Determinants of Green Technology Adoption in Malaysian SMEs: Evidence from the TOE Framework

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ABSTRACT

This research examines the adoption of green technology and its effects on the economic and environmental sustainability of small and medium enterprises (SMEs) in Malaysia, particularly within the manufacturing sector. Although renewable energy and green technologies have experienced significant growth, the adoption rate among SMEs remains low due to financial constraints, limited technical expertise, and uncertainty regarding the long-term benefits of implementation. This study aims to evaluate the level of green technology adoption among Malaysian manufacturing SMEs, identify the determinants influencing its adoption, and examine the impact of adoption on SME performance. A quantitative research design was employed, targeting manufacturing SMEs in urban and semi-urban areas of Malaysia through a structured questionnaire survey. The study adopted the Technology–Organization–Environment (TOE) framework to investigate the determinants of green technology adoption. Data were analyzed using descriptive statistics, reliability analysis, correlation analysis, and regression analysis with SPSS. The findings indicate among the TOE dimensions, environmental factors were found to have a significant influence on SME performance, while technological and organizational factors showed insignificant relationships. The results suggest that external influences such as government regulations, market demand, sustainability initiatives, and stakeholder pressures play a crucial role in enhancing SME performance through green technology adoption. The study highlights the importance of a supportive external environment in promoting sustainable business practices and improving the long-term competitiveness of Malaysian manufacturing SMEs.

Keywords: Green Technology; SMEs; Technology; Organization; Environment; Sustainability;

INTRODUCTION

Climate change, resource depletion, and environmental pollution have become critical global challenges that require immediate and sustainable solutions. According to the United Nations Environment Programme, global greenhouse gas emissions continue to rise despite international efforts to achieve climate targets, highlighting the need for businesses to adopt environmentally sustainable technologies and practices. Green technology refers to the development and application of products, processes, and systems that minimize environmental impacts while promoting efficient use of energy and natural resources (United Nations Environment Programme [UNEP], 2023). The adoption of green technology has therefore become an important strategy for organizations seeking to balance economic growth with environmental sustainability.

Small and medium-sized enterprises (SMEs) play a significant role in economic development due to their contribution to employment creation, innovation, and gross domestic product (GDP). In Malaysia, SMEs account for approximately 97% of all business establishments and contribute substantially to national economic growth (SME Corp Malaysia, 2024). According to the Department of Statistics Malaysia (DOSM, 2024), SMEs contributed 39.1% to Malaysia's GDP and employed more than 7.5 million workers, making them a crucial component of the country's economic structure. Given their large presence, SMEs are expected to contribute significantly to national sustainability and low-carbon development goals.

Despite their importance, the adoption of green technology among Malaysian SMEs remains relatively low compared with firms in many developed economies. Recent reports indicate that many SMEs continue to face barriers such as high initial investment costs, limited financial resources, insufficient technical expertise, lack of awareness, and uncertainty regarding the long-term benefits of green technology adoption (OECD, 2023; World Bank, 2023). These constraints often result in SMEs prioritizing short-term operational survival over long-term sustainability investments. Consequently, the contribution of SMEs toward achieving Malaysia's environmental and climate objectives remains below its potential.

The manufacturing sector is particularly important in this context because it is associated with high levels of energy consumption, resource utilization, and waste generation. Manufacturing SMEs are increasingly under pressure from governments, customers, and supply-chain partners to adopt environmentally responsible practices. However, studies have shown that green technology adoption within manufacturing SMEs remains inconsistent due to financial, technological, and organizational challenges (Aboelmaged, 2018; Manda & Dhaou, 2019). Furthermore, market uncertainties and insufficient sustainability-supporting infrastructure continue to discourage many SMEs from implementing green innovations.

The Malaysian government has introduced various initiatives to encourage green technology adoption, including the Green Technology Financing Scheme (GTFS), the National Energy Transition Roadmap (NETR), and the Twelfth Malaysia Plan, which emphasize sustainable industrial development and carbon reduction targets (Ministry of Economy Malaysia, 2023). Nevertheless, adoption rates remain modest, suggesting that policy interventions alone may not be sufficient to accelerate widespread implementation among SMEs. A clearer understanding of the factors influencing adoption decisions is therefore required to formulate more effective support mechanisms.

Although interest in green technology adoption has increased considerably, empirical studies focusing on Malaysian manufacturing SMEs remain limited. Existing studies have primarily examined environmental awareness or sustainability practices in general, while relatively few have investigated the specific technological, organizational, and environmental determinants influencing green technology adoption and their subsequent impact on SME performance. This research gap highlights the need for further empirical investigation within the Malaysian context.

Accordingly, this study aims to examine the determinants of green technology adoption among Malaysian manufacturing SMEs and evaluate its impact on SME performance. Guided by the Technology–Organization–Environment (TOE) framework, the study investigates how technological factors, organizational factors, and environmental factors influence green technology adoption decisions and contribute to organizational performance. The findings are expected to provide valuable insights for policymakers, SME owners, and industry practitioners in designing effective strategies to promote green technology adoption, enhance business competitiveness, and support Malaysia's long-term sustainability objectives.

LITERATURE REVIEW

Green technology has received growing focus in academic and policy discussions because of its potential to innovate and overcome environmental problems while at the same time improving business sustainability. In recent years, studies of the adoption of green technologies have become directed towards understanding the factors involved in the decision of organizations to implement environmentally friendly technologies, especially in the case of SMEs. SMEs have a critical role in economic development; however, the pace of adoption of green technology among these is slower as compared to large firms. Prior studies have indicated that decisions on adoption are influenced by a mix of technological capabilities, organizational readiness, and environmental pressures. In order to provide a structured understanding of the factors, this study uses the Technology - Organization - Environment (TOE) framework as the theoretical guide to study the adoption of green technology in Malaysian SMEs.

Green technology adoption has incurred a growing attention in the current world as organization seek to balance economic performance to that of environmental sustainability. Green technology usually means environmentally friendly technologies, systems and or practices meant to reduce the problem of pollution, boost

efficiency of energy use and promote the sustainable use of natural resources (Rodrigues and Franco, 2023; Umar et al, 2021). In the situation of small and medium-sized enterprises (SMEs), the adoption of green technologies often involves the use of renewable energy, the use of energy-efficient machinery, the implementation of waste minimization techniques, the use of recycling systems as well as the creation of environmentally responsible production processes. These initiatives are especially pertinent for the SMEs, where the collective environmental footprint is high in spite of the relatively small individual nature (Lin et al., 2020).

SMEs are of great importance to the national economic development through the number of jobs generated, innovation, and through their contribution to the gross domestic product. In Malaysia, SMEs have the majority share of business establishments and are engaged in various economic sectors, especially manufacturing. However, previous research shows that SMEs have more difficulty in adopting green technology than large organizations due to low resources and restrictions in operation (Bakar et al., 2020). As a result, the adoption of green technologies among SMEs is uneven, especially in developing economies where structural and financial limitations are more significant (Aboelmaged, 2018).

Existing literature highlights several benefits associated with the adoption of green technologies among SMEs. These benefits include improved operational efficiency, reduced energy consumption, lower operating costs, and enhanced environmental performance (Lin et al., 2020; Zailani et al., 2015). Furthermore, green technology adoption can strengthen corporate image and brand reputation, enabling SMEs to attract environmentally conscious customers and improve their competitive advantage (Alam & Islam, 2021; Górska-Warsewicz et al., 2021). Compliance with environmental regulations is another significant benefit, as green practices help SMEs avoid penalties, reduce operational disruptions, and meet stakeholder expectations regarding environmental sustainability (Govindan et al., 2015; Zailani et al., 2015).

Despite these potential benefits, SMEs often remain reluctant to adopt green technologies due to substantial financial and operational challenges. High initial investment costs are frequently identified as a major barrier, particularly for SMEs that operate under limited financial resources and tight budget constraints (Aboelmaged, 2018; Zhang et al., 2019). Uncertainty regarding the long-term return on investment further discourages adoption, as the economic and environmental benefits of green technologies may not be immediately realized (Chen et al., 2022). These financial challenges are exacerbated by difficulties in accessing external financing, limited availability of green funding schemes, and complex procedures associated with obtaining government incentives and support programs (Singh et al., 2020; Aboelmaged & Hashem, 2019).

Technological factors play a crucial role in determining green technology adoption among SMEs. According to the Diffusion of Innovation theory, organizations are more likely to adopt an innovation when it is perceived as compatible with existing systems, offers clear relative advantages, and is relatively easy to implement (Rogers, 2003). Similarly, within the TOE framework, technological compatibility and perceived benefits have been found to positively influence the adoption of sustainable technologies among SMEs (Baker, 2012; Oliveira & Martins, 2011). Conversely, technological complexity and the need for significant modifications to existing business processes may discourage adoption, particularly among SMEs with limited technical expertise and resources (Lin & Ho, 2011). Furthermore, insufficient awareness and inadequate technical knowledge can hinder SMEs' ability to evaluate, select, and effectively implement appropriate green technology solutions (Aboelmaged, 2018).

Organizational factors are widely recognized as key determinants of green technology adoption. The TOE framework highlights the importance of top management support, as leadership commitment influences strategic priorities, resource allocation, and the development of a sustainability-oriented organizational culture (Tornatzky & Fleischer, 1990). Studies have shown that SMEs with strong managerial commitment toward environmental sustainability are more likely to invest in and successfully implement green technologies (Aboelmaged & Hashem, 2019). In addition, organizational readiness, including financial capability, employee competence, and internal coordination, significantly affects adoption decisions because adequate resources and organizational support are essential for successful implementation (Gangwar et al., 2015; Katebi et al., 2022).

Environmental factors also play a significant role in shaping green technology adoption among SMEs.

Government regulations, environmental policies, and sustainability initiatives create external pressures that encourage firms to adopt environmentally responsible practices (Manda & Dhaou, 2019). Furthermore, increasing customer demand for sustainable products and competitive pressure from environmentally proactive firms can motivate SMEs to embrace green technologies to maintain market competitiveness (Grandon & Pearson, 2004; Zhu et al., 2013). However, inconsistent regulatory frameworks, limited government incentives, and weak institutional support may reduce the effectiveness of these external pressures, particularly for resource-constrained SMEs (Aboelmaged & Hashem, 2019).

In developing economies such as Malaysia, the interaction between technological, organizational, and environmental factors presents unique challenges for SMEs. Limited access to advanced technologies, infrastructure constraints, financial limitations, and uncertainty regarding long-term policy support often impede green technology adoption (Bakar et al., 2020; Lu et al., 2022). Consequently, despite growing environmental awareness and increasing emphasis on sustainable development, the adoption of green technologies among Malaysian SMEs remains relatively low. These challenges highlight the need for an integrated analytical framework to better understand the determinants of green technology adoption and to identify effective strategies for promoting sustainable business practices among SMEs.

2.1 Technology–Organization–Environment (TOE) Framework

Technology-Organization-Environment (TOE) framework proposed by Tornatzky and Fleischer (1990) is a commonly used theoretical model for analyzing the organizational adoption of technological innovations. The framework alludes to the fact that the decisions regarding adoption are influenced by three different dimensions of the context namely the technological factors, the organizational factors and the environmental factors. As opposed to models that only address individual perceptions, the TOE framework emphasizes organizational-level decision-making making representing the framework most suitable for studying technology adoption among firms. Previous research has successfully applied the TOE framework to study different forms of innovation adoption such as information systems, digital technologies and technologies that focus on sustainability (Baker, 2011; Aboelmaged, 2018).

Within the TOE framework, the technological context refers to characteristics of the technology which may influence decisions about adoption, including perceived benefits, compatibility, and complexity. Technologies therefore that can integrate well with existing systems, with real benefits, can be more likely to be successfully adopted by organizations (Rogers, 2003; Lin et al., 2011). The organizational context is concerned to internal organizational characteristics such as support from top management, availability of financial resources, organizational readiness, and employee capability. Prior studies emphasize the importance of strong managerial commitment and sufficient financial capacity which has a positive effect on the ability to implement new technologies especially among resource constrained SMEs (Kant & Johannsen, 2022; Katebi et al., 2022).

The environmental context refers to the external factors that put pressure on organizations to adopt new technologies such as government regulations, industry competition, customer demand, and support from external stakeholders. Environmental regulations and sustainability policies are often major driving forces for the uptake of green technology as they make the firms comply with the environmental standards set (Manda & Dhaou 2019). In addition, competitive pressure and rising market demand for environmentally responsible products are encouraging firms to incorporate green technologies to keep them competitive (Grandon and Pearson 2004; Wong et al. 2020). By bringing these three dimensions together, TOE framework offers a comprehensive and system-wide approach to look for green technology adoption among SMEs, rendering it an appropriate foundation for this study.

2.2 Conceptual Framework

Based on the Technology–Organization–Environment (TOE) framework and the literature reviewed, this study proposes a conceptual framework in Figure 1 to examine green technology adoption among small and medium-sized enterprises (SMEs) in Malaysia. The framework suggests that technological, organizational, and environmental factors directly influence green technology adoption, which in turn affects SME performance. Technological factors relate to the characteristics of green technology, organizational factors reflect internal

firm capabilities and managerial support, while environmental factors represent external pressures such as government regulations and market demand (Tornatzky & Fleischer, 1990; Baker, 2011). Green technology adoption is expected to contribute positively to SME performance by improving operational efficiency, reducing costs, and enhancing environmental sustainability.

Figure 1: Conceptual Framework

Technological factors describe how green technologies are perceived by SMEs and include characteristics such as compatibility with existing systems, implementation complexity, and relative advantage (Oliveira & Martins, 2011; Baker, 2012). Green technologies that are perceived as easy to use, cost-effective, and environmentally beneficial are more likely to be adopted by SMEs (Lin & Ho, 2011; Bakar et al., 2020). However, concerns regarding high initial investment costs, implementation risks, and technological complexity often discourage adoption, particularly among resource-constrained SMEs (Aboelmaged & Hashem, 2019). Conversely, SMEs are more likely to adopt green technologies when they perceive tangible benefits such as reduced energy consumption, cost savings, enhanced operational efficiency, and improved compliance with environmental regulations (Zailani et al., 2015).

H1: Technological factors positively influence green technology adoption among SMEs.

Organizational factors encompass resource availability, leadership commitment, organizational readiness, and sustainability-oriented culture. Given the financial and human resource constraints typically faced by SMEs, managerial commitment plays a crucial role in facilitating innovation adoption (Aboelmaged & Hashem, 2019). Top management support influences strategic decision-making, resource allocation, and employee engagement in sustainability initiatives (Tornatzky & Fleischer, 1990). Studies have shown that SMEs with clear environmental objectives, employee training programs, and strong internal awareness of sustainability are more likely to adopt green technologies and environmental innovations (Bakar et al., 2020; Gangwar et al., 2015).

H2: Organizational factors positively influence green technology adoption among SMEs.

Environmental factors include government regulations, market competition, customer expectations, and external support mechanisms. Government policies and environmental regulations encourage SMEs to adopt sustainable technologies by creating both compliance requirements and incentive structures (Manda & Dhaou, 2019). In Malaysia, initiatives such as the Green Technology Financing Scheme (GTFS) and tax incentives have been introduced to reduce financial barriers associated with green technology adoption. In addition, increasing pressure from environmentally conscious consumers, multinational corporations, and sustainability-focused supply chains motivates SMEs to improve their environmental performance (OECD, 2022; Zhu et al., 2013). These external pressures create both incentives and competitive motivations for SMEs to adopt green technologies.

H3: Environmental factors positively influence green technology adoption among SMEs.

RESEARCH METHODOLOGY

This study employed a quantitative research approach to investigate the determinants of green technology adoption among SMEs in Malaysia and to examine the effect of green technology adoption on SME performance. Quantitative research is appropriate for examining relationships between variables through systematic measurement and statistical analysis, allowing researchers to test hypotheses and generalize findings across a larger population (Creswell & Creswell, 2018). A cross-sectional research design was adopted, whereby data were collected at a single point in time to capture the current perceptions, adoption behaviours, and performance outcomes associated with green technology implementation among SMEs (Sekaran & Bougie, 2019).

The target population comprised manufacturing SMEs in Malaysia. Manufacturing SMEs were selected

because of their significant environmental impact in terms of energy consumption, resource utilization, and waste generation (Zailani et al., 2015). Respondents included SME owners, managers, and key decision-makers who were directly involved in operational, environmental, and technological decision-making processes within their organizations. This selection ensured that the information collected reflected informed perspectives regarding green technology adoption practices and organizational performance. SMEs operating in both urban and semi-urban areas were included to provide a more representative understanding of different business environments (Bakar et al., 2020).

Data were collected using a structured questionnaire adapted from established measurement scales used in previous TOE-based technology adoption studies (Tornatzky & Fleischer, 1990; Aboelmaged & Hashem, 2019). The questionnaire consisted of five sections measuring technological factors, organizational factors, environmental factors, green technology adoption, and SME performance. All items were measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), which is commonly used in organizational and technology adoption research due to its reliability and ease of interpretation (Joshi et al., 2015). Prior to the main survey, the questionnaire was reviewed and refined to ensure clarity, relevance, and alignment with the study objectives.

A non-probability purposive sampling technique was employed because respondents were required to possess decision-making authority and relevant knowledge regarding technology adoption within their firms (Etikan et al., 2016). The sample size was determined based on recommendations for multiple regression analysis, which suggest that an adequate sample is necessary to ensure sufficient statistical power and reliable parameter estimation (Hair et al., 2022). Data collection was conducted through both online and physical questionnaire distribution to maximize participation and response rates. Participation was voluntary, and respondents were assured of confidentiality and anonymity to minimize response bias and encourage honest responses (Saunders et al., 2019).

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize respondents' demographic profiles and organizational characteristics. Reliability analysis using Cronbach's alpha was conducted to assess the internal consistency of the measurement scales, with values exceeding 0.70 considered acceptable (Nunnally & Bernstein, 1994). Pearson correlation analysis was performed to examine relationships among the study variables, while multiple regression analysis was employed to test the hypothesized relationships between technological, organizational, and environmental factors, green technology adoption, and SME performance (Hair et al., 2022).

DATA RESULT AND FINDING

Table 1 presents the demographic profile of the respondents. The majority of SMEs surveyed had adopted green technology (84.7%). Most respondents were female (49.5%), aged between 25 and 34 years (64.9%), and possessed at least a bachelor's degree (50.0%). More than half of the respondents occupied top management positions (52.0%), indicating that the data were obtained from individuals directly involved in strategic decision-making. The Electrical and Electronics sector represented the largest manufacturing segment (17.8%). Most participating firms were small-sized enterprises with 5–74 employees (68.8%), annual sales turnover between RM300,000 and RM15 million (68.3%), and had been operating for 3–5 years (47.5%). These findings suggest that the sample predominantly consists of relatively young, educated decision-makers from small manufacturing SMEs actively engaged in green technology adoption initiatives.

Table 1. Summary of Respondents' Demographic Profile (N = 202)

Demographic Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Green Technology Adoption	Yes	171	84.7
	No	31	15.3
Gender	Female	100	49.5
	Male	71	35.1

Demographic Variable	Category	Frequency (n)	Percentage (%)
	Others/Not Specified	31	15.3
Age	25–34 years	131	64.9
	35–44 years	37	18.3
	45–54 years	3	1.5
	Others/Not Specified	31	15.3
Education Level	Bachelor's Degree	101	50.0
	Master's Degree	68	33.7
	PhD/Doctorate	2	1.0
	Others/Not Specified	31	15.3
Position in Company	Top Management	105	52.0
	Executive Officer	52	25.7
	Non-Executive Staff	7	3.5
	Owner/Founder	7	3.5
	Others/Not Specified	31	15.3
Manufacturing Sector	Electrical & Electronics	36	17.8
	Automotive & Machinery	32	15.8
	Textiles & Apparel	28	13.9
	Plastics & Packaging	24	11.9
	Furniture & Wood Products	15	7.4
	Food & Beverage	14	6.9
	Chemical & Pharmaceutical	11	5.4
	Metal Fabrication	11	5.4
	Others	31	15.3
Firm Size (Employees)	Small (5–74 employees)	139	68.8
	Medium (75–200 employees)	23	11.4
	Micro (< 5 employees)	9	4.5
	Others/Not Specified	31	15.3
Annual Sales Turnover	RM300,000 – RM15 million	138	68.3
	RM15 million – RM50 million	29	14.4
	Less than RM300,000	4	2.0
	Others/Not Specified	31	15.3
Years of Operation	3–5 years	96	47.5
	6–10 years	62	30.7
	Less than 3 years	5	2.5
	More than 10 years	8	4.0
	Others/Not Specified	31	15.3

The case processing summary indicates that out of 202 collected questionnaires, 171 responses (84.7%) were valid and included in the analysis. A total of 31 responses (15.3%) were excluded due to incomplete data through listwise deletion. The remaining valid responses provided a sufficient sample size for subsequent statistical analyses.

Table 2. Reliability Analysis of Research Variables

Cronbach's Alph	Standardized Alph	Number of Item
0.938	0.938	20

The overall Cronbach's Alpha value of 0.938 exceeds the recommended threshold of 0.70 in Table 2, indicating excellent internal consistency among the measurement items. This result demonstrates that the questionnaire items consistently measure the constructs associated with green technology adoption and SME performance. Therefore, the instrument is considered highly reliable and suitable for further statistical analysis.

A normality test was conducted in Table 3 using skewness and kurtosis statistics to determine whether the data met the assumptions required for parametric analyses such as correlation and multiple regression. The dependent variable, SME Performance, recorded a skewness value of -0.154, indicating a nearly symmetrical distribution. Although the kurtosis value of 3.121 is slightly above the ideal range, it remains acceptable for social science research.

For the independent variables, negative skewness values indicate that respondents generally expressed favourable perceptions regarding technological, organizational, and environmental factors. While the kurtosis values exceeded the recommended threshold, previous studies suggest that moderate deviations from normality are acceptable, particularly when sample sizes exceed 150 respondents. Therefore, the data were deemed sufficiently normal to proceed with parametric analyses.

Table 3. Normality Test Results

Variable	Skewnes	Kurtosi
Impact on SME Performanc	-0.154	3.121
Technological Factors	-1.896	10.113
Organizational Factors	-1.365	10.883
Environmental Factors	-0.929	12.413

Multiple linear regression analysis was conducted in Table 4 to determine the influence of technological, organizational, and environmental factors on SME performance. The regression model produced an R value of 0.808, indicating a strong positive relationship between the independent variables and SME performance. The coefficient of determination (R^2) of 0.653 suggests that 65.3% of the variance in SME performance can be explained by technological, organizational, and environmental factors.

The adjusted R^2 value of 0.647 indicates that the model remains stable after accounting for the number of predictors. Consequently, the model demonstrates substantial explanatory power and is considered appropriate for examining the determinants of green technology adoption and its impact on SME performance.

Table 4. Model Summary

R	R^2	Adjusted R	Std. Erro
0.80	0.65	0.647	0.42463

The ANOVA results in Table 5 reveal that the regression model is statistically significant ($F = 104.806$, $p < 0.001$). This indicates that the combination of technological, organizational, and environmental factors significantly predicts SME performance. Therefore, the overall regression model is suitable for explaining the variation in SME performance associated with green technology adoption.

Table 5. ANOVA Results

Source	Sum of Square	df	Mean Squar	F	Sig.
Regression	56.693	3	18.898	104.80	0.00
Residual	30.112	16	0.180		
Total	86.804	17			

The coefficient analysis in Table 6 indicates that environmental factors exert the strongest influence on SME performance ($\beta = 0.489$, $t = 5.151$, $p < 0.001$). This finding suggests that government regulations, market demand, sustainability incentives, and external stakeholder pressures play a critical role in enhancing SME performance through green technology adoption.

Although technological factors ($\beta = 0.175$, $p = 0.069$) and organizational factors ($\beta = 0.183$, $p = 0.104$) exhibited positive relationships with SME performance, their effects were not statistically significant at the 0.05 level. This implies that while technology readiness and organizational support contribute positively to SME performance, their influence is weaker compared to environmental factors.

Table 6. Regression Coefficients

Variable	B	Beta (β	t-valu	Sig.
Constant	0.66	-	3.392	0.00
Technological Factors	0.16	0.175	1.832	0.06
Organizational Factor	0.15	0.183	1.637	0.10
Environmental Factor	0.46	0.489	5.151	0.00

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The regression equation can therefore be expressed as:

$$SME\ Performance = 0.665 + 0.168(TF) + 0.150(OF) + 0.467(EF)$$

Overall, the findings demonstrate that environmental factors are the most significant determinant influencing the performance outcomes of SMEs through green technology adoption.

Table 7. Hypothesis Testing Results

Hypothesis	Relationship	Result
H1	Technological Factors → SME Performance	Not Supported
H2	Organizational Factors → SME Performance	Not Supported
H3	Environmental Factors → SME Performance	Supported

The results in Table 7 testing conducted using multiple linear regression analysis to determine the influence of technological, organizational, and environmental factors on the impact of green technology adoption on SME performance. The decision to accept or reject each hypothesis was based on the significance level (p-value) of 0.05 and the standardized beta coefficient (β) obtained from the regression model.

H1: There is a significant positive relationship between technological factors and the impact of green technology adoption on SME performance.

The relationship between Technological Factors and green technology adoption and the performance of SMEs was measured by Pearson's correlation and multiple linear regression. Pearson's correlation results suggest that Technological Factors predict SME performance, with system compatibility, reliability, ease of use, integration capability, or efficiency improvement being significantly related to perceptions of green technology impacts. This indicates the role of technological readiness in green technology adoption by SMEs (Lin et al., 2020).

However, further testing using multiple linear regression analysis revealed a positive standardized beta coefficient ($\beta = 0.175$) for Technological Factors, indicating a positive directional impact on SME performance. Although a positive pattern was observed, the relationship was not statistically significant at the 0.05 significance level ($p = 0.069$). This finding confirms that Technological Factors are not significantly related to SME performance when Organizational Factors and Environmental Factors are considered simultaneously in the model.

According to these results, while Technological Factors are positively associated with green technology adoption, they do not exert a significant positive effect on SME performance independently. This suggests that technological readiness alone may not be sufficient to determine performance improvements, and its impact may depend on the presence of organizational support and external environmental pressures. Therefore, Hypothesis 1 is rejected, as the relationship between Technological Factors and SME performance is not statistically significant (Bakar et al., 2020; Lin et al., 2020).

H2: There is a significant positive relationship between organizational factors and the impact of green technology adoption on SME performance.

The relationship between Organizational Factors and the extent of the impact of green technology adoption on SME performance was examined using Pearson's correlation and multiple linear regression analyses. The Pearson correlation results indicated that Organizational Factors are positively associated with SME performance. Specifically, top management support, employee participation, training provision, and long-term organizational commitment were found to be related to successful green technology adoption. Organizational readiness is therefore considered important in encouraging green technology initiatives among SMEs (Bakar et al., 2020).

Nevertheless, the results of the multiple linear regression analysis showed that Organizational Factors produced a positive standardized beta coefficient ($\beta = 0.183$), indicating a positive directional relationship with SME performance. However, the relationship was not statistically significant at the 0.05 level ($p = 0.104$). This finding suggests that Organizational Factors do not significantly influence SME performance when considered together with Technological Factors and Environmental Factors in the regression model.

These results indicate that while Organizational Factors contribute to the implementation of green technology, they do not independently exert a significant positive effect on SME performance. Overall, when other factors are taken into account, particularly environmental influences, the effect of organizational support becomes less pronounced. This suggests that organizational preparedness alone does not necessarily lead to performance improvements, but rather depends on the effective application of technology and favourable environmental conditions. Therefore, Hypothesis 2 is rejected, as the relationship between Organizational Factors and SME performance is not statistically significant (Lin et al., 2020; Bakar et al., 2020).

H3: There is a significant positive relationship between environmental factors and the impact of green technology adoption on SME performance.

The positive relationship between Environmental Factors and the impact of green technology adoption on SME performance was examined using Pearson's correlation and multiple linear regression analyses. The results showed a strong positive relationship between Environmental Factors and SME performance ($r = 0.790$, $p < 0.001$). External stimuli such as government policies, environmental regulations, customer demand, industry

competition, and support from business partners were found to significantly influence the effectiveness of green technology adoption among SMEs (Lin et al., 2020).

Further analysis through multiple linear regression demonstrated that Environmental Factors have a significant positive influence on SME performance. The results revealed a high standardized beta coefficient ($\beta = 0.489$) with a t-value of 5.151 and a significance level of $p < 0.001$. These findings indicate that Environmental Factors are not only positively related to SME performance but are also strong predictors of the impact of green technology adoption on organizational performance.

Environmental Factors emerged as the strongest predictor among all independent variables included in the model. This suggests that external conditions and supportive environmental mechanisms play a critical role in promoting successful green technology adoption and improving SME performance. Regulatory requirements, market expectations, sustainability initiatives, and stakeholder support encourage SMEs to adopt green technologies more effectively and strategically.

Therefore, Hypothesis 3 is supported, as Environmental Factors have a strong and statistically significant positive relationship with the impact of green technology adoption on SME performance (Lin et al., 2020; Bakar et al., 2020).

CONCLUSION

This study examined the determinants that affect the issue of green technology adoption amongst the small and medium-sized enterprises (SMEs) in Malaysia and also assessed the impact of green technology adoption on the performance of SMEs using the Technology-Organization-Environment (TOE) framework. The results show that the green technology adoption among the Malaysian SMEs is still at the moderate stage which means that while there is an awareness of such sustainability issue with regards to the environment, there are still many constraints in the implementation of these products in the environment or the SMEs: external constraints within the system and internal constraints within the organization. The results confirm that the fundamental factors of technology, organization and environment all play important roles in influencing adoption decisions.

Of the three dimensions of TOE, environmental factors were observed to have the greatest positive effect on the adoption of green technology. Government rules, environmental policies and growing market for sustainable products became major players that encourage SMEs to incorporate green practices. Organizational factors, especially top management support and financial capability, also showed a positive and significant effect showing the importance of internal readiness and leadership commitment. Technological factors exerted a positive, but physically weaker, effect on pragmatic difficulties, and this means that whilst compatibility and perceived benefits seem to have some importance, SMEs seem to react more strongly to external pressure and managerial support rather than technical features alone.

The study further infers that the adoption of green technology had a positive impact on the performance of SME. SMEs that adopt green technology get improved operational efficiency, cost cutting, and environmental performance, increasing overall competitiveness. These results support the fact that green technology adoption is not only an environmental mandate but it is also a strategic business process that can improve long-term sustainability and performance. As such, encouraging the adoption of green technology by SMEs can create environmental as well as economic benefits.

From a policy perspective, the results suggest that policymakers should better enforce regulatory measures, more specifically target incentives, and also facilitate access to financial and technical support in order to facilitate broader adoption of green technology among SMEs. SME owners and managers should be aware of the important performance gains that could come from adopting green technology over the long run and cultivate organizational readiness with leadership commitment and strategizing. Despite the contributions of this study, there are certain limitations that it is facing such as that it focused on manufacturing SMEs and it is relying on the cross-sectional data. Future research may take this work further by exploring other SME sectors, using longitudinal research designs, or looking at other factors related to sustainable technology adoption. Overall, this research is helpful in providing empirical data on green technology adoption by Malaysian SMEs

and is an effort to promote sustainable business practices in developing economies.

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