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Empowering Green Innovation: How CEO and Firm-Level Factors Shape Sustainable Business Growth in Indonesia

Nuraini Sari[1]*; Tri Ayu Astari[2]; Pariang Siagian[3]; Nafis Dwi Kartiko[4]

[1-3]Accounting Department, BINUS Online Learning, Bina Nusantara University
Jakarta, Indonesia 11480
[4]Directorate General of Taxes, Ministry of Finance of the Republic of Indonesia
Jakarta, Indonesia 12190
[1]nsari@binus.ac.id; [2]tri.ayu@binus.ac.id;
[3]pariangsiagian@binus.ac.id; [4]nafisdwikartiko@gmail.com

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ABSTRACT

Climate change, driven by global warming, is a critical global issue affecting air quality and the environment. In response, many companies are adopting sustainable practices such as green product innovation. The research examined the impact of CEO and firm-level factors on financial performance through green product innovation in the raw material-producing sector listed on the Indonesia Stock Exchange from 2020 to 2022. The research focused on five key variables: CEO education, gender, experience, firm size, and firm age, analyzing their effects on the adoption of green product innovation and subsequent impact on company growth and profitability. Secondary data were collected from the company's annual and sustainability reports using purposive sampling, resulting in a sample of 81 companies over three years. Data were analyzed using multiple linear regression and mediation tests. The results show that CEO gender and experience have a significant positive effect on green product innovation, while CEO education does not show a significant effect. Additionally, larger and older companies are more likely to implement green innovations due to their established resources and capacities. Green product innovation positively influences financial performance, reflected in increased sales and operational efficiency. These results suggest that both CEO and firm-level factors play a key role in driving sustainability initiatives that contribute to long-term business growth. The research provides valuable insights for companies aiming to enhance their sustainability strategies and for policymakers encouraging green innovation. Managerial implications point to the importance of fostering experienced leadership and leveraging company resources to support environmentally responsible innovation.

Keywords: green product innovation, CEO characteristics, financial performance, firm age, sustainable business growth

INTRODUCTION

Climate change, caused by global warming, continues to be a major issue worldwide, with worsening climate conditions every year. According to a report from the World Meteorological Organization (WMO) released in the WMO Greenhouse Gas Bulletin, the average level of carbon dioxide (CO2) in the 2021-2022 period was recorded at 2.2 million ppm, a slight decrease compared to the previous year. CO2, which contributes around 64% of the impact of global warming, mainly due to the burning of fossil fuels and cement production, is the main greenhouse gas affecting the climate (World Meteorological Organization, 2023). On the other hand, IQAir's 2022 data show that Indonesia experiences the worst air quality in ASEAN, with Particulate Matter (PM) of 2.5 concentrations reaching 30.4 micrograms per cubic meter, far exceeding the ideal WHO standard of 0 to 5 micrograms per cubic meter. This figure reflects the very poor air quality conditions in Indonesia compared to other ASEAN countries (IQAIR, 2022).

*Corresponding Author

Greenhouse gas emissions are primarily caused by the combustion of fossil fuels and the production of cement (World Meteorological Organization, 2023). In response, Presidential Regulation No. 61 of 2011 requires entrepreneurs to reduce carbon emissions, and POJK No. 51/POJK.03/2017 allows companies to report activities that have social and environmental impacts (Otoritas Jasa Keuangan, 2017). Green product innovation is key to mitigating environmental impacts (OECD, 2021). According to Xie and Wang (2024), the adoption of green innovation significantly improves carbon performance, which shows that companies engaging in environmentally friendly innovations achieve better outcomes in reducing carbon emissions. Based on the Organization for Economic Co-operation and Development (OECD) reports in 2020, governments and multinational firms increasingly adopt green innovation as their strategy to achieve long-term economic resilience and sustainable industrial transformation (OECD, 2021). In addition, environmental policies affect a company's operations and encourage resource allocation for green innovation based on Yousaf et al. (2022).

The research focuses on raw material-producing companies listed on the Indonesian Stock Exchange from 2020 to 2022. It combines CEO and firm-level factors to understand their influence on financial performance through green product innovation. It provides insights and references for further corporate research and practice. Failure to implement environmental innovation can lead to divestment and risk of losing market share and brand loyalty. The conceptual framework is illustrated in Figure 1.

Green product innovation refers to the process of developing innovative ideas, new products, and methods and techniques designed to address environmental issues. Green technology in product innovation can enhance a company's financial performance and image, while also facilitating access to international markets (Cahyaningtyas et al., 2022). Green product innovation involves environmentally friendly products and processes (Khan et al., 2021). They include the manufacture or modification of products and services using materials that are easily decomposed during the production process, thereby reducing waste and increasing energy efficiency (Cahyaningtyas et al., 2022).

The application of green product innovation can positively affect business performance because companies that adopt environmentally friendly products often experience an increase in the number of customers and sales. However, green innovation cannot be used as the only standard for assessing good company performance. Managers need to understand market needs and customer expectations (Sulaiman, 2025). The development of environmentally friendly processes provides various benefits, such as reduced operating costs and fuel consumption, energy efficiency, and reduced production costs that can attract investors and increase the company's profits. Along with increased profits and company performance, stock prices also have the potential to increase. Green product innovation can also increase public legitimacy because it shows the company's commitment to the environment through the development of environmentally friendly products and processes. It

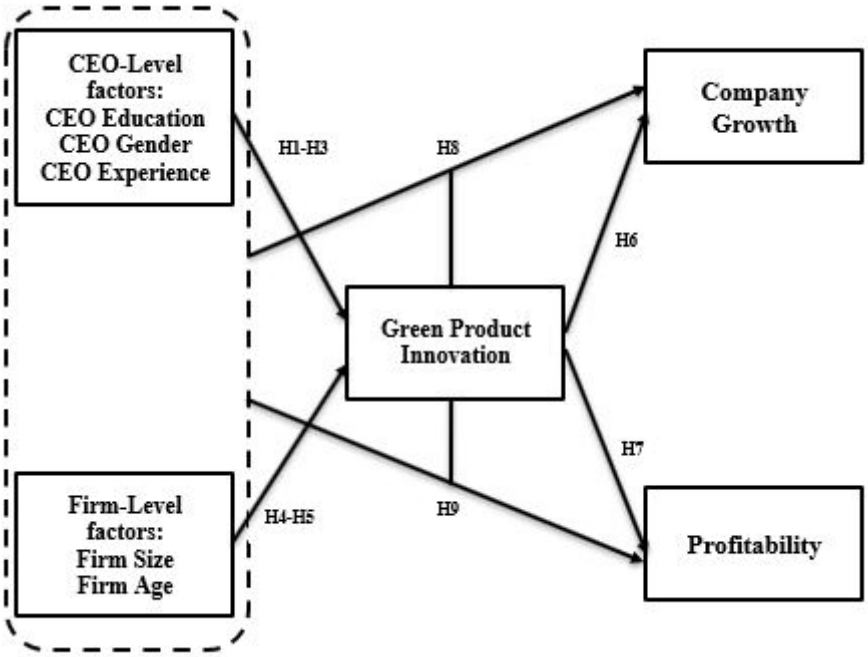

Figure 1 Conceptual Framework

not only benefits companies in terms of their existence but also provides positive benefits for the environment (Chen & Chang, 2013; Zhao et al., 2020).

Next, CEO education is considered an important factor in effective governance to support sustainable growth (Ghardallou, 2022). Previous research shows that CEO's educational background can have a positive impact on the company's sustainable performance (Filipović et al., 2022). Previous studies show that CEO with higher educational levels are likely to have higher environmental awareness, which enables more effective decision-making in sustainability strategies. CEOs with higher education promote corporate green innovation. Similarly, CEOs with higher education and experience in green ecology can encourage green innovation (Zhang et al., 2024). These statements highlight the positive effect of CEO education on corporate environmental behavior, by showing that education can shape a management style that supports the sustainability of corporate behavior

Gender generally refers to the differences in roles, positions, and responsibilities between men and women that are determined by the norms, customs, beliefs, and habits of society (Heise et al., 2019). In the business world, there is a prevailing view that men are more often appointed to high positions than women. However, this view has evolved over time, indicating that gender is no longer a dominant factor in leadership requirements within organizations or companies (He & Jiang, 2019). In the business context, the presence of women on the board of commissioners or directors is still relatively low. The presence of more women on the board of directors has a positive influence on financial performance (Saha, 2023). In addition, companies with at least three female board members experience an increase in their performance (Brahma et al., 2021). These studies show that the diversity of board members can help companies to make more appropriate and wise decisions.

Moreover, CEO experience has become a major focus in research on companies. A CEO with experience, especially in green ecology, is more likely to engage in environmental issues and encourage green innovation (Zhang et al., 2024). Environmental protection values and experience in green ecology can influence the CEO's decision to choose a plan in accordance with their ecological values, after considering various alternatives (Wang et al., 2023). Thus, the CEO's background experience can have an impact on their attitudes toward environmental management and more sustainable innovation.

H1: CEO education has a significant effect on green product innovation,

H2: CEO gender has a significant effect on green product innovation,

H3: CEO experience has a significant effect on green product innovation.

Firm size, as explained by Setiawan et al. (2021), refers to the scale of a company. It can be measured through various indicators, including total assets, average assets, total revenue, stock market value, and others. It is generally categorized into three types: small, medium, and large, which are determined by the amount of assets owned. Companies with large total assets are often more attractive to investors because they have better access to financing resources, which in turn can increase investor confidence (Lé & Vinas, 2024).

Some studies show that the longer a company has been established, the more experience it has in improving its operational efficiency and strategic decision-making. Companies that have been in operation for a long time can manage their costs more effectively and improve their product quality, which in turn increases their profit. Experienced firms in manufacturing industries are better at managing their operational costs, which affect their innovation, profitability, and reputation (Istan et al., 2021). In addition, the age of the company also shows the extent to which the company can face difficulties and obstacles and take advantage of opportunities in the surrounding environment for growth (Matemilola et al., 2025). The experience gained during operation can increase its ability to adapt to environmentally friendly products (Yin et al., 2022). Therefore, firm age not only indicates the company's resilience but also the ability to adapt and develop over time. Long-established companies typically demonstrate greater stability and a better ability to attract and retain investors.

H4: Firm size has a significant effect on green product innovation,

H5: Firm age has a significant effect on green product innovation.

Profitability, or the company's ability to generate profits from its operational activities, is a key indicator of the company's financial performance. Profitability is often measured by comparing the profits generated with the total assets owned by the company in a period (Kieso et al., 2020). This profitability ratio helps to assess how effectively the company is utilizing its assets for development.

Moreover, company growth refers to the change in the company's total assets from year to year, which is calculated as the percentage change in assets in a given year compared to the previous year (Savitri et al., 2023). This growth reflects the company's progress. It is also the general focus because it shows the company's overall development. CEO competencies, including educational background and professional experience have a significant impact on company profitability. Thus, the selection and development of a competent CEO is important to drive company growth (Wang et al., 2025).

Green product innovation has a positive impact on company performance, including increasing market share, sales revenue, and profit (Rahman, 2023). Thus,

synergy between process and product innovation becomes a crucial element in achieving a competitive advantage and driving company growth (Wang & Ahmad, 2024). The application of green technology in product innovation can improve a company's financial performance and mitigate financial risks (Farza et al., 2021).

H6: Green product innovation has a significant effect on company growth,

H7: Green product innovation has a significant effect on profitability,

H8: CEO and firm-level factors have a significant effect on company growth mediated by green product innovation,

H9: CEO and firm-level factors have a significant effect on profitability mediated by green product innovation.

METHODS

The research objects are companies in the raw material producing sector listed on the Indonesia Stock Exchange from 2020 to 2022. The research objects encompass aspects such as the efforts by companies to create green product innovations, which are influenced by independent variables including CEO education, CEO gender, CEO experience, firm size, and firm age. In addition, the research also focuses on how companies improve financial performance, including company growth and profitability, through green product innovation. The research design details a plan to collect, process, and analyze data systematically.

Data are from financial reports, annual reports, and/or sustainability reports of companies in the raw material producing sector on the Indonesia Stock Exchange for the period of 2019−2022. The data are taken from the Indonesia Stock Exchange website and/or the company's official website. The research utilizes quantitative data, which are numerical and can be analyzed using statistics. The main data source is secondary data taken from the company's sustainability report and/or annual report. The data are used to analyze the relationship between the variables studied.

Determining the number of samples involves considering the population and the sampling techniques. The research population is all raw material producing companies listed on the Indonesia Stock Exchange during the 2020–2022 period, totaling 106 companies. The sample is taken using a non-probability sampling technique with a purposive sampling type, where the sample must meet certain criteria. The sample criteria include companies engaged in the raw material producing sector, publishing annual reports and/or sustainability reports during the 2020–2022 period, disclosing environmental responsibilities in the report, and not delisting or relisting during the research period. From these criteria, 81 companies meet the requirements, resulting in a total of 243 samples for analysis.

Then, data are analyzed using multiple linear regression and mediation tests. The software used to process data in the research is the Statistical Package for Social Sciences (SPSS). To conduct the analysis, the researchers utilize operationalized variables using established indicators from previous studies (see Table 1).

RESULTS AND DISCUSSION

Based on Table 2, the CEO education varies from 0 to 4, with an average of 2.2305 and a standard deviation of 0.8259. The result indicates that most CEOs have a secondary to high level of education, although some have a low level of education. The gender proportion of CEOs has a value of 0 for women and 1 for men. The average value of 0.0288 indicates that only a small portion of the sample is male, with a standard deviation of 0.1676. It means that most CEOs in this sample are female.

Next, CEO experience is measured with a value of 0 or 1, with 0 for inexperience and 1 for sufficient experience. The average of 0.7243 indicates that most CEOs in this sample have sufficient experience, with a standard deviation of 0.4478 indicating moderate variation in experience. Firm size ranges from 9.36 to 14.18, with a mean of 12.3540 and a standard deviation of 0.7875. It indicates that the sample studied varies in size, but the majority fall around medium size. Firm age ranges from 5 to 92 years with a mean of 38.8848 years and a standard deviation of 15.70. Most of the companies in the sample have a fairly long history, with some very young and some very old.

Company growth shows a very large variation, from -34506.00 to 9297.52, with a mean of -210.0437 and a very high standard deviation of 2529.5501. The negative means indicate that, in general, the companies in this sample may face growth challenges. Meanwhile, some experience significant and positive growth. Company profitability ranges from -107.99 to 26.56 with a mean of 1.2782 and a standard deviation of 11.8426. The low mean and high standard deviation indicate a significant variation in company profitability, with some companies experiencing large losses and some making profits. Last, green product innovation is measured on a scale from 0 to 100, with a mean of 53.9092 and a standard deviation of 31.3035. The result suggests a wide variation in the extent to which companies adopt green product innovation, with some companies focusing heavily on green innovation and others focusing less.

The results of the normality test, presented in Table 3, indicate that the multiple regression model created is normally distributed. The significance of the test results is greater than 0.05. Thus, it can be concluded that the regression model used as a research hypothesis has met the normality assumption (Ghozali, 2018).

Based on the results of the multicollinearity test in Table 4, all variables have a Variance Inflation

Factor (VIF) value smaller than 10, indicating that there is no multicollinearity (H0 is accepted). In addition, the tolerance value also shows a value greater than 0.10, so it can be concluded that there is no correlation between the independent variables (Ghozali, 2018). The absence of multicollinearity suggests that each predictor contributes uniquely to the model. The estimated regression coefficients are stable and reliable. Therefore, the regression analysis can be continued with confidence. Then, the process proceeds to the autocorrelation test.

Based on the autocorrelation test results in Table 5 at a 5% significance level, with a sample size of 243, the Durbin-Watson (DW) statistic provides an upper limit value (DU) of 1.8199. Therefore, the DW value of 1.902 for CEO characteristics against green product innovation, 1.841 for green product innovation against company growth, and 1.927 for green product innovation against profitability is greater than DU of 1.8199 and less than 4-DU (4-

Table 1 Operationalization of Variables

Variables	Formula	Description	Source
Green Product Innovation (GPI)	GPI = (∑X/n) x 100%	X1 –Using raw materials for products that produce less pollution and energy X2 –Using environmentally friendly packaging X3 –Using products that are easy to recycle or can be recycled	Xie et al. (2019) and Meilani and Sukmawati (2023)
CEO Education	CEOEDUC = 4, 3, 2, 1, 0	4 = Doctoral Degree 3 = Master's Degree 2 = Bachelor's Degree 1 = High School 0 = Below	Zhang et al. (2022)
CEO Gender	CEO Gender = 1 and 0	1 = Man 0 = Woman	He and Jiang (2019)
CEO Experience	CEOEXPE = 1 and 0	1 = If the CEO has green ecology experience 0 = If the CEO has no green ecology experience	Wang et al. (2023)
Firm Size	Firm Size = Log of total assets	The total amount of assets owned by the company currently	Tonay and Murwaningsari (2022) and Meilani and Sukmawati (2023)
Firm Age	Age = Year of research – year the company was founded		Meilani and Sukmawati (2023)
Company Growth	Company Growth = ((Present – past)/past) x 100%	Present = Current net profit Past = Net profit in the past (n-1)	Triansyah et al. (2020) and Irwhantoko and Basuki (2016)
Profitability	ROA = Net profit/total assets		Amalia (2023) and Kieso et al. (2019)

Table 2 Descriptive Statistics Results

Descriptive Statistics					
	N	Min	Max	Mean	Std. Deviation
CEO Education	243	0.00	4.00	2.230	0.825
CEO Gender	243	0.00	1.00	0.029	0.168
CEO Experience	243	0.00	1.00	0.724	0.448
Firm Size	243	9.36	14.18	12.354	0.787
Firm Age	243	5.00	92.00	38.885	15.700
Company Growth	243	-34506	9297	-210.04	2529.55
Profitability	243	-107.99	26.56	1.278	11.84
Green Product Innovation	243	0.00	100.00	53.91	31.30
Valid (N) Listwise	243				

Table 3 Normality Test Results

One-Sample Kolmogorov Smirnov Test				
		Unstandardized residual		
		CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation	Green Product Innovation on Company Growth	Green Product Innovation on Profitability
N		**243**	**243**	**243**
Normal Parameters	Mean	0.000	0.000	0.000
	Std. Deviation	30.405	31.033	31.303
	Absolute	0.108	0.194	0.232
	Positive	0.107	0.194	0.232
	Negative	-0.108	-0.146	-0.166
Test Statistic		0.108	0.194	0.232
Asymp. Sig (2-tailed)		0.063	0.055	0.055

Table 4 Multicollinearity Test Results

Coefficients							
Model	**Unstandardized Coefficients**		**Std. Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
	B	**Std. Error**	**Beta**			**Tolerance**	**Variance Inflation Factor (VIF)**
CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation							
(Constant)	67.800	32.274		2.101	0.037		
CEO Education	-0.711	2.496	-0.019	-0.285	0.776	0.925	1.081
CEO Gender	-15.854	12.218	-0.085	-1.298	0.196	0.938	1.066
CEO Experience	5.637	4.743	0.081	1.189	0.236	0.872	1.146
Firm Size	-2.309	2.777	-0.058	-0.832	0.407	0.822	1.216
Firm Age	0.318	0.134	0.159	2.365	0.019	0.884	1.131
Company Growth	-0.002	0.001	-0.126	-1.972	0.050	0.979	1.021
Profitability	-0.068	0.173	-0.026	-0.395	0.693	0.940	1.063
a. Dependent Variable: Green Product Innovation							
Green Product Innovation on Company Growth							
(Constant)	361.038	321.521		1.123	0.263		
Green Product Innovation	-10.593	5.160	-0.131	-2.053	0.041	1.000	1.000
a. Dependent Variable: Company Growth							
GPI on Profitability							
(Constant)	1.332	1.518		0.878	0.381		
Green Product Innovation	-0.001	0.024	-0.003	-0.041	0.967	1.000	
a. Dependent Variable: Profitability							

1.8199=2.2824). Since the DW value falls within the range of no autocorrelation (DU < DW < 4-DU), it can be concluded that there is no autocorrelation (Ghozali, 2018).

The results of the heteroscedasticity test, presented in Table 6, indicate that all variables have significance values greater than 0.05. Therefore, it can be concluded that the regression model is not constrained by heteroscedasticity. It means that the error terms are evenly distributed and do not systematically increase or decrease with changes in predictors. With the fulfillment of the classical assumption test as explained, multiple linear regression analysis is feasible to be used in the research model.

Based on Table 7, the adjusted coefficient of determination test (R^2) value is 0.847. It means that the variation in the independent variable can explain the variation in the mediation variable (green product innovation) by 84.7% while other factors explain the remaining 15.3% of the variable. Then, green product innovation can explain the variation of profitability by 31.1% and company growth by 41.4%. These values suggest that while green product innovation has a moderate impact on both outcome variables, there are still other external or internal factors affecting profitability and growth.

Based on Table 8, the significance value of F is 0.005. This value is smaller than 0.05 ($\alpha = 0.05$), and the F-calculated is greater than the F-table. Thus, with a confidence level of 95%, all variables together have a significant effect on green product innovation. Then, green product innovation also has a significant effect simultaneously on profitability and company growth.

Table 5 Autocorrelation Test Results

DL	Durbin-Watson	DU
CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation		
1.7176	1.902	1.8199
Green Product Innovation on Company Growth		
1.7176	1.841	1.8199
Green Product Innovation on Profitability		
1.7176	1.927	1.8199

Table 6 Heteroscedasticity Test Results

Coefficients

Model	Unstandardized Coefficients		Std. Coefficients	t	Sig.
	B	Std. Error	Beta		
CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation					
(Constant)	-0.540	16.521		-0.033	0.974
CEO Education	-1.181	1.278	-0.060	-0.924	0.356
CEO Gender	-18.471	6.254	-0.190	-2.953	0.346
CEO Experience	1.307	2.428	0.036	0.538	0.591
Firm Size	2.924	1.422	0.141	2.057	0.408
Firm Age	-0.198	0.069	-0.191	-2.876	0.439
a. Dependent Variable: Green Product Innovation					
Green Product Innovation on Company Growth					
(Constant)	27.173	0.979		27.758	0.000
Company Growth	-0.001	0.000	-0.090	-1.409	0.160
a. Dependent Variable: Company Growth					
Green Product Innovation on Profitability					
(Constant)	27.375	0.984		27.822	0.000
Profitability	-0.068	0.083	-0.053	-0.822	0.412
a. Dependent Variable: Profitability					

Before running the t-test, the samples have passed the descriptive statistical, normality, multicollinearity, autocorrelation, and heteroscedasticity tests. Table 9 shows the partial effect of CEO and firm characteristics on green product innovation and green product innovation on company growth and profitability. It shows that partially CEO gender, CEO experience, firm size, and firm age have a positive effect on green product innovation. Then, green product innovation has a positive effect on company growth and profitability. These results are significant because the significance value is greater than 0.05, the unstandardized beta value is in a positive direction, and the t-count is greater than the t-table value (Ghozali, 2018). However, only the CEO education does not affect green product innovation because it does not meet the above requirements.

The first hypothesis regarding the influence of CEO education on green product innovation is rejected. It is contrary to the findings of Zhang et al. (2022) that CEO education level is not directly correlated with the extent to which a company adopts green product innovation. Several key reasons can explain why CEO education has a limited effect on green product

Table 7 Coefficient of Determination Test (R^2) Results

Model Summary					
Model	**R**	**R-Square**	**Adj. R-Square**	**Std. Error of the Estimate**	**Durbin-Watson**
CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation					
1	0.238	0.566	0.847	30.85468	1.902
b. Dependent Variable: Green Product Innovation					
Green Product Innovation on Company Growth					
2	0.131	0.172	0.311	2512.91712	1.841
b. Dependent Variable: Company Growth					
Green Product Innovation on Profitability					
3	0.003	0.294	0.414	11.86714	
b. Dependent Variable: Profitability					

Table 8 F-Test Statistics Results

ANOVA					
Model	**Sum of Squares**	**Degree of freedom (df)**	**Mean Square**	**F**	**Sig.**
CEO Education, CEO Gender, CEO Experience, Firm Size, and Firm Age on Green Product Innovation					
Regression	13415.585	7	1916.512	2.131	0.054
Residual	223722.639	235	952.011		
Total	237138.224	242			
a. Dependent Variable: Green Product Innovation					
Green Product Innovation on Company Growth					
Regression	26611661.279	1	26611661.279	4.214	0.041
Residual	1521855344.073	241	6314752.465		
Total	1548467005.352	242			
a. Dependent Variable: Company Growth					
Green Product Innovation on Profitability					
Regression	0.241	1	0.241	3.171	0.007
Residual	33939.768	241	140.829		
Total	33940.009	242			
a. Dependent Variable: Profitability					

innovation within a company. According to Huang et al. (2021), although CEO education provides strong managerial knowledge and skills, green product innovation is often more influenced by external factors such as environmental regulations, market demands, and stakeholder pressure. Highly educated CEOs have a good understanding of the importance of green innovation. However, its implementation requires broader support from the entire organization and the business ecosystem in which the company operates (Zhang et al., 2022).

The second hypothesis regarding the influence of CEO gender on green product innovation is accepted. The result is in line with the research findings by He and Jiang (2019), indicating that the presence of female CEOs in a company can encourage the adoption of green product innovation. Previous research has shown that women tend to have a higher sensitivity to environmental and social issues. Female CEOs may be more aware of and concerned about the environmental impacts of their business operations. Therefore, they are more likely to drive initiatives aimed at reducing these negative impacts (Huang et al., 2025). This sensitivity may encourage them to adopt and implement sustainable green product innovations.

The third hypothesis regarding the influence of CEO experience on green product innovation is accepted. The result supports the research findings by Wang et al. (2023) that CEO experience in a particular industry or field can encourage the adoption of green product innovation. Several key reasons explain why CEO experience has a positive effect on green product innovation in a company. An experienced CEO has comprehensive knowledge of the various challenges and opportunities that exist in the market, as well as the best ways to overcome them (Kallias et al., 2023). This knowledge is invaluable in identifying opportunities to develop and implement sustainable and competitive green product innovations (Wang et al., 2023).

The fourth hypothesis, which examines the influence of firm size on green product innovation, is accepted. This finding aligns with the results of Lin et al. (2019), who suggest that firm size plays a crucial role in promoting green product innovation. This finding is consistent with the theory that companies with larger sizes tend to have more resources, both in terms of finance, technology, and human resources, which can be used to develop and implement sustainable product innovation (Lé & Vinas, 2024). In addition, large companies often have larger and more experienced R&D teams, as well as access to broader knowledge and expertise, which can accelerate the green product innovation process (Lin et al., 2019).

The fifth hypothesis regarding the influence of firm age on green product innovation is accepted. The result supports the research findings by Leyva-de la Hiz and Bolívar-Ramos (2022), indicating that firm age can contribute to increased green product innovation. Companies that have been operating longer tend to have more experience, resources, and capacity to invest in green product development (Asad et al., 2024). Companies that have been operating longer generally have more extensive experience in their industry, which allows them to understand better market needs and challenges related to green product innovation (Najib et al., 2022).

The sixth hypothesis regarding the influence

Table 9 T-Test Results

Coefficients						
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Sig. One Tailed**
(Constant)	66.852	32.241		2.073	0.039	
CEO Education	1.234	1.265	0.063	0.975	0.330	0.165
CEO Gender	18.418	6.214	0.190	2.964	0.003	0.002
CEO Experience	5.055	4.491	0.072	3.146	0.002	0.001
Firm Size	2.910	1.409	0.141	2.065	0.040	0.020
Firm Age	0.328	0.132	0.164	2.476	0.014	0.007
a. Dependent Variable: Green Product Innovation						
(Constant)	361.038	321.521		2.123	0.002	0.001
Green Product Innovation	10.593	5.160	0.131	2.053	0.041	0.021
b. Dependent Variable: Company Growth						
(Constant)	9.191	12.889		2.713	0.004	0.002
Green Product Innovation	8.336	0.238	0.690	2.408	0.016	0.008
b. Dependent Variable: Profitability						

of green product innovation on company growth is accepted. The result aligns with the research findings by Fabiola and Khusnah (2022), which indicate that environmentally friendly product innovation plays a crucial role in driving company growth. The adoption and development of green products can provide various significant benefits for company growth, both in terms of market, reputation, and operational efficiency (Maziriri & Maramura, 2022). Then, green product innovation often allows companies to enter new markets or previously unreached market segments. Consumers are increasingly aware of environmental issues and are more likely to choose products that have a lower environmental impact (Pinto et al., 2023). By offering green products, companies can attract a wider range of customers and differentiate themselves from competitors.

The seventh hypothesis regarding the effect of green product innovation on profitability is accepted. The result is in line with the research findings by Amalia (2023) that green product innovation can have a positive impact on company profitability. The research reveals that the development and adoption of green products not only support sustainability goals but can also improve the company's financial performance through several mechanisms. Green product innovation can open new opportunities for market differentiation (Wang & Ahmad, 2024). Consumers who are increasingly aware of environmental issues are often willing to pay more for products they perceive as more environmentally friendly (Du & Wang, 2022). By offering products that meet this demand, companies can increase revenue per unit and profit margins, which directly contribute to profitability.

Based on Figure 2, the coefficient path from the CEO and firm-level factors to green product innovation (A) is 66.852, and the coefficient path from green product innovation to company growth (B) is 10.593. Standard Error of (A) is 32.241, and Standard Error of (B) is 5.160. From these data, a two-tailed probability of 0.14 > 0.05 is produced, which means that the mediating variable is not able to act as a mediator. The results of Figure 2 show no influence of CEO and firm-level factors on company growth mediated by green product innovation. The result is inconsistent with the research findings by Fabiola and Khusnah (2022) that CEO and firm-level factors have a direct influence on company growth and are mediated by green product innovation. CEOs with high experience and education tend to be more able to encourage companies to innovate, including developing environmentally friendly products (Huang et al., 2021; Chen et al., 2022). Moreover, companies with large resources or assets and experienced CEOs can implement green innovation. Furthermore, environmentally friendly product innovation can improve the company's reputation among external stakeholders.

Then, in Figure 3, the coefficient path from the CEO and firm-level factors to green product innovation (A) is 66.852, and the coefficient path from green product innovation to profitability (B) is 8.336. Then, the Standard Error of (A) is 32.241, and the Standard Error of (B) is 0.238. From these data, a two-tailed probability of 0.03 < 0.05 is produced. It means that the mediating variable can act as a mediator. The results of Figure 3 indicate a positive influence of CEO and firm-level factors on profitability mediated by

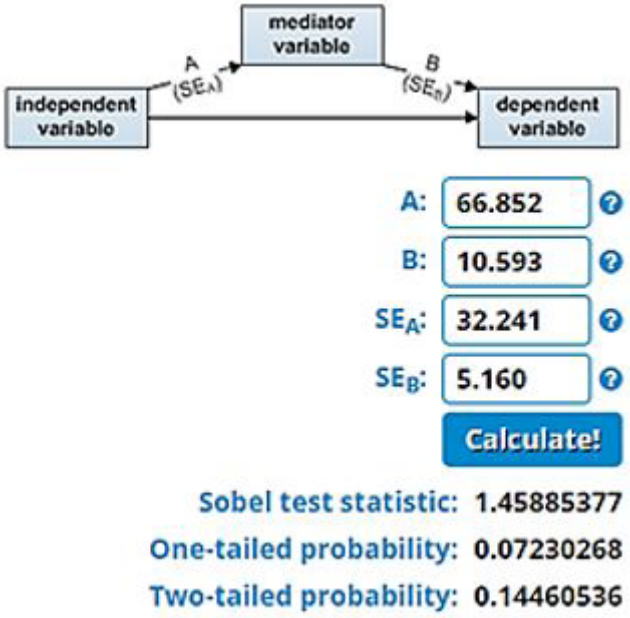

Figure 2 Sobel Test Results for CEO and Firm-Level Factors on Company Growth Mediated by Green Product Innovation

green product innovation. It is in line with the research findings by Amalia (2023), Abimanyu and Nugraha (2024), and Irham et al. (2023) that CEO and firm-level factors have a positive influence on profitability and are mediated by green product innovation. Factors that can affect a company's profitability include operational efficiency, optimal cost structure, good risk management, and product or service innovation. To achieve good profitability, companies need to consider the right steps to manage assets, resources, and operations. One of them is implementing green product innovation.

The research findings provide compelling evidence for companies, particularly to achieve long-term sustainable growth, to take strategic actions. First, companies must focus on building a strong environmental culture, aligning with market-driven sustainability trends, and responding to regulatory expectations. Second, companies are encouraged to diversify leadership teams, recognizing gender diversity and experienced leadership in fostering innovation in green products. Finally, green product innovation has been proven to enhance profitability and serves as a key mediator between organizational characteristics and financial performance. Thus, companies should prioritize green investment, including green research, development, product, and operations as part of their core growth strategy.

CONCLUSIONS

Based on the results, it can be concluded that various factors influence green product innovation, and green product innovation impacts company growth and profitability. However, CEO education does not show a significant effect on green product innovation. Although CEOs with higher education backgrounds understand the importance of such innovation, its implementation is more influenced by environmental regulations, market demands, and corporate culture. In contrast, CEO gender, CEO experience, firm size, and firm age are proven to have a positive effect on green product innovation. Green product innovation contributes positively to company growth and profitability. In addition, green product innovation can mediate CEO and firm-level factors on profitability but not on company growth. The results can be used as an input for companies to implement diverse leadership, support green product innovation, and optimize resources to drive growth.

For managerial implications, companies are advised to develop internal training programs that focus on sustainability and green innovation and promote gender diversity in leadership positions to bring new and innovative perspectives. Companies should also leverage the experience of CEOs and senior executives through green innovation strategies and continue to invest in infrastructure and Research and Development (R&D) facilities that support green product innovation. In addition, companies that have been operating for more than 38 years can leverage their experience in strengthening green innovation and sharing sustainable practices with other companies. For policy implementation, developing regulations or policies regarding commitment to green innovation and ensuring full compliance with environmental regulations are also key steps to strengthen reputation and support sustainable growth.

The research has been conducted in accordance with scientific procedures, but there are some

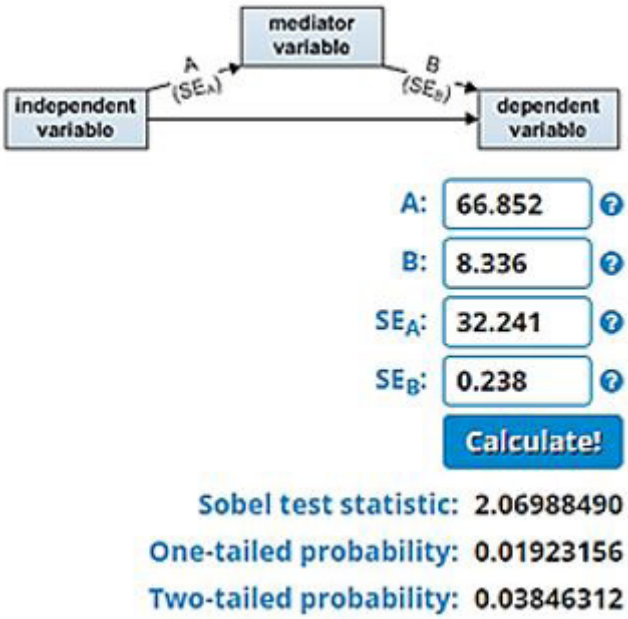

Figure 3 Sobel Test Results for CEO and Firm-Level Factors on Profitability Mediated by Green Product Innovation

limitations that need to be considered. For example, not all companies routinely issue sustainability reports throughout the 2020−2022 period. It causes many companies to be eliminated, resulting in a small sample scope. Another limitation is that there are not many studies that discuss this topic. Therefore, it is a little difficult to find supporting journals for the results of the tested variables. In addition, not all companies have the required variables, so the research cannot be generalized to all companies listed on the Indonesia Stock Exchange. The last limitation is in the measurement of green product innovation, which may not fully reflect all aspects of innovation carried out by the company, especially if there are innovations that are not formally recorded or not reported in the annual report.

Further researchers are advised to expand other factors that may influence green product innovation in addition to CEO and firm-level factors, such as organizational culture, environmental regulations, or stakeholder pressure. In addition, further researchers are expected to expand the scope of the sample by involving companies from various industrial sectors listed on the Indonesia Stock Exchange. It can enhance the generalizability of the findings and capture potential sector-specific differences in implementing green product innovation.

AUTHOR CONTRIBUTIONS

Conceived and designed the analysis, N. S.; Collected the data, P. S. and N. D. K.; Contributed data or analysis tools, T. A. A., P. A., and N. D. K.; Performed the analysis, N. S. and T. A. A.; Wrote the paper, N. S. and T. A. A.; and Curated data, N. S.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of the research are available within the article [and/or] its supplementary materials.

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