

Does green innovation play an important role in the effect board gender diversity has on firm performance?

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Abstract

Purpose: This research is motivated by the developments in the debates in the literature about addressing the 17 SDGs promoted by the UN, particularly the urgent calls for green innovation and women's empowerment. This study aims to investigate the mediating role of green innovation in the effect board gender diversity has on firm performance.

Design/methodology: This research employs regression analysis. The data set comprises a sample of 518 public listed companies on the Indonesia Stock Exchange during the 2017 to 2019 period.

Findings: The results demonstrate that the presence of board gender diversity has a negative effect on green innovation and the relationship between green innovation and firm performance is insignificant. However, the results also show that board gender diversity has a positive effect on firm performance. More importantly, green innovation is not an essential factor in the relationship between board gender diversity and firm performance.

Research limitations/implications: This research only uses a sample of companies drawn from a single country; therefore, the implications of the results might only apply to emerging countries with similar conditions to Indonesia. Future research needs to have more samples drawn from multiple countries. Also, future research could apply, amongst others things, corporate governance characteristics as variables.

Practical implications: The findings from our results can, firstly, be used to support companies seeking to implement alternative low cost green innovations. Secondly, this paper can be used to give insight to the Indonesian government regarding its support for the business-based environment by strengthening the regulations pertaining to the environmental aspects, and providing incentives for companies to implement green innovations.

Social implications: Our results can be used as a reference to promote women's participation on the boards of firms. Furthermore, this study also describes the changes in people's behaviour regarding the use and consumption of green products and environmental concerns.

Originality/value: Our study contributes to the literature in many ways. First, it contributes to the literature on gender regarding the presence of female directors on boards by demonstrating they have a greater commitment to improving their firms' performance. Second, the findings also provide an

important insight into green innovation's role in the relationship between board gender diversity and firm performance. This is still a controversial issue, and here the results show that green innovation is not an important factor in the relationship between gender and improving firm performance.

Keywords: Green innovation, Firm performance, Board gender diversity, Sustainability, SDG, SDG05

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1. Introduction

In recent years, green innovation (GI) has become a popular concept, along with the issues of global warming and environmental damage, which pose a serious threat to the world's population. Sustainable development addresses humanity's aspirations for a better life while observing the limitations imposed by nature. The 17 sustainable development goals (SDGs) promoted by the United Nations (UN) aim to address the current and forthcoming stakeholders' needs and ensure a better and sustainable future for all, while balancing economic, social, and environmental developments (Fonseca, Domingues & Dima, 2020). Therefore, sustainability is a crucial concern (Zhang, Rong & Ji, 2019) and calls for green development and innovation require urgent action. However, investment in green innovation, whether it is in the manufacturing process or in environmental product designs, is costly (Lee & Min, 2015; Zhang et al., 2019). The concept of green, in terms of international economies and societies, has now changed, as components of research analysis that are relevant to the current issues now complete with strategic future orientations to support policies related to the transition towards a greener economy (Istudor, Dinu & Nitescu, 2021), including the role of green innovation in improving firm performance (Novitasari & Agustia, 2021; Tang, Walsh, Lerner, Fitza & Li, 2018). Rooted in this context, this study aims to investigate the impact of the implementation of green innovation by a company in order to improve firm performance.

Furthermore, research into the role of women on boards of directors has been a central topic in both academic and policy debates in recent years (Đăng, Houanti, Reddy & Simioni, 2020; Terjesen, Sealy & Singh, 2009). According to the UN, the proportion of women on boards of directors has also increased significantly, now reaching 26% (Catalyst, 2020). Amongst the SDGs, No.05 calls explicitly for gender equality and more empowerment for women and girls, as well as increased participation (Fonseca, Domingues & Dima, 2020). Previous research, on gender issues, which examined the composition and the role of women in the highest echelons of the boards of directors of organizations, considered it to be an ethical issue (Đăng et al., 2020). Furthermore, a study by Robinson and Dechant (1997) looked at the issue of women on boards through business case studies and found the presence of women could improve the quality of their boards' decision-making, which could also improve firm performance. According to research conducted by the United Nations, it is also documented that if women's representation should reach 30%, this would improve the quality of the decision-making (www.tirto.id, 7 September 2017). UN Economic and Social Council (ECOSOC) resolution 1990/15 called on governments, political parties, trade unions and other professional and representative groups to adopt a minimum 30% quota of women in leadership positions (Catalyst, 2020), with the aim of achieving equal representation. This study also sheds new light in this direction, by examining the impact board gender diversity has on firm performance.

Diving deeper into this issue, previous empirical evidence shows that the role of women on boards of directors could potentially increase the transparency and informativeness of information disclosures (Cecchetti, Allegrini & Monteduro, 2018; Gao, 2018; Gul, Srinidhi & Ng, 2011), while reducing information asymmetry (Abad, Lucas-Pérez, Mínguez-Vera & Yagüe, 2017). Other studies have shown that the presence of women on boards

of directors has increased their companies' value (Campbell & Mínguez-Vera, 2008), which in turn is linked to corporate innovation (Liu, 2018; Torchia, Calabrò & Huse, 2011). Gender diversity enhances a company's value through the mechanism of excellent creativity and innovation, as a firm with greater gender diversity engages in more innovation. Previous research has also demonstrated that women on boards of directors have a positive impact on companies in terms of their green innovations (He & Jiang, 2019). Specifically, research by Liu (2018) concluded that women on boards of directors have a positive impact on reducing the chances of legal prosecution for companies' environmental violations. However, these previous studies did not investigate the impact women on boards of directors have through green innovations on firm performance. Therefore, this study also aims to scrutinise the mediating role of green innovation on the effect gender diversity has on firm performance.

As outlined in previous studies (Đăng et al., 2020; Post & Byron, 2015), there exists some theoretical framework that can help us examine the impact of board gender diversity on firm performance, such as the agency theory (Jensen & Meckling, 1976), and the upper echelons theory (UET) (Hambrick, 2007). According to He and Jiang (2019), both the legitimacy theory (Suchman, 1995) and the UET (Hambrick, 2007) serve as a good theoretical basis for the corporate implementation of green innovation. Green innovation is a part of the significant issue of sustainability and its relationship with firm performance, which in turn relies on the stakeholder theory (de Leaniz & del Bosque, 2013; Fonseca & Ferro, 2016; McWilliams & Siegel, 2001). Existing evidence suggests that many companies have applied green innovations as a formal response to their need for environmental legitimacy (He & Jiang, 2019; Walls, Berrone & Phan, 2012). While some companies have adopted more green innovations than others, they are all exposed to the same level of pressure regarding legitimacy.

This study examines the role of green innovation in the relationship gender diversity has with firm performance. Our study follows Berrone, Fosfuri, Gelabert and Gomez-Mejia (2013), Fonseca and Ferro (2016) and, He and Jiang (2019) by adopting the framework of the UET and the stakeholder theory. Originally, the UET was focused on top management teams (He & Jiang, 2019) where the UET assumes that directors differ in terms of their cognitive frames, and that these cognitive differences significantly influence firm outcomes (Hambrick, 2007). These cognitive frames are difficult to measure, gender and age are examples of the observable characteristics of directors proxies for cognitive frames (Dezsö & Ross, 2012). The UET supports many attributes of gender diversity where women are related to environmental innovation (He & Jiang, 2019). It assumes that board gender (women on the board) could motivate a company's green practices (Berrone et al., 2013; He & Jiang, 2019). The UET emphasises that female directors have more concerns about the environment and they are more responsive to society (Adams, Licht & Sagiv, 2011; Carlson, 1972; Liu, 2018).

This study adds to the literature in different ways. First, the results contribute to the gender literature and the debate over what role female directors play in increasing a company's value. Likewise, the results show how female directors determine a company's policies, particularly those related to green innovation. Second, this research also contributes to studies into the impact women representatives on boards of directors have on firm performance, which currently is characterised by divergent findings (Chen, Leung & Evans, 2018; Matsa & Miller, 2013). This study complements the literature on the mediating role of green innovation on the effect gender diversity has on firm performance, with our results indicating that the relationship is not supported.

This study employs regression analysis, where the data set use a sample of 518 public listed companies on the Indonesia Stock Exchange, with 1,554 firm-year observations for the 2017 to 2019 period. This research applies in Indonesia, as a contribution of this study is its focus on assessing the implications of board gender diversity and green innovation practices in firms located in an emerging country, where its relevance is to increase firms' commitment to sustainable development goals (Martínez-Ferrero, Lozano & Vivas, 2021). Moreover, recent research highlights that research trends are changing to study the commitment of companies to sustainability in emerging economies such as Indonesia, which is one of the ASIAN powerhouses (Lau, Lu & Liang, 2016). The presence of female board chairs shows a better track record, as Indonesia has the highest proportion (11.7%) of female board chairs in ASEAN (www.ifc.org, 2021). The Government of Indonesia has set a target of 41% emission reductions by 2030, as part of its commitment to be involved in the SDGs

(www.greengrowth.bappenas.go.id, 2021). Therefore it is feasible for Indonesia to represent an emerging country with a commitment to establish SDGs.

The remainder of this article is structured as follows. In Section 2, this study summarises the literature and explains the development of our hypotheses. Then, in Section 3 we present the methodology used. The results are laid out in Section 4 and the conclusions, along with the study's contributions, implications and research limitations, are presented in Section 5.

2. Literature review and hypotheses development

2.1. Green innovation issues and firm performance: an institutional background

The importance placed on green innovation (GI) issues has been underpinned by the trending issue of sustainability around the world, by technological innovations which promote efficiency and introducing the use of clean and green resources as a new way to achieve sustainability (Cancino, La Paz, Ramaprasad & Syn, 2018; Zhang et al., 2019). GI's common purpose is to emphasise product and process innovations in terms of how they can improve a product's design and manufacturing processes using concepts such as saving energy, decreasing pollutants, minimising waste and reducing the negative impacts on the environment of a company's activities (Tang et al., 2018).

GI encompasses the conceptual issues which are concerned with the theory of development and methodological approaches to promote the understanding of innovation and the sustainability of development (Rennings, 2000). Therefore, GI and green development are two approaches to achieving strong policies in a company (Zhang et al., 2019). Also, regarding the concept of green and environmental orientations, international economies and societies have now changed and there are components of research analyses that are relevant to these current issues, complete with future-minded strategies, to support policy measures relating to the transition towards the green economy (Istudor et al., 2021).

Indonesia, as one of the emerging countries which has committed to the SDGs programme's implementation, has the PROPER (Public Disclosure Programme for Environmental Compliance) index for the implementation of environmentally-friendly policies. The PROPER is managed by the Ministry of the Environment and Forestry, and it facilitates the public disclosure of environmental compliance. The objective of the PROPER is to drive business and to increase managements' performance regarding the environment for sustainability aligned with science. The Government of Indonesia also has targeted a 41% emissions' reduction by 2030. The eco-innovation activities or green innovations that have been initiated by the Ministry of the Environment and Forestry are in accordance with the RPJMN's (the Mid Term Strategic Development Plan's) mission, which emphasises efforts to improve the management and implementation of development, so that a balance can be maintained between utilising natural resources and maintaining the function of the environment. According to the yearly book report of the Ministry of the Environment and Forestry, compliance by companies in Indonesia has reached 75%, from a total of 2,593 registered companies (listed companies and private companies) (<https://proper.menlhk.go.id/>, 2021). Therefore, Indonesia is suitable to represent an emerging country with a commitment to and support for the SDGs, particularly in their environmental concerns.

Firm performance (FP) typically refers to what is shown by a firm's financial and related indicators, such as sales, ROI, market share, stock market performance and related intangibles (Tang et al., 2018). This research follows the work of Darmadi (2011) where FP indicators use Tobin's Q, which is the ratio of a firm's market value to the book value of its assets.

2.2. Gender and corporate policies

According to Ryan (2017), gender plays an important role in people's decision-making. Furthermore, female representation on boards and as CEOs is an important determinant of the formulation of firms' corporate policies (Adams & Ferreira, 2009; Huang & Kisgen, 2013; Liu, 2018). Previous studies related to female representation on boards have demonstrated a significant impact on FP and more women being involved as

representatives on boards also has a significant impact in terms of better financial returns and market value (Campbell & Mínguez-Vera, 2008; Erhardt, Werbel & Shrader, 2003; Liu, Wei & Xie, 2014).

The global community's response to demands to change the composition of boards of directors and promote female CEOs has also been driven by publications on the topic of board diversity in corporate literature, the mass media, the wishes of stockholders and legal and regulatory requirements for the development of good corporate governance practices (Ben-Amar, Chang & McIlkenny, 2017). The literature has also found that women bring a different cognitive frame into board discussions due to their different experiences and knowledge, compared to men. Women are also more likely to possess a university degree or hold postgraduate degrees (Đặng et al., 2020). The existing studies into board gender diversity (BGD) support our argument that gender issues are seen as an important topic of discussion since the UN's SDG No.5 on gender equality is still far from being successfully fulfilled.

2.3. Board gender diversity and green innovation

This study uses Upper Echelon Theory (UET) as the basis for the relationship of BGD and GI, where the UET assumes that the individual characteristics of a board (such as gender) could motivate green innovation practices (Berrone et al., 2013; He & Jiang, 2019). The UET, originally presented by Hambrick & Mason in 1984, states that a managerial background characteristic is the determinant of an organization's choices and it affects its performance levels. Hambrick (2007) also argued that the experiences, values and personalities of executives have a significant influence on their decision-making. This UET supports many attributes of gender diversity where women are related to environmental innovation (He & Jiang, 2019). This theory emphasises that women have greater concerns about the share holders' welfare and they are more responsive to taking action to prevent risks to the environment that could harm society (Adams et al., 2011; Carlson, 1972; Liu, 2018). Women may also have stronger environmental preferences compared to men (McCright, 2010).

In the context of green innovation, female directors are more likely to have more environmental awareness (Groysberg & Bell, 2013). The study by Horbach and Jacob (2018) also argues that having a large proportion of highly qualified women on boards has correlated with innovation activities in the environmental sector. The concept of GI's implementation is a part of environmental management. GI is a signal to stakeholders that the company could be actively involved in sustainable strategies, which might be conducted by a diverse number of directors (He & Jiang, 2019; Post, Rahman & Rubow, 2011). Some empirical evidence also shows that companies' implementation of GI is seen as an official effort to establish their legitimacy regarding aspects of the environment (Berrone et al., 2013; Frondel, Horbach & Rennings, 2008). The role of gender diversity is significant for improving firms' environmental policies (Liu, 2018) and to increase green innovation practices (He & Jiang, 2019).

Based on the above theoretical frameworks, this research proposes the following hypothesis:

H1: Gender diversity has a positive effect on green innovation.

2.4. Green innovation and firm performance

This study follows Fonseca and Ferro (2016), where GI is part of the significant issue of sustainability, and the relationship between sustainability and firm performance is often explained by the stakeholder theory, which emphasises the importance of a firm's relationships with its critical shareholders (de Leaniz & del Bosque, 2013; Fonseca & Ferro, 2016; Freeman, Dmytriiev & Phillips, 2021; McWilliams & Siegel, 2001). The stakeholder theory states that a firm's managers have the obligation to fulfil the needs of consumers, investors, competitors, suppliers, the government, and other stakeholders to ensure their own survival and to achieve a competitive advantage. The integration of business and societal considerations promotes better performance, improves stakeholder value and creates positive and enduring societal impacts (Fonseca & Ferro, 2016). This may contribute to the creation of new jobs, the enhancement of environmental performance and the reduction of pollution, while improving goodwill and trust, thus aiding the organization's enduring success (de Leaniz & del Bosque, 2013; Fonseca & Ferro, 2016; McWilliams & Siegel, 2001). The implementation of green innovations is

closely related to the stakeholders' well-being (Peng & Liu, 2016). This is in the context of expanding environmental pressures from different stakeholders, who exert different levels of pressure on firms to accomplish their environmental responsibilities, including green innovations. Firms must take on these environmental responsibilities to achieve acceptance from the various stake-holders (Jiang & Bai, 2022).

Furthermore, improvements in productivity and innovation can increase firm value (Rosenbusch, Rauch & Bausch, 2013), including innovation, which is related to the environment where GIs are one of the keys to increasing the competitive advantage of a firm, while at the same time possibly also increasing firm value and firm performance (Agustia, 2019; Ar, 2012; Sezen & Cankaya, 2013). Previous evidence from Huang and Li (2017) showed that green innovation has an impact on firm performance. Therefore, mindful of the above empirical framework, this study postulates a second hypothesis:

H2: Green innovation has a positive effect on firm performance.

2.5. Board gender diversity and firm performance

This study follows the research by Đăng et al. (2020) which in turn relied in the work of Post and Byron (2015) which used the UET as its basic conceptual framework, where the UET was focused on the top management team. The UET assumes that 'boards may differ in term of their cognitive frames, which are difficult to measure.' This research uses the proxy of gender to observe the characteristics of boards (Đăng et al., 2020; Dezsö & Ross, 2012). This study argues that the cognitive frames of male and female directors can significantly affect firm performance differently (Carpenter, 2002). Furthermore, previous empirical evidence has shown the importance of board gender diversity for firm performance, where the female members are more likely to possess a university degree and hold professional certifications (Terjesen et al., 2009). A diverse board has the potential to provide more critical and valuable information because of the members' experience and differences in their knowledge (Hillman, Shropshire & Cannella Jr, 2007).

The concept of the UET states that the experiences, values, personalities and the cognitive functions of executives affect the choices they make (Hambrick, 2007). Post and Byron (2015) argue that the presence of females on boards is significant, as this can influence the decision-making processes. Some previous research has also sought to evaluate the cognitive functions of executives using a proxy for gender or board gender diversity, where female executives have an important role in improving firm performance (Chen et al., 2018; Dezsö & Ross, 2012; Hillman, Cannella Jr & Harris, 2002). Evidence from Carter, D'Souza, Simkins and Simpson (2010) shows that female directors have a greater capacity and capability to generate profits from their company's assets and investments. Conversely, several previous studies produced different results, where the presence of women on the board had no effect on the market's reaction (Lee & James, 2007) and no impact on firm performance (Carter et al., 2010). Due to the variations in previous studies' findings, our paper contributes to the literature on the debate about the relationship between gender diversity and firm performance.

Based on the above research, this study proposes the following hypothesis:

H3: Gender diversity has a positive effect on firm performance.

2.6. The mediating role of green innovation on gender diversity and firm performance

The main framework of the triple bottom line (TBL) proposed by Elkington (1998), is that a company should not only be profit-oriented, but also it should emphasise the sustainability of its operations, which should include its effect on the planet, people and profits (Tseng et al., 2020). This study uses the UET as a base framework theory, where in this context, some empirical evidence shows that female representation on boards of directors (top management) can improve firm performance (Chen et al., 2018; Đăng et al., 2020; Dezsö & Ross, 2012; Post & Byron, 2015). Furthermore, previous research has shown different results, where females on company boards has created a negative market reaction (Lee & James, 2007), negative performance (Adams & Ferreira, 2009; Matsa & Miller, 2013) and moreover, has had no impact on firm performance (Carter et al., 2010). The above findings show inconsistencies in the relationship between gender diversity and firm performance and there

is no empirical literature about any other role being an important factor. This study addresses this gap, as it examines green innovation practices for their mediating role in the effect board gender diversity has on firm performance.

In order to achieve better firm performance, innovation should be an important component of a company's strategy (Ar, 2012). Conversely, Porter (1991) also emphasises that a company can reduce its cost of production and increase its economic efficiency by implementing initiatives that are related to the environment. Therefore, the best sustainability practices can be achieved by implementing environmental and social management standards such as ISO 14001 and ISO 26000, along with sustainability reporting in accordance with GRI guidance standards and other environmental, social and economic innovations (Borsatto & Amui, 2019). Due to the fact that female representatives on the board of directors of a company are more likely to improve its environmental policies, this could reduce its environmental violations (Borsatto & Amui, 2019). Some previous research has also shown that a company's board gender diversity is connected to systematic concerns regarding GI (Erhardt et al., 2003; He & Jiang, 2019). Based on the existing empirical evidence, this study proposes its fourth hypothesis:

H4: Green innovation mediates the effect of gender diversity on firm performance.

Table 1 summarises the theories that might be applied to the hypotheses stated above.

No.	Hypothesis	Theories applied	References
1.	BGD --> GI (H1)	UET	(Adams et al., 2011; Carlson, 1972; Liu, 2018; McCright, 2010).
2.	GI ---> FP (H2)	Stakeholder theory	(de Leaniz & del Bosque, 2013; Fonseca & Ferro, 2016; Freeman et al., 2021; McWilliams & Siegel, 2001)
3.	BGD ---> FP (H3)	UET	(Đặng et al., 2020; Post & Byron, 2015)
4.	BGD -> GI -> FP	UET	(Đặng et al., 2020; Post & Byron, 2015)

Table 1. Summary of the theories

To conclude this section, Figure 1 graphically illustrates the model this study aims to test, which focuses on the relationships between BGD with GI and FP.

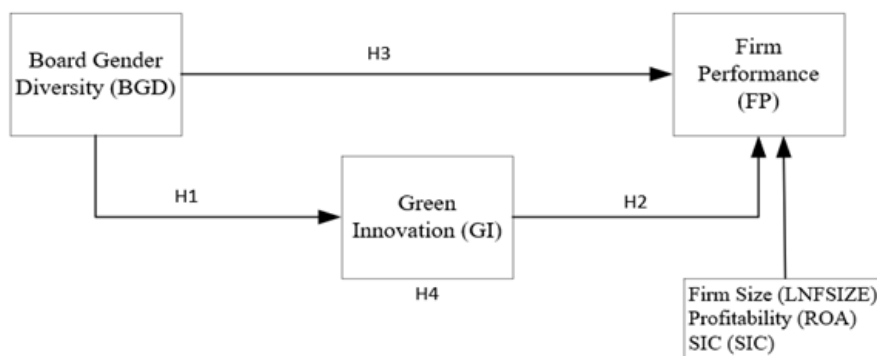


Figure 1. Framework model

3. Methodology

3.1 Research design

The mediation approach in this study referred to the mediation model by Baron and Kenny, (1986). It comprised the following stages: first, regressing the independent variable to the mediator variable (H1); second, testing the effect of the mediator variable on the dependent variable (H2); third, testing the effect of the independent variable on the dependent variable (H3) and fourth, testing the effect of the mediation (H4). Two models were

tested. First, following He and Jiang (2019), this study examined the relationship between BGD and GI (see Equation 1). Second, as done by Ar (2012), Chen et al. (2018) and Liu (2018), this study examined the determinants of FP, by means of a linear regression model in which this research included as explanatory variables BGD, as well as other aspects related to firm performance and its characteristics (see Equation 2). STATA 13.0 was used to examine the hypotheses using a regression model.

Model 1

$$GI_{it} = \beta_0 \text{INTERCEPT} + \beta_1 \text{BGD}_{it} + \epsilon \quad (1)$$

Model 2

$$FP_{it} = \beta_0 \text{INTERCEPT} + \beta_2 \text{BGD}_{it} + \beta_3 \text{GI}_{it} + \beta_4 \text{ROA}_{it} + \beta_5 \text{LNFSIZE}_{it} + \beta_6 \text{SIC}_{it} + \epsilon \quad (2)$$

3.2. Operational definitions and measurement of variables

This study investigated the relationship between board gender diversity (BGD) and firm performance (FP) with green innovation (GI) as the mediating variable. Table 2 shows how each construct of interest has been operationalised. To measure FP, this study used Tobin's Q (Darmadi, 2011; Goyal, Rahman & Kazmi, 2013; Low, Roberts & Whiting, 2015). Following Lee and Min (2015) this study calculated it as the sum of the book value of the assets and the market value of the equity divided by the book value of the assets. Tobin's Q is commonly used to measure a firm's value, but it can be used to measure accounting performance by examining how the accounting principles have changed (Demsetz & Lehn, 1985; Lee & Min, 2015).

Concerning the explanatory variables, BGD was measured by dividing the number of female directors by the total number of directors (Chen, Crossland & Huang, 2016; Gul et al., 2011; Levi, Li & Zhang, 2014), and this study used the ISO 14001 certification as the proxy of the GI variable, which has been acknowledged internationally by the Environmental Management System (EMS) (He & Jiang, 2019). A value of 1 was assigned if the firm has ISO 14001 certification, and 0 otherwise (Frondel et al., 2008; He & Jiang, 2019).

Three control variables were used. First, it controlled by size (TASSET) (Ben-Amar et al., 2017; Borsatto & Amui, 2019; Adams & Ferreira, 2009; Darmadi, 2011; Low et al., 2015), measured as the logarithm of the total assets. Profitability was our second control variable operationalised by means of the return on assets (ROA) (Chen et al., 2018). Finally, this study also controlled by the sector of activity. To this end this study used the first two digits of the Standard Industrial Classification (SIC) code as a control variable following Chae, Koh and Park (2018), because this indicates the major industry sector and because the sector plays a role in firm performance.

Variable Type	Variable Name	Measurement	Reference	Sources
Dependent Variable	Firm Performance (FP)	Tobin's Q = (book value of asset + market value of equity)/book value of asset	Chen et al. (2018); Darmadi (2011); Goyal et al. (2013); Low et al. (2015); Yao, Liu, Sheng and Fang (2019)	OSIRIS database (osiris.com)
Independent Variable	Board Gender Diversity (BGD)	Number of Woman Directors/ Total Directors	G. Chen et al. (2016); Gul et al. (2011); Levi et al. (2014)	Annual report, Indonesia Stock Exchange website (idx.co.id)
	Green Innovation (GI)	ISO14001 (dummy, Yes=1, No=0)	Frondel et al. (2008); He and Jiang (2019)	Annual report, Indonesia Stock Exchange website (idx.co.id)

Variable Type	Variable Name	Measurement	Reference	Sources
Control Variable	Firm Size (LNFSIZE)	Total Asset (logarithm)	Ben-Amar et al. (2017); Borsatto and Amui (2019)	OSIRIS database (osiris.com)
	Profitability (ROA)	Return on Assets (ROA)	Chen et al. (2018)	OSIRIS database (osiris.com)
	SIC	The first 2 digits of SIC Code	Chae et al. (2018)	OSIRIS database (osiris.com)

Table 2. Definitions of variables

3.3. Sample selection

Two sources were used to construct our dataset. This study used data from the Indonesia Stock Exchange database, in the form of annual reports during the period 2017, 2018 and 2019. A sample of 518 firms was considered, where the criterion was firms from the Standard Industrial Classification (SIC) non-financial and banking sectors. These sectors are worth investigating because the non-financial and banking industries are more suitable as they can indicate a greater impact from the corresponding inferences (Foerster & Sapp, 2005) and the non-financial industry firm sector tends to be related with green innovation issues (Zhang et al., 2019). Furthermore, the main reason to exclude non-financial and banking sectors was because of their limited direct environmental impact (Forcadell, Aracil & Úbeda, 2019). Taking into account the three-year period, this research had a balanced panel dataset containing 1,554 observations. Table 3 shows that there were missing values from the variables, however the STATA procedures (<https://stats.oarc.ucla.edu/>) summarised the results for each variable by using the number of non-missing values. The correlation of the results, shown in Table 4, was computed based on the number of rows with non-missing data for the variables listed. Meanwhile, for the regression results in Tables 5, 6, 7 and 8 the observation(s) with missing value(s) were excluded from the results of the analysis. The information concerning the dependent variable (FP) and the control variables (ROA, LNFSIZE, SIC), was gathered from the OSIRIS database (<http://osiris.bvdinfo.com.unair.remotexs.co>). Also, this research derived data from the published annual reports of non-financial companies listed on the Indonesia Stock Exchange (IDX) database (<https://www.idx.co.id/>), which contained information such as GI and BGD.

4. Results and discussion

4.1. Descriptive statistics

Table 3 provides the descriptive statistics. The mean value for FP was 1.681. with huge differences between its minimum (0.01) and maximum (195.457) values, meaning that firm performance for the companies that were sampled varied; it showed a mean value of 1.681, which was below its standard deviation value of 6.479 indicating that the data were spread out (widely distributed). Compared to Chen et al. (2018), the mean values were lower, indicating that, on average, the sample companies used in this research mostly had a lower performance than the sample companies used by Chen et al. (2018). This research also used a smaller samples than Chen et al. (2018) did. Meanwhile, GI indicated a value of 0.367, which was higher than in the research conducted by He and Jiang (2019), which meant that, in this study, only 36% of the companies participated in green innovation campaigns(practices). BGD, where the number of female directors was divided by the total number of directors, indicated a mean value of 0.129, (13% of all the companies in the sample). This meant a small number of companies involved women in their management. The UN resolution recommended that women's representation should be 30% in organizations, including companies. Our finding showed that this was far below the Unstandard's recommendation. It still needs efforts by the authorities to support campaigns and motivate companies to involve more women in their boardrooms.

Variable	Obs.	Mean	Std. Dev.	Min	Max
FP	1,227	1.681	6.479	0.016	195.457
GI	1,355	0.367	0.482	0	1
BGD	1,351	0.129	0.192	0	1
ROA	1,350	2.701	12.925	-130.82	110.26
LNFSIZE	1,314	21.377	1.862	15.298	26.587

Note: FP is firm performance; GI is green innovation; BGD is board gender diversity; ROA is return on assets; LNFSIZE is natural log of total assets; SIC is 2 digits of the SIC code

Table 3. Descriptive statistics (for sample firms 2017-2019, n= 1,554)

4.2. Does green innovation mediate the effect of board gender diversity on firm performance?

Table 4 shows the correlations between the variables of interest. As observed in Table 4, the correlation between GI and FP was not significant, while BGD positively correlated with firm performance, which was consistent with the expected direction and initially indicated that Hypothesis H2 was reasonable. For the most part, many of the other correlations were below 0.5, suggesting that there were no serious multicollinearity problems. Notwithstanding this, we used variance inflation factors (VIF) to further corroborate it (Wooldridge, 2006). The results are reported in the last row in Table 4, with values ranging between 1.03 and 1.26, which are below the cut-off value of 10 (Đăng et al., 2020; Wooldridge, 2006). Therefore, this shows that this study did not have multicollinearity problems.

This research performed structural equation modelling (SEM) to examine the direct effect of the hypotheses and continued to run the testing and the confidence intervals of the direct and indirect effects to examine the mediating hypothesis by using the approach employed by Baron and Kenny (1986). This study performed SEM to examine model 1 of the regression for the effect of BGD on GI, as shown in Table 5 (below), which presents the results of the first regression, for which we followed Chen et al. (2016), Gul et al. (2011) and Levi et al. (2014) where the BGD measurement was indicated by dividing the number of female directors by the total number of directors. This research shows in Table 5 that Hypothesis H1 showed a significant ρ -value of 0.000 (***) ($\rho < 0.01$). This result is supported by He and Jiang (2019), who found that BGD affected GI.

Variables	FP	GI	BGD	ROA	LNFSIZE	SIC
FP	1.000					
GI	-0.044	1.000				
BGD	0.093*	-0.118*	1.000			
ROA	-0.064	0.168*	-0.003	1.000		
LNFSIZE	-0.123*	0.426*	-0.084*	0.158*	1.000	
VIF		1.255	1.05	1.06	1.24	1.07

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Pearson rank correlations are reported in the table; FP is firm performance; GI is green innovation; BGD is board gender diversity; ROA is return on asset; LNFSIZE is natural log of total asset; SIC 2 digits of the SIC code

Table 4. Pairwise correlations for sample firms (2017 – 2019, n= 1,554)

Therefore, this research concluded that Hypothesis H1 was not accepted. This research reinforces the previous studies that argued for the UET, where gender diversity had a negative impact on green innovation processes in countries with low gender parity (Post & Byron, 2015). This research strengthens the opinion of this implication, where female directors are consistently negative and significant in predicting the likelihood of environmental litigation (Liu, 2018). This finding contributes to the gender literature examining the role of female directors in firms' policies (Adams & Ferreira, 2009; McGuinness, Vieito & Wang, 2017; McGuire, Sundgren & Schneeweis, 1988; Srinidhi, Gul & Tsui, 2011), particularly on environmental issues (Erhardt et al., 2003; He & Jiang, 2019; Liu, 2018). Only 13% of the firms in the research sample had lady board members, which is well below the UN's recommendation of 30%. Indonesia is a country with low gender parity; therefore, it is important to increase women's involvement in the boardrooms so they have a positive impact on companies by applying green

innovation strategies. Further research using a larger sample and more countries may provide a positive result. This study also showed that the effects of ROA, LNFSIZE, and SIC on green innovation were also significant.

Model 1				
Effect	Regression Coefficient	p-value	Hypothesis	Support
GI <- BGD	-0.214*** (0.072)	0.003	H1	No
Const_				0.415*** (0.018)
Model 2				
GI -> FP	0.547 (0.494)	0.269	H2	No
BGD -> FP	3.125* (1.155)	0.007	H3	Yes
BGD -> GI -> FP	-0.117 (0.113)	0.300	H4	No
ROA -> FP	-0.034** (0.017)	0.046		
LNFSIZE -> FP	-0.457*** (0.134)	0.001		
SIC -> FP	0.008 (0.011)	0.427		
Constant				10.844 (2.911)

Note: (***) $\rho < 0.01$, (**) $\rho < 0.05$, (*) $\rho < 0.1$); The first regression board gender diversity (BGD) is measured by divided the total number of female directors with the total number of directors; ISO14001 certification is used as a proxy for the green innovation (GI) variable; ROA is return on assets; LNFSIZE is firm size, which takes the natural logarithm of total assets; SIC is 2digitsof the SIC code; ρ -value statistics in parentheses

Table 5. The result of model 1 and model 2for sample firms (2017 – 2019, n= 1,554)

The result of our second regression model GI on FP (firm performance) is shown in Table 5. This shows that Hypothesis H2 has been rejected, as the ρ -value was 0.269, which meant that GI, which was proxied by the variable ISO 14001 certification, did not affect FP (firm performance). The ISO 14001, as a proxy measurement of GI, comprising the required international standards for environmental management systems (EMS), assumed that better environmental performance could be reached when environmental aspects have been systematically identified and managed through pollution prevention, improved environmental performance and compliance with the applicable laws, thus making a significant contribution to sustainability (Da Fonseca, 2015). The reported benefits of GI practices, which were proxied by ISO 14001, included an improved EMS and process efficiencies, leading to cost reductions and the minimisation of environmental impacts and their associated risks, which in turn contribute to improved organizational performance (Fonseca & Domingues, 2018; Murmura, Liberatore, Bravi & Casolani, 2018) and, in the long run, they foster profitability and market benefits (Lee, Noh, Choi & Rha, 2017). The research findings contradict the previous results yielded by Agustia (2019), Ar (2012), Sezen and Cankaya (2013) and Zhang et al. (2019) where GI and FP showed a significant relationship. This research is supported by the previous research from Stucki (2019), Driessen, Hillebrand, Kok and Verhallen (2013), Lee and Min (2015) and Palmer, Oates and Portney (1995), who showed that GI did not have an impact on FP. Some researchers have argued that the high costs for companies of GI's implementation may cause a phenomenon where GI does not have an impact on FP (Lee & Min, 2015; Liu, Da & Cheng, 2011). Therefore, it is still very important to ensure that green strategies and incentives are created by the authorities, which may be essential for individual firms. For this reason, many nations worldwide, including Indonesia, have signed off on agreements such as the Paris Agreement, to proceed down the green development track.

Table 5 shows that Hypothesis H3, which is about the effect of BGD on FP, showed a significant ρ -value of 0.007 ($\rho < 0.1$). This result was in line with Chen et al. (2018), Liu et al. (2014), and Low et al. (2015) who

demonstrated that female gender had a significant role in the improvement of FP. Our findings have an implication for the literature on gender, particularly in terms of the debates on the effect of female members on boards when deciding on FP (Chen et al., 2018; Dezsö & Ross, 2012; Liu et al., 2014; Unite, Sullivan & Shi, 2019). Although this research has shown the significant impact of BGD on FP, the sample statistics of this research showed that only 13% woman were members of the boards of directors of our sample companies. This is far below the UN recommendation of 30%. Therefore, it is expected that female representation among executives will be increased further in the future. Moreover, this research also has consequences regarding the UN's recommendation and the Government of Indonesia: the UN target is that 30% of the members of the board of a company should be women and they should play an important role in the improvement of FP. Therefore, the contribution of our research also emphasises the significant role of the literature about BGD on FP. This research recommends that the Government of Indonesia must improve its policies, as the UN's 30% recommendation for woman representatives on boards is not being met. These policies are significant for achieving SDG no. 5 regarding gender equality.

Furthermore, as for Hypothesis H4, the result in Table 5 shows that the contention that GI mediates BGD's effect on FP was not supported, so H4 was rejected. This meant that GI did not play an important role in terms of the effect BGD had on FP. Although this research has shown that female directors having a negative effect on GI was not supported (hence H1 not supported) and that female directors show great concern for GI (Liu, 2018), while the presence of female directors did have a significant effect on FP (so H3 was supported), the fact is that the role of female directors in improving FP is not mainly due to their concerns regarding the environment. This result is supported by the previous research by Stucki (2019), Driessen et al. (2013), Lee and Min (2015), and Palmer et al. (1995). This research's findings represent an important indication that green innovation is not an essential factor in terms of the effect BGD has on FP.

This research also tested the control variables' effect on firm performance and the results showed that the return on assets had an impact on FP, as the q -value was 0.046 (** $q < 0.05$), this was consistent with Đăng et al. (2020) who demonstrated that ROA had a positive relationship with firm performance. Furthermore, our study showed that the control variable of firm size (LNFSIZE) exhibited a significant effect on FP where the q -value was 0.001 (***) ($q < 0.01$). This result was also consistent with the findings of Hillman et al. (2002) who demonstrated that firm size was a key driver for FP and firm value. Meanwhile, the SIC code results were to the contrary, as the effect of SIC on FP was insignificant ($q < 0.427$).

In empirical terms, this research has identified several implications that have both theoretical and practical aspects. First, the theoretical implication of this research is to complement the BDG literature, especially in the area of its impact on firm performance, which is still an issue being debated. Previous studies found conflicting findings regarding the relationship between BGD and FP. In responding to these differences, this study used the UET and the stakeholder theory to examine the mediating role of GI, which has been used by several studies as the dependent variable of BGD, with GI as the independent variable of FP. This study found that GI was not a significant factor in improving the relationship between BGD and FP.

Furthermore, in practical terms the weakness of the authorities in Indonesia, in terms of enforcing regulations, may be one of the main factors that have caused the deterioration in the implementation of green innovations for sustainability. This paper can provide the Indonesian government with insights regarding support for the business world by strengthening the regulations governing environmental matters and by providing incentives for companies to implement green innovations. It is important to recommend that the government delivers green strategies and incentives as part of an agreed programme of green initiatives, such as those stated in the Paris Agreement, to which Indonesia is a signatory. Nevertheless, it is still important to keep the Indonesian government's commitment to be involved in the SDGs by implementing the PROPER (the Public Disclosure Programme for Environmental Compliance) since 1995, where the objective has been to drive business and to increase managements' performance environment. Therefore, the number of companies in the sample which had implemented GI (currently only 36.7% of them had done so) is expected to increase to align with the target of a 41% emissions' reduction by 2030. Therefore, the consistency of the authorities' support for green campaigns for society is important. The result of this study can also be used as a reference for the companies

implementing low-cost green innovation processes and products. This green campaign aims to boost society's awareness to only use green products or services. This research also recommends that companies should refocus their strategies along with their environmental concerns' orientation. This research also found the significant impact of BGD on FP; the sample's statistics forth is research show only 13% of boards have women members, which is below the UN's recommendation of 30%. Therefore, this research result suggests that the percentage of female representatives among executives be further increased in the future.

4.3. Robustness test

To ensure the robustness of the main result, which showed that green innovation did not play an important role in the effect BGD had on FP, this study conducted an additional analysis by taking the following steps. First, it calculated the average of the total assets as a representation of firm size. Then, it separated the sample into two clusters/groups, where cluster A was above average (big companies), and cluster B was below average (small companies). The additional analysis was applied based on the consideration that GI's implementation is strongly related to a firm's investment in R&D and FP (Lee & Min, 2015). After re-estimating the SEM model for cluster A, where the sample was n=1,227 (above the average of total assets) and cluster B, where the sample was n = 327, both cluster A and cluster B in model 1 (Table 6) yielded the same result, that BGD's effect on GI was significant. With model 2 (Table 7), both cluster A and cluster B yielded the same result and supported the main result; GI did not play an important role in the effect board gender diversity has on firm performance.

Panel A Result of model 1 with clustering base on group of firm size				
Effect (for sample firms (2017 – 2019, n= 1,554)	Cluster A (Big companies) (firms sample n=1,227)		Cluster B (Small companies) (firms sample n=327)	
	Regression Coefficient	p-value	Regression Coefficient	p-value
GI <- BGD	-0.641 (0.195)	0.001	-0.150 (0.076)	0.050
Const_	-0.409 (0.850)		-1.857 0.248	

Note: (***) $\rho < 0.01$, ** $\rho < 0.05$, * $\rho < 0.1$). The first regression board gender diversity (BGD) is measured by dividing the total number of female directors with the total number of directors; ISO14001 certification is used as a proxy of the green innovation (GI) variable; ρ -value statistics in parentheses

Table 6. Clustering sample based on firm size – model 1

Panel B - Result of model 2 with clustering base on group of firm size				
Effect (for sample firms (2017 – 2019, n= 1,554)	Cluster A (Big companies) (firms sample n=1,227)		Cluster B (Small companies) (firms sample n=327)	
	Regression Coefficient	p-value	Regression Coefficient	p-value
BGD -> FP	0.800 (0.758)	0.291	3.400 (1.416)	0.016
GI -> FP	-0.001 (0.242)	0.997	0.608 (0.655)	0.353
BGD -> GI -> FP	0.000 (0.155)	0.997	-0.091 (0.108)	0.401
ROA -> FP	0.177 (0.014)	0.000	-0.056 (0.021)	0.007
LNFSIZE -> FP	-0.116 (0.135)	0.392	-0.781 (0.230)	0.001

Panel B - Result of model 2 with clustering base on group of firm size				
	Cluster A (Big companies) (firms sample n=1,227)		Cluster B (Small companies) (firms sample n=327)	
SIC -> FP	0.004 (0.006)	0.524	0.016 (0.014)	0.262
Constant	0.004 (0.006)		17.159 (4.763)	

Note: The second model regression board gender diversity (BGD) is measured by dividing the total number of female directors with the total number of directors; ISO14001 certification is used as a proxy of the green innovation (GI) variable; ROA is return on assets; LNFSIZE is firm size and takes the natural logarithm of total assets; SI, C is 2-digits of the SIC; ρ -value statistics in parentheses. (***) $\rho < 0.01$, ** $\rho < 0.05$, * $\rho < 0.1$

Table 7. Clustering sample based on firm size – model 2

5. Conclusion

The implementation of the 17 Sustainable Development Goals (SDGs), initiated by the US, has introduced concerns not only about their environmental aspects, but also about the calls for gender equality. Female representation is expected to increase to 30% in leadership positions. Several previous studies have shown that female representation on boards of directors can improve FP (Chen et al., 2018; Đanggih et al., 2020; Dezsö & Ross, 2012; Post & Byron, 2015). Meanwhile, others empirical evidence has shown different results, where the presence of females on boards has led to a negative market reaction (Lee & James, 2007) and they had no impact on firm performance (Carter et al., 2010). Based on the inconsistent results from the previous research into the effect board gender diversity has on firm performance. There is no empirical evidence of any other factors affecting the relationship between BGD and FP. Therefore, this study addresses this gap, since this research examines the role of GI on the effect of BGD on FP. By using the EUT and the stakeholder theory, this research finds that GI is not an important factor in improving the relationship between BGD and FP. This study did find that board gender diversity (BGD) has a significant effect on green innovation (GI), this is in line with the findings of Chen et al. (2016), Gul et al. (2011), and Levi et al. (2014).

From this study's practical implication, it can also be concluded that the high cost of green innovation may be the main reason why companies do not invest in it. Therefore, this research implies that it is important to recommend that the authorities deliver green strategies, along with incentives to keep supporting companies to implement low cost green innovation practices. Moreover, this support must be aligned with the Paris Agreement, to which Indonesia is a signatory, and the Indonesia government must remain committed to the SDGs. Furthermore, it is important to achieve the targeted 41% reduction in emissions by 2030, as part of the sustainability programme. This study also supports the changes in individuals' and communities' behaviour regarding using and consuming more eco-friendly products.

The results of this research show that BGD has a negative effect on GI, this finding strengthens the opinion that gender diversity has a negative impact on the innovation of green processes in countries with low gender parity (Post & Byron, 2015), where, from the descriptive statistics, female representation is only shown to be 13%, which is below the UN's recommendation of 30%. BGD has a significant effect on firm performance (FP), which is consistent with the findings of Chen et al. (2018), Liu et al. (2014), and Low et al. (2015). Therefore, this study supports the presence of female directors on executive boards, as this is expected to support GI practices and to increase FP. The results of this study have social implications, in terms of encouraging women's participation on the boards of firms. Furthermore, this study also relates to the changes in the community, which expects to consume more green products because of their environmental concerns. Our study contributes to the literature in many ways. Firstly, to the literature on gender, it shows that the female directors' presence on boards is proven to create a greater commitment to improving the performance of their firms and to support GI practices. Secondly, the findings also provide an important insight into green innovation's role in the relationship between BGD and FP, which is still a controversial issue. Green innovation is not an important factor in the relationship between gender and the improvement of FP, so this needs further investigation.

Our study has some limitations, in so far as it used a sample of companies drawn from a single country (Indonesia). The theoretical implications might apply to emerging countries with similar conditions, where it is possible that they have identified institutional problems such as a lack of environmental concern on the part of the authorities, including weaker law enforcement in terms of environmental support, less support for regulation by governments and less knowledge about the importance of eco-green products and processes. Therefore, further research is expected to be able to investigate the impact of green innovation on firm performance by using a larger research sample drawn from different countries, with different measurements and with a longer observation period. Also, future research might examine variables related to corporate governance's characteristics, such as duality, board size and the number of independent directors.

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