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An Investigation of Barriers to Adopt Green Innovation Among Manufacturing Organizations in Vietnam

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Abstract.

This research aims to identify the main barriers to green innovation in Vietnam manufacturing organizations. This study began by reviewing the relevant literature and providing a solid theoretical framework to understand the determinants of green innovation for manufacturing firms in the global context. It also helps internal and external stakeholders figure out what influence and how to implement green innovation more efficiently by removing all impediments. Additionally, this article is considered a valuable and rational evidence for prioritizing and directing innovation policies in the manufacturing industry. Based on numerical data from 143 employees at middle- and upper-level managers among manufacturing companies around Vietnam, the study found that deficiency of financial resources primarily significantly impacts green innovation adoption, followed by the uncertainty of market demand and lack of government support. However, with limited observations, the investigation did not observe the dynamic effect of green innovation over periods and only focused on the manufacturing sector instead of different industries for generalizing the research results. Moreover, the circumstances of green innovation would be diverse in other nations.

Keywords: green innovation, manufacturing organizations, government supports, financial barriers, market barriers

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1. Introduction

According to WorldBank (2018), the manufacturing industry accounts for nearly 70% of solid wastes released into the environment, which will continue to increase until 2050. It is considered the leading cause of natural disasters and global warming (Shahzad, 2015, Kasprzyk et al., 2014, Sun et al., 2020). Therefore, international cooperation was established and still maintained its operations activities for environmental protection worldwide (Zarei and Madan, 2020). Nowadays, people are more discerning about the importance of preserving our environment. Moreover, consumers have been

encouraged to shift their shopping habits into “green” consumption, prioritise health protection, and stimulate renewable energy usage (de Koning et al., 2015). As a result, green innovation or green transition is a common trend widely applied by manufacturing enterprises, pioneered by European countries, and gradually spreading to other regions (Erygit and Ozcure, 2020, Rehman et al., 2020). Green innovation has been successfully recognised and adopted among European and American manufacturers along with governments promoting sustainable economic development (Holzl and Janger, 2014, Ho and Nguyen, 2016).

Following the global trends for sustainable development, Vietnam aims for green innovation and to become a green economy among developing countries by 2030 (Ho and Nguyen, 2016, UnitedNations, 2017). In addition, based on ILO (2020), 54% of Vietnam’s organisations are manufacturing firms dependent on raw material production. The consumption of vast amounts of unsustainable chemicals, fossil fuels, and natural resources leads to increased environmental pollution. It drives the attention of the government and stakeholders to assist and support these businesses in pollution prevention and mitigation, which is beneficial to maintain ecological balance. Gupta and Barua (2018a) stated that green innovation contributes to creating essential products, services, or processes that limit the dissemination of pollutants and harmful impacts. Yet, adopting green innovation would be challenging when the transition process is not consistent and comprehensive throughout different regions and countries (Holzl and Janger, 2014, Patrick, 2017, Ullah et al., 2021).

The green practices implementation has been presented as sluggish and powerless in Vietnam due to various barriers (ADB, 2020). Additionally, the knowledge of green innovation is still ambiguous and negligible in public (Ho and Nguyen, 2016). In consequence, manufacturing firms are significantly unfavourable for acting upon sustainable development in terms of the green transition (Kushwaha and Talib, 2017). Hence, it is necessary to study factors that significantly influence green innovation initiatives among Vietnam’s manufacturers. Precisely, this research first aims to synthesise the conceptual framework about obstacles to green innovation implementation worldwide. Next, it will examine the significant impediments for manufacturing organisations to adopt green innovation in the context of Vietnam. Finally, the recommendation for solutions to reduce hurdles of green transition in Vietnamese production enterprises.

To comply with the goals, the researchers conduct a mixed-method approach to understand the theoretical structure and practical viewpoints for manufacturing firms in Vietnam. With support from VCCI (Vietnam Camper of Commerce and Industry) and the Enterprise Relations Office at the University of Greenwich (Vietnam), the surveys

were sent to targeted participants, including middle- and upper-level managers from Vietnam's manufacturing companies and data from online responses are analysed using SPSS 26 to investigate the barriers to green applications.

2. Literature Review

2.1. Green Innovation

Innovation is the process of doing something new (Cetindamar et al., 2009, Drucker, 1998). Accordingly, green innovation is defined and measured by that process's "greenness" and "newness". The "newness" of innovation can be assessed from three aspects: new to the industry, the customer, and the initiator. "Greenness" involves saving energy, preventing pollution, and recycling waste (Liao and Wang, 2018). Besides, Wong (2012) argues that reducing the business impact on the environment is driven by green innovation. Green innovation is classified into three main categories: green product innovation, green process innovation, and green system innovation (Chen et al., 2006, Chen, 2008, Madrid-Guijarro et al., 2009). Green product innovation is the reduction or elimination of a product's negative impact on the environment throughout its life cycle (Rubik et al., 2007, Greenpeace, 2014, Dangelico and Pujari, 2010, Liu et al., 2012). Those impacts include the extraction of raw materials and energy to produce products, pollution caused while using period, and waste of the end (Reap et al., 2008, Azapagic, 2010). A green product is measured based on a life cycle assessment (LCA) according to three criteria: recyclability, ecological impact, and environmental performance (Groot and Borén, 2010, Chiou et al., 2011). Green process innovation is defined as manufacturing technologies and processes to create products with little or no environmental impact (Chen, 2011, Wilson et al., 2011). It is assessed with compliance with local, national, and international environmental requirements and customer expectations. Additionally, the companies will comply with requirements for efficient energy, resources, and materials used. In other words, the production process creates no or negligible influence on the environment and people (Groot and Borén, 2010, Chiou et al., 2011, Curkovic and Sroufe, 2011). Green system innovation is defined as identifying, implementing, and monitoring corporate ideas on environmental-related activities, thereby enhancing the company's competitiveness (Chen et al., 2006, Chen, 2008). Abdullah et al. (2015) mentioned that green system innovation significantly influences the launching of new green products in the market.

Nevertheless, there are many obstacles to putting environmental innovations into practice. Many studies have pinpointed numerous challenges that prevent enterprises, especially SMEs, from green transition. Table 1 - Meta-data table compiles updated research results about the hurdles to environmental innovation and environmentally responsible business practices.

Table 1: Meta-data of previous studies.

Article	Region	Findings	Method
(Musaad O et al., 2020)	Saudi Arabia	The study identified six main barriers, 24 sub-barriers, and ten strategic solutions to overcome the obstacles.	Fuzzy analytical hierarchy process (FAHP)and Fuzzy technique for order of preference by similarity to ideal solution (FTOPSIS)
(Hazarika and Zhang, 2019)	Hong Kong	The study identified and prioritised five barriers following their influence on green innovation adoption.	Hierarchical regression analysis and linear regression analysis
(Gupta and Barua, 2018b)	India	Seven main category barriers, thirty-six sub-category barriers, and twenty solutions to overcome these barriers were defined.	BWN and Fuzzy TOPSIS
(Ghisetti et al., 2017b)	European Union	The authors revealed that financial barriers are a major impediment to the adoption of environmental innovation	Bivariate probit model – Equation Modelling
(Pinget et al., 2015)	France	Knowledge barriers, market-related barriers, and financial barriers were classified as the most important ones impacting on environmental innovation	Regression Analysis
(Abdullah et al., 2015)	Malaysia	Environmental resources, attitude and perception, business practices, government support, and customer demand hinder green product innovations. Attitude and perception, business practices, poor external partnerships, insufficient information, lack of customer demand, and commercial environmental benefits impede green process innovations.	PLS-SEM
(Holzl and Janger, 2014)	18 European countries	Knowledge barriers related to the availability of skilled labour, innovation partners and technological knowledge, as well as the availability of external finance, are more critical for firms to adopt innovation	Distance to the frontier – levels of sectoral total factor productivity

In this study, the authors propose the research model shown in Figure 1, comprising eight impediments to green innovation in terms of organisation, human resources, finance, technology, attitude, government, supplier and market information extracted from the primary references in Table 1.

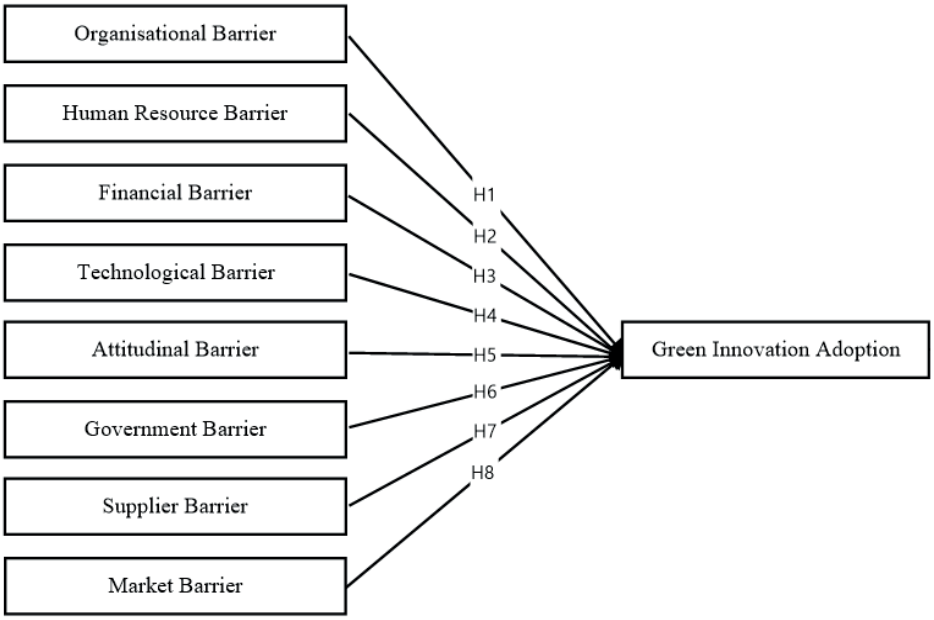

Figure 1: The Proposed Research Model.

2.2. Organisational Barriers

According to Mangla et al. (2017), the most significant barrier to green innovation is organisational barriers. Other research also indicates that organisational structure needs to be transformed for green innovation in enterprises (Kong et al., 2002, Benn et al., 2014). Additionally, corporate environmental awareness is crucial in implementing green innovation, as Walker et al. (2008) and Mudgal et al. (2010) mentioned. Within the business, top management is responsible for setting long-term strategies and driving business changes (Dubey et al., 2015). It means that a lack of support and commitment from leadership is a substantial hurdle to implementing green practices in the organisation (Pun, 2006, Gupta and Barua, 2018a).

Moreover, Moch and Morse (1977) emphasised a positive relationship between innovation adoption and firm size. In other words, large firms could enhance innovation adoption's feasibility, significantly affecting their organisational environmental performance. Similar ideas are also found in several studies by Spencer (2003), Stock (1998) and Tilley (1999). Furthermore, because the concept of sustainable development and green innovation is still complex and multidimensional, leaders are still not fully understanding it, leading to hesitation and stagnation in initiating green innovation projects (Lorek and Spangenberg, 2014, Sarkis et al., 2010). One of the main goals of green innovation is to balance the benefits of economic activities with their environmental impacts. However,

businesses often fail to reconcile short-term financial goals and long-term ecological goals (Mangla et al., 2017).

2.3. Hypothesis 1 (H_1): Organisational barriers negatively impact green innovation.

2.3.1. Human Resources Barriers

Human resource development plays a vital role in the progress of green innovation (Mehrabi et al., 2000). So, a lack of environmental knowledge hinders green innovation, as Muduli et al. (2013) proposed. In other words, employees who do not grasp the advantages of applying these innovations, concern more about customer disputes towards new products. Besides, a lack of competent staff might impede organisational initiatives' improvement (Hoffman et al., 1998, Holzl and Janger, 2014). Therefore, implementing innovation requires the ability to quickly adapt to changes and technological advancements from employees and managers (Ashford, 1993, Hart, 1995, Mangla et al., 2017). In particular, green innovation implementation may increase the complexity of the whole business and demand to update and train the workforce before any transitions (Groenewegen and Vergrat, 1991, Russo and Fouts, 1997, Abdullah et al., 2015). Training programs are crucial for environmental advocacy and green innovation in order to support employees in acquiring new knowledge and skills (Rothenberg, 2003, Sarkis et al., 2010). Remarkably, the value recognition of organisational innovation needs to be informed and educated to all staff and workers to reduce the roadblocks to green transformation, as suggested by Cohen and Levinthal (1990) and Baldwin and Lin (2002).

2.4. Hypothesis 2 (H_2): Human resource barriers negatively impact green innovation.

2.4.1. Financial Barriers

Ghisetti et al. (2017a) proposed that the financial barrier is challenging for any organisation, specially manufacturing companies, to invest in the R&D of green innovation. Insufficient financial resources regularly derive from the requirements of high initial investments and the difficulties in accessing internal and external resources (Rennings, 2000). Internal financial hurdles are owing to specific characteristics of green innovation, such as greater technical risk, uncertainty, and more extended payback periods than 'conventional' innovation (Ghisetti et al., 2017a, Kapoor and Oksnes, 2011). In fact,

green innovation may reduce the deterioration of the environment, yet hazardous waste disposal often requires a high cost to initiate (Mathiyazhagan et al., 2013). Moreover, manufacturers fear switching to green processes because they would place extra financial burdens to implement (Ghisetti et al., 2017a, Mudgal et al., 2010). On the other hand, enterprises find it hard to get bank loans for green initiations (Mathiyazhagan et al., 2013). Even though innovation might be heterogeneous among industries and business sizes, lack of financial availability, as well as the accessibility of government subsidies and loans from commercial banks, remarkably makes firms less prone to innovate (Hottenrott and Peters, 2012, WorldEconomicForum, 2013, Hojnik and Ruzzier, 2016, Canepa and Stoneman, 2007).

2.5. Hypothesis 3 (H_3): Financial barriers negatively impact green innovation.

2.5.1. Technological Barriers

Green innovation relies heavily on green technology development (Jinzhou, 2011). The shortages in finance, time, technical knowledge, and human resource often lead to the prevention of R&D for green innovation (Perron, 2005). Besides, Jinzhou (2011) argued that the development of green technology must pass through various uncertain stages, including technical, R&D, test and trial, and market..., increasing the risk of green technology and decelerating green innovation implementation. In addition, the probability of success in green technology is relatively low because it must comply with technical innovation requirements and environmental legislation. As Del Río et al. (2010) pointed out, inadequate technical proficiency limits organisations from absorbing green ideas created by competitors. Besides, it is also tricky for manufacturing organisations to embrace new technologies developed by other companies because they are often too expensive or irrelevant to their existing manufacturing process.

2.6. Hypothesis 4 (H_4): Technological barriers negatively impact green innovation.

2.6.1. Attitudinal Barriers

Lee and Rhee (2007) emphasised that the extent firms invest in environmental initiatives depends on top management's attitudes towards environmental issues. A positive attitude toward the environment is critical in promoting organisational pro-environment

activities (Naffziger et al., 2003, Abdullah et al., 2015). Besides, King and Lenox (2002) reported that organisations perceive few advantages from environmental management. Similarly, scepticism about the ecological benefits of green innovation is also a barrier to internal attitudes and perceptions of organisations (Perron, 2005, Govindan et al., 2014). Generally, managers are more risk-averse with transitioning from conventional works to green innovation (Murphy et al., 1996, Mathiyazhagan et al., 2013). Fear of failure in environmental awareness is related to fear of monetary loss in green initiatives or might reduce the products' durability and further lose the company's competitive advantages (Revell and Rutherfoord, 2003, Wang, 2011). Moreover, organisational stakeholders may also react adversely to green implementation (Zwick, 2002, Osterman, 2000, Kane et al., 1999). The study by Pawanchik and Sulaiman (2010) conducted in Malaysia showed that employees are unwilling to risk their work for innovation.

2.7. Hypothesis 5 (H_5): Attitudinal barriers negatively impact green innovation.

2.7.1. Lack of Government Supports

Runhaar et al. (2008) concluded that the rigidness and ambiguity of government regulations and policies could stifle green innovation. The government was generally apathetic towards environmental challenges, leading to inconsistent regulations and enterprises' difficulties in applying green innovation. Hence, companies merely complied with the government rules of environmental protection. In other words, the fewer commitments and efforts from organisations, the less prevention of harmful impacts on the environment (Runhaar et al., 2008, Al Khidir and Zailani, 2009). Nevertheless, it is unfair for any company that integrates green practices into its business to address environmental issues. Moreover, insufficient government financial support such as loans, grants, or subsidies might demotivate firms to initiate green innovation (Runhaar et al., 2008, Abdullah et al., 2015).

2.8. Hypothesis 6 (H_6): Lack of Government Support negatively impacts green innovation.

2.8.1. Supplier Barriers

The production phase decides whether products or services are environmentally friendly or not. Therefore, integrating suppliers into the decision-making process in

manufacturing firms is critical for fostering green innovation (Bowen et al., 2001, Rao, 2002, Rao and Holt, 2005). However, it is challenging to identify suppliers with a shared interest since they lack passion for green initiatives unrelated to their existing processes or materials (Ylinenpää, 1998). Additionally, companies struggle to locate a good supplier willing to redesign their current materials into "green materials" (Abdullah et al., 2015). Suppliers are vital stakeholders in the green transition process (Carter and Dresner, 2001). Nevertheless, they frequently are uncommitted and hesitant to exchange information about green programs (Walker et al., 2008, Wycherley, 1999, Luthra et al., 2011). Additionally, coordination and communication are often inadequate across the supply chain network, which may reduce green innovation adoption (Mangla et al., 2017).

2.9. Hypothesis 7 (H_7): Supplier Barriers negatively impact green innovation.

2.9.1. Market Barriers

Market and customer are the essences of business. Businesses must design, produce and supply goods and services to satisfy customers' needs. It means consumers may significantly shape the development of environmental-friendly products. "Green" customers are the key to the success of green innovation (Dhull and Narwal, 2016). Customers' awareness is considered a barrier to green innovation (Chen et al., 2006, Mudgal et al., 2010, Dhull and Narwal, 2016). Ghisetti et al. (2017a) mentioned that the high cost of producing green products might discourage firms from becoming "green". However, if the market has a high demand for green products, it can spur enterprises to adopt "green" operations. Several studies have shown that uncertain market demand for green products substantially affects organisational motivation towards innovation (Ashford, 1993, Silva et al., 2008, Dhull and Narwal, 2016, Tseng et al., 2015). In addition, buyers are still concerned that the price of green products is relatively higher than the others even though they perceive the benefits for the environment (Orsato, 2006, Walker et al., 2008, Min and Galle, 2001, Kidwell et al., 2013). Abdullah et al. (2015) also indicated that companies should pay more attention to product quality and customers' expectations while impeding green practices.

2.10. Hypothesis 8 (H_8): Market Barriers negatively impact green innovation.

3. Methodology

The study synthesises the theoretical framework from published literature sources and generates new insights from the extensive accessibility of previous research papers. Besides, the research mainly focuses on quantitative analytical techniques for identifying manufacturing organisations' barriers to green innovation. This study ran data analysis using SPSS 26, starting with reliability testing for internal consistency of Likert scale questions from the survey. Next, applying Exploratory Factor Analysis (EFA) defines which manifest variables measure underlying factors. Lastly, a Multiple Linear Regression Model is applied to test research hypotheses and check the reliability and validity of the model with five assumptions.

3.1. Data Collection

The questionnaire is designed with a five-point Likert Scale measuring all factors, followed by the demographical information. In addition, data were collected from December 10^{th}, 2022, to January 20^{th}, 2022, including 133 respondents participating in the survey. Online surveying manufacturing firms collect the primary data around Vietnam. The published questionnaires included 38 main questions regarding barriers to green innovations. The sample size is 133, distributed according to the sample structure by gender, education level, company sectors, operating time, number of employees, and asset size. Hair (2009) provided the specific guidance in defining the adequacy of sample size as following: 100= poor, 200 = fair, 300 = good, 500 = very good, 1,000 or more = excellent. So, 133 is affordable to ensure the representative of Vietnam's manufacturing firms under eight predictors and one dependent variable.

As can be seen from Table 2, most respondents are graduates and own university degrees (accounted for 69.9%) in various physical or service sectors. Also, their companies have worked in the manufacturing industry for over three years (86%). In addition, the company with an asset size above 100 billion amounted to approximately 50%.

3.2. Econometric Research Model

The econometric model aligning with the research model (Figure 1) is illustrated in (1) below for studying the barriers to green innovation among manufacturing in Vietnam:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 \, \varepsilon (1)$$

In which:

Table 2: Demographic Information of Research Sample.

Variables		Frequency (N)	Percent (%)
Gender	Male	77	57.9
	Female	56	42.1
Education level	Vocational Schools & Colleges	8	6.0
	Graduates	93	69.9
	Post-graduates	32	24.1
Sector	Physical products	52	39.1
	Service products	81	60.9
Operating time	Under 3 years	18	13.5
	3 - 10 (years)	30	22.6
	Over 10 years	85	63.9
Asset size	Under 20 billion VND	28	21.1
	20 - 50 (billion VND)	26	19.5
	50 - 100 (billion VND)	14	10.5
	Over 100 (billion VND)	65	48.9
No. of Employees	Under 20 people	17	12.8
	20 - 50 (people)	8	6.0
	50 - 100 (people)	15	11.3
	Over 100 people	93	69.9
Total		**133**	**100**

1. Y: Green Innovation
2. X_1: Organisational Barrier; X_2: Human Resource Barrier; X_3: Financial Barriers; X_4: Technological Barrier; X_5: Attitudinal Barriers; X_6: Government Barrier; X_7: Supplier Barrier; X_8: Market Barrier
3. β_0: The Constant Coefficient
4. β_i (i=1-8): The Unstandardised Coefficients X_i
5. ε: The Residuals of the model (1)

3.3. Reliability Testing

Table 3 shows the Cronbach's Alpha values of all factors including dependent and independent variables. They are entirely greater than 0.8: Green Innovation (0.903); Human Resource (0.915); Market (0.889); Finance (0.892); Government Support (0.903); Attitude (0.879); Technology (0.916); Organization (0.890) and Supplier (0.866). All Corrected item-total and Correlation coefficients of 8 groups are greater than 0.3 (can be

seen from Appendix 1), indicating that all component questions can be used to identify the latent factors in the next step.

TABLE 3: Summary of Reliability Testing and Exploratory Factor Analysis.

Factors	Reliability Testing	Exploratory Factor Analysis			
	Cronbach's Alpha	KMO	Bartlett's Test (Sig)	Initial Eigenvalues	Rotation Sums of Squared Loadings (%)
Green innovation	.903	.869	.000	3.610	72.209
Human Resource Barrier	.915	.870	.000	12.485	43.053
Market Barrier	.889			2.540	51.813
Financial Barrier	.892			2.186	59.352
Government Barrier	.903			1.761	65.425
Attitudinal Barrier	.879			1.358	70.109
Technological Barrier	.916			1.078	73.826
Organisational Barrier	.890	-	-	-	-
Supplier Barrier	.866	-	-	-	-

4. Data Analysis

4.1. Exploratory Factor Analysis (EFA)

In Table 3 and Appendix 1, EFA results show that the barriers to green innovation decrease from 8 determinants according to the proposed research framework (Figure 1) to 6 components with the KMO value (0.870) within the scope [0.5 – 1] and Sig. The value of Bartlett's Test is 0.000 less than the significance level of 1%, and Initial Eigenvalues are more significant than 1. Therein, the eigenvalues of each factor are followed: Human Resources (12.485), Market (2.540); Finance (2.186); Government Supports (1.761), Attitude (1.358), and Technology (1.078). Furthermore, the Rotation Sums of Squared Loadings value is 73.826% greater than 50%, and all loading values of 6 factors are greater than 0.5. It means Organization and Supplier barriers are eliminated based on the EFA results.

Similarly, the result of the EFA analysis for Green Innovation has the KMO value of 0.903 within the scope [0.5 – 1] and Sig. value of Bartlett's Test is 0.000 lower than 1% - significance level. The Initial Eigenvalues value is 3.610, greater than one by five items with loading values higher than 0.5, and the Rotation Sums of Squared Loadings value is 72.209%, higher than 50%.

In summary, Exploratory Factor Analysis results illustrate that barriers influencing green innovation amid manufacturing enterprises are reliable (Appendix 1). The adjusted research model is presented in Figure 2.

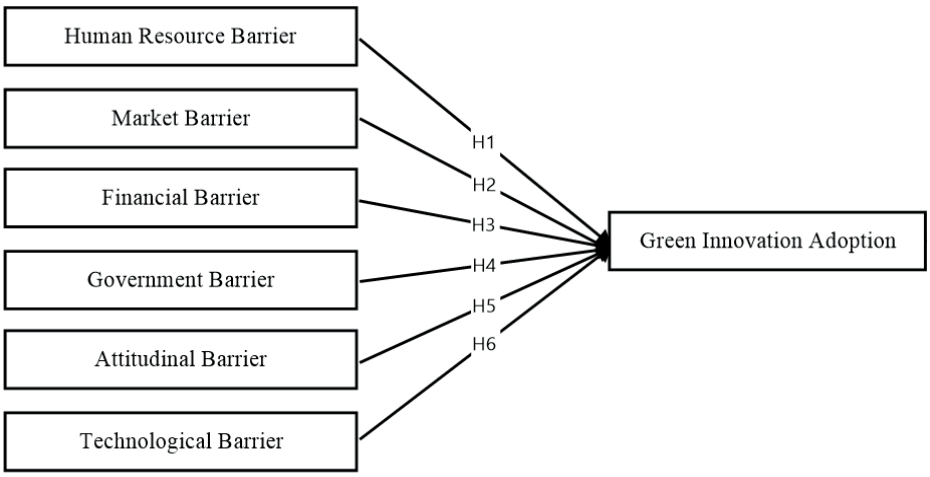

Figure 2: The adjusted research model.

4.2. Results of the Regression Model

TABLE 4: Result of Anova Testing.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30.623	6	5.104	6.344	.000[b]
	Residual	101.377	126	.805		
	Total	132.000	132			

a. Dependent Variable: Green Innovation

b. Predictors: (Constant), Technology, Attitude, Government Supports, Finance, Market, Human Resource.

From Table 4, Sig. values of F-statistics are approximately 0.000 lower than the significant level of 5%, implying that the research model is statistically significant and exists. In other words, at least one of the six factors will influence green innovation among Vietnam's manufacturers.

The next step is testing assumptions for the regression model using the OLS method. Based on the results from Appendices, all assumptions are confirmed with a significance level of 5%.

1. Assumption 1 (A1): Model (1) have the residuals (Ui) that are normally distributed, confirmed by One-Sample Kolmogorov-Smirnov Test (Appendix 3).

2. Assumption 2 (A2): Model (1) has the mean (Estimation) of the residuals (Ui) equal to 0, tested by the One-Sample Test (Appendix 4).
3. Assumption 3 (A3): Model (1) does not have any autocorrelation, as defined by Standard Runs Test (Appendix 5).
4. Assumption 4 (A4): Model (1) does not have any multicollinearity, tested by examining VIF values (Variance Inflation Factors) (Appendix 6).
5. Assumption 5 (A5): Model (1) has homoscedasticity, tested by using Spearman's RHO test between unstandardised residuals and all independent variables (Appendix 7).

5. Discussion and Recommendation

5.1. Testing Hypotheses

Sig. values of 3 factors (Finance, Market; Government Supports) are lower than the 5% of the significance level so that H_2; H_3; H_4 of the modified Research model (Figure 2) are accepted, but Sig. value of Human Resource, Attitude and Technology equal to 0.252, 0.695 and 0.297, respectively, more than 5% that means H_1, H_5, H_6 would be rejected. As a result, it can be concluded that the significant barriers, including Finance, Market and lacks government support, statistically negatively influence green innovation adoption, but the impact of Human Resources, Attitude and Technology are not statistically significant. Additionally, the financial barriers apparently have the most substantial effect on the embracement of Green Innovation, followed by market barriers and insufficient government support.

5.2. Discussion & Recommendation

The R^2 value of model (1) is relatively low, about 23.2%, indicating that six barriers are less likely to affect green innovation adoption. In other words, there are other determinants of Green Innovation, accounting for 76.8%. In the six factors of the research model, there are three statistically significant barriers: financial, market, and government barriers impacting green adoption. It means that if any factor of these three factors is improved, it will enhance green innovation among manufacturing companies and otherwise.

Precisely, the financial barriers have the most decisive influence because of the most significant standardised coefficient (-0.343) compared to other independent variables.

Table 5: Conclusion of Hypotheses Testing.

No.	Factor	Research Hypotheses	Standardised Coefficients	Sig.	Concluded
1	**Human resource**	H_1: *Human resource barriers negatively impact green innovation.*	.090	.252	Reject
2	**Market**	H_2: *Market barriers negatively impact green innovation.*	-.263	.001	Accept
3	**Financial**	H_3: *Financial barriers negatively impact green innovation.*	-.343	.000	Accept
4	**Government Supports**	H_4: *Lack of government support barriers negatively impacts green innovation.*	-.171	.030	Accept
5	**Attitudinal**	H_5: *Attitudinal barriers negatively impact green innovation.*	.031	.695	Reject
6	**Technological**	H_6: *Technological barriers negatively impact green innovation.*	.082	.297	Reject
R Square			**.232**		

Likewise, the studies from Canepa and Stoneman (2007) to Hojnik and Ruzzier (2016) also confirm that the less financial availability and lack of financial support, the less prone to green innovation. Financial impediments to green innovation include enterprises' inability to invest in R&D and difficulty approaching external investments owing to obsolete legislation. Investors see green innovation as hazardous (Ghisetti et al., 2017a, Kapoor and Oksnes, 2011). Vietnam's government has not yet approved or released transparent promoting programs for sustainable business development since 2017, when establishing the National Action Plan for 17 sustainable development goals (United Nations, 2017).

Moreover, Vietnam companies have suffered many challenges, such as loss of liquidity, financial shortages, employee reduction, and supply chain disruption due to the Covid-19 pandemic (MOIT, 2021). Even though firms spend much more money on handling goods, distributing and developing markets, and protecting brands, there are still no incentives for approaching government funds for green growth to the high initial investment. Therefore, the lack of government aid and financial subsidies triggers difficulties for Vietnam enterprises to maintain their business operations. So, they will not be interested in and unable to promote green innovation initiatives, as reported by the Sustainable Production and Consumption Office – Ministry of Trade

and Industry. According to the Ho Chi Minh City University of Technology survey, 89% of Vietnamese firms did not receive state assistance and incentives for producing and selling green products. Only 26% of businesses indicated they got help from green product makers and distributors (SPCO, 2018). Therefore, the optimal solution is to provide manufacturing organisations with more straightforward and available ways to access financial investments. Public policymakers should act as “market activators” and “investors”, complementing their policies with low-interest rates and developing financial markets such as expanding long-term private funds, venture capital, and crowdfunding.

Followed by Market barriers, it ranks in second place with the standardised coefficient of -0.263, revealing that companies are postponing the green transition due to the lack and irrelevant market information on customer demands for green products (Silva et al., 2008, Dhull and Narwal, 2016, Tseng et al., 2015, Min and Galle, 2001, Kidwell et al., 2013, Walker et al., 2008). Unawareness and reluctance to pay more for green items hinder customer demand. Customers are uninformed of green innovation’s environmental advantages, resulting in low demand (Mangla et al., 2017). Accelerating green consumption is an important content mentioned in the national strategy shown in the Decision No. 1393 of the Prime Minister on “Approval of Green Growth Strategy for the period 2011 - 2020 and vision to 2050” (MOIT, 2021). Currently, many firms are implementing programs to stimulate green consumption, especially efforts to reduce plastic waste and limit the use of plastic bags. For example, many milk tea and coffee shops use bamboo or stainless-steel straws instead of plastic straws, restrict bottled water with non-biodegradable packaging, and use only paper bags instead of plastic bags.

Additionally, many supermarkets across Vietnam, such as Coopmart and Lotte mart, have joined hands to reduce plastic bags and waste by using banana leaves to pack vegetables and food instead of neoprene bags. Thus, green consumption propaganda has helped raise public awareness of ecological products and ecological nylon bags (SPCO, 2019). Therefore, governments and policymakers must analyse green market constraints to increase market demand and promote the propagation of environmentally friendly advantages (Ullah et al., 2021). In other words, consumers need to be educated on how the consequences of environmental pollution are currently affecting their lives and, in the future, the long-term influences that green innovations will contribute to minimising environmental issues.

Lacking of government encouragement will restrain green adoption and implementation (Runhaar et al., 2008, Al Khidir and Zailani, 2009, Abdullah et al., 2015). The policies are contradictory and rigid, and regulations and procedures are often unclear, making

enterprises difficult to follow (Abdullah et al., 2015). The government may minimise obstacles by implementing transparent and rigorous tax laws for carbon emissions, as suggested by Ullah et al. (2021). The government might give financial assistance to environmentally adapted enterprises. In contrast, firms' environmental invasion should be punished harshly to warn and remind everyone. Until February 2022, Deputy Prime Minister Le Minh Khai signed a decision to launch a program assisting private companies in developing more sustainably from 2022 to 2025 (MOIT, 2022). More precisely, the program intends to mobilise social resources to establish an ecosystem supporting sustainable business so enterprises may contribute to job creation, improved living circumstances for low-income and disadvantaged groups, environmental protection, and climate change response in Vietnam. The initiative will help businesses develop sustainable strategies and plans. Sustainable enterprises will get help with training, technology, digital transformation, financial resources, communications, and trade promotion. Under the SME Support Law and other laws, small and medium-sized firms (SMEs) will get the most state funding assistance for sustainable company growth (MOIT, 2022).

In addition, long-standing plastic bag consumption habit is not simple to modify because they are inexpensive to acquire, easy to use, and even free. One-time plastic bag buying will only be decreased when retailers and purchasers adjust their sales and shopping behaviour contemporaneously. In addition, traditional retail channels also need to shift to promote green consumption habits (Toan, 2022). In reality, all actions are isolated and unconnected from each other, leading to limited impact and lacking appeal and sustainability. Furthermore, Vietnam presently has no apparent green purchasing or consumption rules. Many legal documents have integrated and regulated green procurement, sustainable procurement, environmental friendliness, and cleaner production, but these contents only support producing environmentally friendly products and services. There is no robust adjustment tool to regulate the consumption behaviour of products that are not "green" and not yet environmentally friendly (SPCO, 2019).

Apparently, managers always face a conflict between profit and green innovation, especially in SMEs. In other words, the contention above makes the companies' leaders apprehensive of green transition, so they are primarily interested in profit, not green and sustainable products. Furthermore, the global trend is innovation, which impacts efficiency and business strategy in the long term. It means that the vision and mission of enterprises are unaffected by the managers' attitudes (SPCO, 2018).

Lastly, high initial investments and expenditures hinder green technology availability. Most SMEs lack funds for green product investment and development. Indeed, the Ministry of Science and Technology, in collaboration with the University of California Berkeley, held a seminar to develop policies that attract high technology to transform Vietnam into a green and digital economy. The event is within the framework of Prime Minister Pham Minh Chinh's business trip to the United States in May 2022 (MOST, 2022). Hence, Vietnam's adoption of green technology is limited, despite its global development. We are still importing technology from foreign countries.

Nevertheless, the speed of transferring and absorbing the updated technology in Vietnam is relatively high compared to other developing countries based on the acknowledgement from the government that science and technology play a vital role in the industrialisation and modernisation of our country. High-quality human resources, science-technology, and innovation are the "key" to determining the speed of modern manufacturing and further economic growth. In several Party documents and decisions, science and technology are regarded as the top national policy, basis, and driving force for socioeconomic development and national security.

6. Conclusion

6.1. Findings

The analytical results indicate that the obstacles in terms of financial resources, market information, and government supports negatively influence green innovation among Vietnam manufacturing firms. Precisely, lack of financial resources has the highest impact, followed by insufficient and irrelevant green information on the market and a lack of government encouragement for green adoption. The research provides a solid theoretical framework for the barriers to green innovation. Additionally, the study helps internal and external stakeholders understand the barriers and how to combat them to implement green innovation by removing all impediments. It is valuable and rational evidence for prioritising and directing innovation policies in the manufacturing industry.

6.2. Limitations and Future direction

The authors only focus on specific manufacturing companies instead of various sectors for generalising the research results. It means that the theoretical framework and

this research design could be applied in different industries. Moreover, the research sample consists of 133 Vietnamese production firms, which may be pretty small to be representative of the whole population of the manufacturing industry in Vietnam. In addition, the R^2 value of the research model is lower than 50%, indicating that future studies should consider running different mathematical techniques to examine the barriers to green innovation to improve the significance of the research. Moreover, we could add more sub-barrier to define more accurately the determinants and obstacles impacting the adoption of green technology. Besides, qualitative research carries out at the beginning to examine the potential demonstration of these discrepancies is necessary.

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Appendices

Appendix 1 -- Reliability Testing

Table 1

No	Factor	Items		Corrected Item-Total Correlation	Loading values
GI1	**Green Innovation**	The company intends to prioritise choosing green materials for product design and development stages.	(Abdullah et al., 2015)	.781	.864
GI2		The company intends to focus on the possibility of reusing and recycling manufacturing products.		.737	.833
GI3		The company intends to reduce the emission of hazardous substances or wastes maximally.		.808	.886
GI4		The company intends to optimise the consumption of natural power and resources.		.755	.850
GI5		The company have recently launched and continued releasing new green products.		.711	.814
HR1	**Human Resource**	Employees are aware of the benefits of green transformation for businesses	(Zhu et al., 2021)	.688	.737
HR2		Employees have sufficient knowledge to apply green transformation in the business	(Mangla et al., 2017, Abdullah et al., 2015, Perron, 2005)	.831	.788
HR3		Employees have sufficient skills to apply green transformation in the business	(Mangla et al., 2017, Abdullah et al., 2015, Perron, 2005)	.812	.825
HR4		Employees receive training in knowledge to apply green innovation in business activities	(Zhu et al., 2021)	.807	.729
HR5		Employees receive training in skills to apply green innovation in business activities	(Zhu et al., 2021)	.779	.668
M1	**Market**	Customers are aware of green products and services	(Zhu et al., 2021)	.736	.712
M2		Market demand for green innovation products and services	(Abdullah et al., 2015, Mudgal et al., 2010)	.728	.760
M3		Customers put pressure on businesses on the price of products if green innovation is applied	(Dhull and Narwal, 2016)	.714	.697

TABLE 1: (Continued)

No	Factor	Items		Corrected Item-Total Correlation	Loading values
M4		Customers have not yet accepted the quality of green products.	(Dhull and Narwal, 2016, Abdullah et al., 2015)	.696	.713
M5		Green products have not yet met the requirements of customers	(Balasubramani 2012)	.649	.722
M6		Distribution channels have not yet supported introducing the company's green transformation products.	(Mangla et al., 2017)	.707	.761
F1	**Financial**	Investing in green innovation requires high cost	(Ghisetti et al., 2017a, Kapoor and Oksnes, 2011)	.745	.825
F2		Investing in green innovation takes a longer payback than conventional innovation.	(Ghisetti et al., 2017a, Kapoor and Oksnes, 2011)	.740	.838
F3		Investing in green innovation is often riskier in terms of finance compared to conventional innovation.	(Kapoor and Oksnes, 2011)	.629	.668
F4		The disposal of hazardous wastes requires high costs to conduct	(Mathiyazhagan et al., 2013)	.669	.687
F5		The insufficient accessibility to external financial institutions remarkably makes the firm less prone to green innovation.	(Mathiyazhagan et al., 2013)	.753	.573
F6		The insufficient accessibility to external non-financial institutions remarkably makes the firm less prone to green innovation.	(Hojnik and Ruzzier, 2016, Hottenrott and Peters, 2012)	.738	.572
GS1	**Government Supports**	Complex, unclear procedures and rigid rules obstruct green innovations.	(Runhaar et al., 2008)	.750	.743
GS2		Government is passive towards environmental issues, then providing irrelevant, unhelpful, and confusing regulations and policies	(Runhaar et al., 2008)	.827	.854
GS3		Inadequate enforcement of environmental regulations favours trespassers and disadvantages of "green innovation" leaders.	(Abdullah et al., 2015, Runhaar et al., 2008)	.790	.811
GS4		Organisations are often demotivated due to a lack of government financial support to carry out green innovation activities	(Abdullah et al., 2015, Runhaar et al., 2008)	.767	.756

Table 1: (Continued)

No	Factor	Items		Corrected Item-Total Correlation	Loading values
A1	**Attitudinal**	The company is uncertain about the effect of green innovation on its performance	(Zhu et al., 2021, Perron, 2005)	.692	.796
A2		The company does not believe in the environmental benefits by doing green innovation	(Abdullah et al., 2015, Govindan et al., 2014)	.775	.797
A3		The company is afraid of failure when investing in green transformation projects will affect its competitive advantage	(Govindan et al., 2014, Mathiyazhagan et al., 2013)	.762	.797
A4		Employees are not willing to take risks with innovation affecting business adoption of green transformation	(Abdullah et al., 2015, Fayyazi et al., 2015, Perron, 2005)	.729	.708
TE1	**Technological**	Lack of capabilities (new technology, materials, processes, and skills) in R&D for green innovation	(Perron, 2005)	.835	.709
TE2		The need to comply with the requirement of technical innovation and environmental law makes the success probability of green technology relatively low	(Jinzhou, 2011)	.871	.758
TE3		The company's existing technology capability is incompetent to absorb green innovations developed by others	(Del Río et al., 2010)	.849	.658
TE4		The green technology innovation developed by others is incompatible with the existing manufacturing process of the company.	(Del Río et al., 2010)	.687	.554
O1	**Organizational**	The company lacks awareness about the environmental impact on business operations	(Zhu et al., 2021, Govindan et al., 2014)	.628	-
O2		The company lacks support commitments from the top management for green transformation projects	(Mangla et al., 2017, Fayyazi et al., 2015, Mudgal et al., 2010)	.780	-
O3		The company does not have enough economic potential to implement green transformation projects.	(Moch and Morse, 1977)	.720	-
O4		The company lacks an understanding of the concept of sustainable development of green innovation	(Mangla et al., 2017)	.806	-

TABLE 1: (Continued)

No	Factor	Items		Corrected Item-Total Correlation	Loading values
O5		The company cannot balance short-term economic goals and long-term environmental goals in business operations	(Mangla et al., 2017)	.733	-
S1	**Supplier**	Finding suppliers interested in corporate and working on green innovation initiatives is difficult.	(Abdullah et al., 2015)	.755	-
S2		Finding suppliers ready to invest in redesigning materials into green materials is difficult.	(Abdullah et al., 2015)	.777	-
S3		Suppliers show low interest and reluctance to provide an idea for improvement	(Wycherley, 1999)	.666	-
S4		Poor coordination among supply chain members is a significant problem in efforts to achieve green innovation.	(Mangla et al., 2017)	.673	-

Appendix 2: The results of the Regression Model

TABLE 2

Coefficients						
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.248E-016	.078		.000	1.000
	Human Resource	.090	.078	.090	1.151	.252
	Market	-.263	.078	-.263	-3.366	.001
	Financial	-.343	.078	-.343	-4.397	.000
	Government Supports	-.171	.078	-.171	-2.196	.030
	Attitudinal	.031	.078	.031	.393	.695
	Technological	.082	.078	.082	1.047	.297
a. Dependent Variable: Green Innovation						

Appendix 3: One-Sample Kolmogorov-Smirnov Test to test the normal distribution of the model

Table 3

One-Sample Kolmogorov-Smirnov Test		
		Unstandardised Residual
N		133
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	.87635973
Most Extreme Differences	Absolute	.068
	Positive	.068
	Negative	-.054
Kolmogorov-Smirnov Z		.789
Asymp. Sig. (2-tailed)		.561
a. Test distribution is Normal.		
b. Calculated from data.		

Appendix 4: One-Sample Test to assess the level of agreement of survey participants

Table 4

One-Sample Test			
			Unstandardised Residual
Test Value = 0	t		.000
	df		132
	Sig. (2-tailed)		1.000
	Mean Difference		0E-8
	95% Confidence Interval of the Difference	Lower	-.1503158
		Upper	.1503158

Appendix 5: Standard Runs Test check for autocorrelation

Table 5

Runs Test	
	Unstandardised Residual
Test Value[a]	0E-7
Cases < Test Value	64
Cases >= Test Value	69
Total Cases	133
Number of Runs	69
Z	.278
Asymp. Sig. (2-tailed)	.781
a. Mean	

Appendix 6: VIF (Variance Inflation Factors) test for multicollinearity

Table 6

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Human Resource	1.000	1.000
	Market	1.000	1.000
	Financial	1.000	1.000
	Government Supports	1.000	1.000
	Attitudinal	1.000	1.000
	Technological	1.000	1.000

Appendix 7: Spearman's RHO test for homoscedasticity of the model

TABLE 7

Correlations			
			Unstandardised Residual
Spearman's rho	Unstandardised Residual	Correlation Coefficient	1.000
		Sig. (2-tailed)	.
		N	133
	Human Resource	Correlation Coefficient	.033
		Sig. (2-tailed)	.705
		N	133
	Market	Correlation Coefficient	.032
		Sig. (2-tailed)	.714
		N	133
	Financial	Correlation Coefficient	-.087
		Sig. (2-tailed)	.320
		N	133
	Government Supports	Correlation Coefficient	-.020
		Sig. (2-tailed)	.822
		N	133
	Attitudinal	Correlation Coefficient	-.002
		Sig. (2-tailed)	.981
		N	133
	Technological	Correlation Coefficient	.038
		Sig. (2-tailed)	.667
		N	133