0.001
Return on equity	0.806	<0.001
Leverage	0.769	<0.001
Current ratio	0.890	<0.001
Tobin's Q	0.968	<0.001

characteristics GI, CED, and firm performance are 0.815, 0.868, 1.000, and 0.823, respectively, which are the highest value compared to the construct values horizontally. In conclusion, the measurement model of this study is valid and reliable.

4.4. Structural Model Analysis

The structural model analysis aims to test the hypothesis studied. It investigates the effect of TMT characteristics and GI on firm performance directly and indirectly (mediated by CED). Table 8 (Panel A) shows that TMT characteristics is positively associated with firm performance ($\beta = 0.39$; $P < 0.01$; $R^2 = 0.31$). GI is also positively associated with firm performance ($\beta = 0.22$; $P < 0.01$). Thus, the first hypothesis and the second hypothesis are supported.

Table 8 (Panel B) shows that the direct effect of TMT characteristics on firm performance after including the mediating variable of CED has decreased from 0.39 to 0.21 but it remains significant ($P < 0.01$). Furthermore, the direct effect of GI on firm performance after including the mediating variable of CED has also decreased from 0.22 to 0.17 but it remains significant ($P = 0.02$). The results indicate the existence of partial mediation (Kock, 2014). Thus, the third hypothesis and the fourth hypothesis are supported.

5. DISCUSSION

5.1. TMT characteristics and firm performance

As predicted by agency theory, the empirical results support the first hypothesis stating that TMT characteristics are positively associated with firm performance. This is in line with agency theory explaining the crucial role of good governance in achieving firm performance. TMT characteristics represent good governance structure. TMT is the key to the success of a good governance execution because they are the key decision makers in the company (Shar Baloch, 2020; Saleh et al., 2020). In the current study TMT characteristics consist of the proportion of female in TMT, CEO educational background, TMT size, CEO age, and CEO nationality.

Table 7: Result of discriminant validity

Variables	TMT characteristics	Green innovation	Carbon emission disclosure	Firm performance
TMT characteristics	**0.815**	0.11	0.172	0.202
Green innovation (GI)	0.11	**0.868**	0.561	0.355
Carbon emission disclosure (CED)	0.172	0.561	**1**	0.435
Firm performance	0.202	0.355	0.435	**0.823**

Table 8: Results of structural model analysis

Panel A (before mediation)	
From	**To**
	Firm performance
TMT characteristics	0.389***
Green innovation	0.223***
R^2	0.31

Panel B (after mediation)		
From	**To**	
	Carbon emission disclosure	**Firm performance**
TMT characteristics	0.359	0.214***
Green innovation	0.475	0.167**
Carbon emission disclosure		0.367***
R^2	0.45	0.41

*** $P<0.01$; ** $P<0.05$; ***; * $P<0.1$

The findings are in line with the studies of Fernández-Temprano and Tejerina-Gaite (2020), Pucheta-Martínez and Gallego-Álvarez (2020), and Nyeadi et al. (2021). In the context of Indonesia that follows a two-tier good governance system, the findings confirm and provide empirical evidence that a good governance structure represented by TMT characteristics determines firm performance. The proportion of female in TMT, CEO educational background, TMT size, and CEO nationality are the key attributes that must be considered by investors, management, and other stakeholders who are concerned with good corporate governance and firm performance. Indonesia has passed several regulations to support the participation of women in leadership. Indonesia has transformed policies and regulations to enhance the quality of human capital in terms of education, abilities, and talents as important keys of growth, job creation, and innovation (RDK, 2020). In summary, the empirical results of the current study confirm and provide the evidence that the better the good governance structure proxied by TMT characteristics, the better the firm performance.

5.2. Green innovation and firm performance

As predicted by sustainability theory, especially the triple bottom line (TBL), the empirical results support the second hypothesis stating that GI is positively associated with firm performance. In this study, GI consists of GPI and GPR. The findings support sustainability theory explaining that sustainability performance will be achieved if the company properly manages the environment, social, and economic issues. These findings support some previous studies of Al-Qahtani and Elgharbawy (2019), Kılıç and Kuzey (2019), and Lee et al. (2021). In the context of Indonesia, the findings provide important empirical evidence regarding the efforts in reducing negative impacts of corporate activities to the environment.

Indonesia has passed the regulation to protect and manage the environment, namely the Law Number 32 of 2009 which contains planning, utilization, control, maintenance, supervision, and law enforcement. This law binds all organizations operating in Indonesia, especially high-profile companies which have a high potential to pollute the environment. Therefore, companies must innovate in term of product innovation and environmentally friendly process innovation. Indonesia also has established the Ministry of Environment and Forestry to ensure the implementation of environmental protection and management laws and regulations. In carrying out its activities, the Ministry awards PROPER (Company Performance Rating Program in Environmental Management) which is given to the companies that demonstrate compliance with environmental management laws and regulations.

Some green innovations have been made by the Indonesian companies. For example, in terms of green product innovation, a mineral water producer has improved its performance by launching a product innovation. The company has developed environmentally friendly bottles produced from 100% recycled polyethylene terephthalate (RPET) which is comparable to pure plastic seeds (Tanobel, 2020). In term of green process innovation, a company has succeeded in carrying out sustainable business practices gaining the 4 awards at the 2019 Indonesia Green Awards. In summary, the better the green innovation (green product innovation and green process innovation), the better the firm performance.

5.3. Carbon emission disclosure mediates the effect of TMT characteristics on firm performance

This research proves that carbon emission disclosure mediates the effect of TMT characteristics on firm performance. These findings empirically prove that carbon emissions disclosures partially mediate the effect of the TMT characteristics on the firm's performance. These results support the TMT characteristics research on CED (Al-Qahtani and Elgharbawy, 2020; Kılıç and Kuzey, 2019; Lee et al., 2021; Liao et al., 2015; Nuber and Velte, 2021). The results of this study also support CED research on firm performance (Alsaifi et al., 2020; Cucchiella et al., 2017; Hardiyansah et al., 2021; Lewandowski, 2017; Soewarno et al., 2018; Trinks et al., 2020). As stated by agency theory, GCG reflected through the characteristics of the TMT affects CED because they are responsible for all decisions, including those related to environmental care. In addition, CED disclosure can also improve firm performance because investors can give a higher assessment to companies that implement carbon efficiency (Trinks et al., 2020). The results of this study support sustainability theory, which states that the firm's performance will be sustainable if the company can balance economic, social, and environmental activities. In conclusion, the better the good governance structure (proxied by TMT characteristics), the better the CED. Furthermore, the better the CED, the better the firm performance.

5.4. Carbon emission disclosure mediates the effect of green innovation on firm performance

This research proves that carbon emission disclosure mediates the effect of green innovation on firm performance. These findings empirically prove that carbon emission disclosures partially mediate the effect of green innovation on firm performance. These results support the GI study of CED (Li and Zeng, 2020; Zhang et al., 2020; Xu et al., 2021; Yue et al., 2021). As previously discussed, the results of this study also support CED research on firm performance (Alsaifi et al., 2020; Cucchiella et al., 2017; Hardiyansah et al., 2021; Lewandowski, 2017; Soewarno et al., 2018; Trinks et al., 2020). The results of this study support sustainability theory, which reveals that GI can improve carbon emission performance through direct and indirect carbon emission reduction innovations. When companies implement GI, the community will benefit from reducing carbon emissions, more green products will be available and economic growth so that people's quality of life will improve. In conclusion, it is empirically proven that the better the green innovation (green product innovation and green process innovation), the better the CED. Furthermore, the better the CED, the better the firm performance.

6. CONCLUSION, CONTRIBUTIONS, AND LIMITATION

6.1. Conclusion

This study uses 156 firm-year high-profile companies listed on the Indonesia Stock Exchange for the 2015-2019 period by investigating the relationship of four constructs, namely the characteristics of the TMT, green innovation, carbon emission disclosure, and firm performance. We use agency theory and sustainability theory to explain the relationship between each construct. SEM PLS was used to test the hypotheses, and the results showed that all hypotheses were supported. The results have answered the four main research questions previously stated in the introduction and become the main contribution of this study. First, the characteristics of the TMT have a positive effect on firm performance. Second, green innovation has a positive effect on firm performance. Third, carbon emission disclosure partially mediates the relationship between the TMT characteristics and firm performance. Fourth, carbon emission disclosure partially mediates the relationship between green innovation and firm performance. The study's results prove that carbon emission disclosure is a mediator, as proposed.

6.2. Theoretical Contributions

Theoretically, the current study enhances the existing literature on the TMT characteristics, green innovation, carbon emission disclosures, and firm performance. First, it provides additional empirical evidence about the positive effects of the TMT characteristics and green innovation on firm performance. Second, the current study empirically proves the critical role of carbon emission disclosures in mediating the readiness of green human resources to improve business performance. This finding also strengthens the literature on the critical role of the TMT characteristics and green innovation in improving firm performance. In particular, it provides empirical evidence on the mediating effect of partial carbon emissions disclosures on the effect of the characteristics of the TMT and green innovation on firm performance. Investigations of the mediating effect of carbon emission disclosures are rarely investigated and, therefore, contribute to the absence of literature. In summary, these findings also imply that agency theory and sustainability theory are relevant to explain the determinants of firm performance.

6.3. Managerial Implication

The current study has the following managerial implications. First, it increases the understanding of the management of high-profile companies regarding the mechanism of how to improve firm performance. Second, it implies that in achieving a better firm performance, management and stakeholders must collaborate in building a good governance structure, GI, CED to face green economy challenges. They should provide specific green programs. Third, it has important implications for new policies or approaches to enhance firm performance in the era of sustainability.

6.4. Limitation and Future Research

This study has the following limitations. First, the limited number of high-profile companies in Indonesia that disclose their carbon activities through sustainability reports or annual reports results in a lack of information about CED. This is because the disclosure of carbon emissions in Indonesia is still voluntary. Second, the limited literature on CED makes it challenging to access secondary research information sources. It is recommended for: (1) OJK (Indonesian Financial Services Authority) to require reporting of carbon activities through a sustainability report or a sustainability statement in the annual report as a form of corporate social responsibility; (2) For tax regulators to immediately implement and tighten carbon tax in Indonesia so that carbon emissions in Indonesia can be reduced. (3) For the next researcher to test the same research model with different samples, periods, and types of industrial sectors to see the validity of the research model. It is also recommended to add new indicators of the characteristics of the TMT, such as tenure and board meeting frequency which have not been studied in this study.

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