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Unlocking Profitability: Exploring Green Production Adoption and Financial Performance in Malaysian SME Manufacturing

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Abstract

The adoption of green practices in Small and Medium Enterprises (SMEs) has gained significant traction as organizations strive to balance economic growth with environmental sustainability. This study provides a comprehensive review of recent research on green practices and their impact on organizational performance, particularly within the context of SMEs in Malaysia and other regions. By examining a range of studies, including empirical analyses and theoretical explorations, this review identifies key drivers, challenges, and outcomes associated with the implementation of green practices. Factors such as competitive pressures, regulatory influences, and green innovation are highlighted as critical elements influencing the adoption of sustainable practices. The findings underscore the role of green practices in enhancing operational efficiency, reducing environmental impact, and improving financial performance. This study contributes to a deeper understanding of how SMEs can strategically integrate green practices to achieve sustainable development goals and offers practical insights for policymakers and business leaders aiming to foster environmental responsibility in the SME sector.

Keywords: *Green Practices, Organizational Performance, Sustainable Development, Small and Medium Enterprises (SMEs).*

Introduction

The adoption of environmentally sustainable production methods has emerged as a critical factor for organisations on an international level in response to growing environmental concerns (Lim, Nadarajah, & Wahab, 2022). In light of its significant ecological impact, the manufacturing industry represents a critical domain for the implementation of environmentally sustainable technologies and procedures (Chen et al. 2020). By situating the investigation within the theoretical framework of the Diffusion of Innovation (DOI) model and focusing on its influence on financial performance, this study undertakes a thorough investigation of the extent to which Small and Medium-sized Enterprises (SMEs) in the manufacturing sector of Malaysia have embraced green production practices (Posadas, et al. 2023, Shahzad, et al. 2020).

Malaysia, an emerging economic force, has experienced notable expansion in its manufacturing industry, which has made a substantial contribution to the country's Gross Domestic Product (GDP) (Baskaran, Chandran, & Rajaghantham, 2023). Malaysia's manufacturing sector is characterised by its wide-ranging diversity, comprising industries including automotive, electronics, and food processing. SME participation is crucial in this industry, as it constitutes a considerable proportion of Malaysia's industrial infrastructure (Department of Statistics Malaysia, 2021). There has been a significant shift in global business practices towards sustainability in recent years (Siyal, et al. 2023). A growing number of organisations are acknowledging the imperative of harmonizing environmental accountability with economic expansion (Liu et al., 2021; Dangelico & Pujari, 2010). Increasing consumer awareness of environmental issues, shifting consumer preferences, evolving regulatory frameworks, customer pressure, and competitive forces all contribute to this shift. Malaysia, operating in this global arena, has concurrently adopted the tenets of sustainable development, which entail the conscientious management of the environment in its economic endeavours (Chen et al. 2020). SME manufacturing sector pillars in Malaysia, significantly contributing to

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innovation, employment creation, and economic expansion (Hassan et al. 2017). However, in regard to employing innovative practices, the distinctive attributes of small and medium-sized enterprises (SMEs), including constrained resources and operational scale, frequently pose unique obstacles (Arshad et al., 2018). With these obstacles, small and medium-sized enterprises (SMEs) possess tremendous capacity to drive sustainable practices by virtue of their adaptability and receptiveness to market trends (Haque et al. 2024).

Green production practices comprise a wide range of approaches that are designed to reduce the ecological harm caused by manufacturing operations (Yin et al. 2022; Kniazieva, 2021). These may encompass the integration of energy-efficient technologies, the adoption of waste reduction strategies, the utilisation of sustainable materials, and the execution of environmentally conscious production techniques. The adoption of environmentally friendly manufacturing methods not only enables organisations to correspond with worldwide sustainability objectives but also presents possible financial advantages, including reduced expenses, heightened market rivalry, and an enhanced corporate image (Posadas, et al. 2023; Ismail et al., 2018). The foundation of this investigation is the Diffusion of Innovation (DOI) paradigm, which Everett Rogers initially proposed in 1962. The DOI model offers a methodical framework for comprehending the adoption and diffusion of innovations green production practices in this instance within a social system or organisation (Rogers, 2003). The model explores crucial characteristics that exert an impact on the process of adoption, encompassing compatibility, complexity, and relative advantage.

The global trend towards green production practices is accelerating, but SMEs in Malaysia face distinct obstacles in their attempt for sustainability (Gao et al. 2020). Some tight constraints on resources, encompassing financial assets as well as specialised expertise, present substantial obstacles. Additionally, SMEs might encounter opposition and uncertainty regarding the perceived complexity of novel technologies and processes when attempting to adopt green practices (Arshad et al., 2018; Hassan et al. 2017). Along with these obstacles, manufacturers and suppliers in Malaysia are subject to escalating pressures from consumers and competitors (Shahzad, et al. 2022). In an effort to raise awareness of environmental concerns, consumers are placing increasing demands on products and processes that are more sustainable. As companies seek to differentiate themselves by incorporating green practices, the competitive landscape is shifting, putting SMEs under double pressure to satisfy customers and maintain market competitiveness (Wan et al. 2022). An issue of considerable importance that has not been thoroughly examined in the current body of research is the direct correlation between the implementation of environmentally friendly manufacturing methods and the financial performance of SMEs in Malaysia (Siyal, 2023; Shahzad et al. 2020). Although the environmental advantages of sustainable practices are generally recognised, it is crucial for SMEs that operate in resource-constrained and competitive environments to comprehend the concrete economic consequences as well (Dangelico & Pujari, 2010).

Regarding the adoption of green production practices by Malaysian SMEs is concerned, there is a discernible research vacuum in the literature, despite the increasing recognition of the significance of sustainability in manufacturing. A limited number of extant studies in the Malaysian context delve into the complexities of the challenges and opportunities unique to SMEs or concentrate on larger corporations (Chen et al. 2020; Yusuf et al., 2014). Furthermore, despite its widespread application in diverse contexts, the DOI model has yet to be thoroughly utilised in the investigation of green production practices adoption among Malaysian SMEs (Chang et al. 2019; Song & Yu, 2018). In order to comprehend the mechanisms that promote or inhibit the adoption process and to identify the factors that influence the diffusion of green innovations among SMEs, it is vital to apply the DOI model to this particular context (Shahzad et al. 2020; Chang et al. 2019).

As a result of providing a thorough understanding of the adoption of green production practices by Malaysian SME manufacturing, this study aims to fill in the gaps that currently exist. The study seeks to demonstrate, via the DOI model, the determinants of adoption, the obstacles encountered by SMEs, and the immediate consequences of environmentally sustainable practices on their financial outcomes. This study possesses practical implications for policymakers, industry practitioners, and small and medium-sized enterprises (SMEs) seeking to navigate the dynamic realm of sustainable manufacturing in Malaysia, in addition to its academic significance.

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Literature Review

Adoption of Green Production Practices in SMEs

The investigation of green production practices implemented by SMEs has become a significant subject of examination in relation to environmental sustainability in Malaysia (Hami et al. 2018). SMEs encounter diverse obstacles when it comes to integrating environmentally sustainable practices into their manufacturing operations due to their constrained resources and scope of operations in Malaysia (Arshad et al., 2018). Despite these obstacles, SMEs are acknowledged for their pivotal role in promoting sustainable practices, owing to their flexibility and responsiveness to market trends (Lim, et al. 2022).

SMEs are of considerable importance in the manufacturing sector of the Malaysian economy, making a substantial contribution to the country's gross domestic product (GDP) and constituting an integral component of the industrial infrastructure (Department of Statistics Malaysia, 2021). The importance of conducting comprehensive research on the unique challenges and opportunities faced by SMEs in this industry is underscored in the existing body of literature, which primarily focuses on larger corporations (Siyal, et al. 2023; Yusuf et al., 2014). This kind of information is lacking, which underscores the necessity for research that investigates the complexity of green practice adoption among Malaysian SMEs.

Rogers (1962) introduced the Diffusion of Innovation (DOI) model, which offers a systematic framework for comprehending the process by which organisations employ innovations, such as environmentally sustainable production methods. The DOI model, although extensively utilised in diverse contexts, has yet to be applied specifically to explain the determinants that impact the diffusion of environmentally friendly innovations among SMEs in Malaysia (Song & Yu, 2018). It is essential to examine the ways in which the DOI model can clarify the adoption process in order to comprehend the mechanisms that either promote or hinder the incorporation of environmentally friendly practices in these smaller businesses (Shahzad et al. 2020).

Furthermore, external pressures as well as internal factors intersect with the implementation of green production practices in SMEs (Lai et al. 2006). The demand for sustainable products and processes is growing among customers due to their raised awareness of environmental concerns. Concurrently, SMEs are under double pressure to distinguish themselves through the incorporation of environmentally friendly practices due to competitive forces in the market (Oliveira et al. 2019; Bose & Luo, 2011; Dangelico & Pujari, 2010). As SMEs navigate the delicate balance between satisfying customer demands and maintaining market competitiveness, this external influence further complicates their decision-making process (Saeed et al. 2018).

Finally, it can be stated that the implementation of environmentally friendly manufacturing methods in SMEs in Malaysia is a complex occurrence. Complexity is added to the adoption process by the distinctive attributes of small and medium-sized enterprises (SMEs), the theoretical framework of the DOI model, and external influences from rivals and consumers. Additional investigation is necessary to attain a thorough comprehension of the complexities surrounding the adoption of environmentally friendly practices by small and medium-sized enterprises (SMEs) in Malaysia. Such research would provide policymakers, industry professionals, and scholars in the field of sustainable manufacturing with invaluable insights.

Theoretical Framework: Diffusion of Innovation (DOI) Model

Since it was developed by Everett Rogers in 1962, the Diffusion of Innovation (DOI) Model has served as a fundamental framework for comprehending the process by which innovations are adopted in a variety of contexts. With regard to the adoption of green production practices by SMEs in the Malaysian manufacturing sector, this theoretical framework is especially crucial (Liu et al. 2021; Yeng et al. 2020).

The DOI model's initial critical attribute is relative advantage. SMEs are more inclined to embrace environmentally sustainable technologies and processes within the context of green production practices when they perceive a distinct advantage over their current practices. This benefit could potentially

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materialize such as cost reductions, increased productivity, and strengthened market position (Li et al. 2021; Liang, 2021). According to a study by Dangelico and Pujari (2010), it is crucial to comprehend the economic benefits linked to sustainability. Consequently, for SMEs to implement green practices, it is significant to examine the concept of relative advantage (Liu et al. 2021; Yin et al. 2022).

Another attribute within the DOI model is compatibility, which assesses the degree to which an innovation is consistent with established values, norms, and practices (Rogers et al. 2014). Compatibility evaluation denotes the extent to which green production practices are integrated into the operational procedures and corporate culture of Malaysian manufacturing SME's (Wang et al. 2021). Arshad et al. (2018) assert that compatibility research is crucial for comprehending the obstacles and prospects that SMEs face when incorporating green practices into their prior frameworks.

The third attribute, complexity, refers to the perceived degree of difficulty that is involved in understanding and implementing an innovation. SME adoption of green production practices may be impeded by their perception of the technologies as complex or as requiring specialized knowledge (Acquah et al. 2021). Yusuf et al. (2014) underscore the importance of conducting thorough investigations into the challenges faced by SMEs. Through an in-depth exploration of the dimension of complexity, it can acquire significant insights into potential obstacles that could hinder the execution of ecologically sustainable methodologies (Acquah et al. 2021; Deng & Ji, 2015).

The Diffusion of Innovation (DOI) paradigm posits that trialability indicates that organizations or individuals are more inclined to embrace innovations when they have the opportunity to conduct preliminary experiments or tests prior to complete adoption (Rogers et al. 2014). Nevertheless, when considering green production practices, particularly for SMEs, the integration of environmentally sustainable technologies may require significant investments and process modifications. Particularly in the manufacturing sector, SMEs may be constrained in terms of both financial and operational resources (Arshad et al., 2018). Trial runs for environmentally friendly practices may be deemed impracticable on account of the substantial financial investments necessary and the possible interruption to routine production operations. Trialability becomes less practical and applicable for SMEs due to the complexity involved in integrating sustainable technologies, which may involve alterations to instruments or production lines (Deng & Ji, 2015). Hence, an emphasis on trialability might fail to correspond with the actual circumstances and constraints encountered by SMEs within the manufacturing sector of Malaysia (Shahzad, et al. 2022).

Another DOI attribute, observability, concerns the degree to which the outcomes of an innovation are visible to others (Rogers, et al. 2014). Green production practices frequently yield internal benefits such as increased efficiency, decreased waste, and energy conservation. In contrast to innovations that yield readily observable results, such as the introduction of a new product to the market, external stakeholders may not immediately perceive the advantages associated with the adoption of environmentally friendly practices (Yin et al. 2022; Liu et al. 2021). SMEs operating in the manufacturing sector, which are resource-constrained and competitive by nature, might place greater emphasis on internal advantages rather than external visibility. Although green practices yield advantageous results for the organization as a whole, they might not be immediately visible to consumers or competitors (Wang et al. 2021). Consequently, in the context of Malaysian manufacturing, the attribute of observability is deemed less significant in revealing the decision-making processes of SMEs regarding the adoption of green production practices (Chang et al. 2019; Song & Yu, 2018).

Finally, in the context of Malaysian manufacturing, the DOI model provides a comprehensive framework for comprehending the implementation of environmentally friendly production methods by SMEs. This theoretical framework offers a strong basis for examining the determinants that impact the adoption process and revealing the complex issues of sustainable technology integration in SMEs through the examination of attributes including relative advantage, compatibility, and complexity.

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External Influences

The adoption of environmentally sustainable production methods by SMEs is progressively being shaped by external forces, specifically the demands and expectations of customers and competitors (Gholami et al. 2013; Butler, 2011). The present literature review examines the impact of these pressures on the development of sustainable practices in the manufacturing sector of Malaysia (Altayar, 2018).

Customers, who possess an increased consciousness regarding the environment, are exerting a critical influence on businesses to guide them towards sustainability (Deng & Jing, 2015). Demand for environmentally responsible practices has increased substantially due to a shift in consumer preferences toward eco-friendly products and services (Saeed et al. 2018). Research conducted by Dangelico and Pujari (2010) highlights the rising pressure on organisation to integrate their activities with the expanding sustainability demands of their customers. This burden is especially pertinent in the manufacturing sector of Malaysia, where SMEs make substantial contributions to the industrial infrastructure of the country (Xie et al. 2019). The strategic decisions of SMEs are significantly impacted by the demand for sustainable products, which is not simply a passing fad. In response to the growing environmental awareness among consumers, SMEs are obliged to implement green production methods in order to satisfy these demands (Siyal et al. 2023). According to a study by Ismail et al. (2018), for SMEs to maintain market competitiveness, it is not only a moral imperative but also a strategic necessity to align with consumer values and preferences.

SMEs operating in the manufacturing sector of Malaysia not only encounter consumer pressures but also intensifying competition that revolves around sustainability (Oliveira et al. 2019). A growing number of organizations are coming to understand the strategic value of distinguishing themselves by incorporating environmentally sustainable practices. SME performance in environmental responsibility is not only being pushed to satisfy customer expectations, but also to surpass that of industry rivals due to competitive pressures (Altayar, 2018). The dynamic competitive environment is marked by an intensifying competition among enterprises to showcase their dedication to sustainability. SMEs that embrace and effectively communicate their green initiatives are able to attract environmentally aware consumers, thereby enhancing their competitive advantage (Altayar, 2018). In order to maintain competitiveness, Yusuf et al. (2014) assert that SMEs must actively adopt sustainable practices; failure to do so may result in a decline in market share.

Financial Performance

The academic literature pertaining to the financial performance of SMEs operating in the manufacturing sector of Malaysia demonstrates an intricate interplay of various elements that impact the implementation of environmentally sustainable production methods. The examination of the financial consequences of incorporating environmentally friendly technologies and processes into the manufacturing sector has become a significant subject of research due to the increasing attention that businesses worldwide have turned to environmental sustainability issues (Siyal et al. 2023).

Financial performance of SMEs is closely associated with a wide range of internal and external factors that influence economic outcomes. The implementation of effective financial management procedures, including budgeting, cash flow control, and strategic investment planning, is essential (Richard, 2019; Serrasqueiro & Nunes, 2012). In Malaysia's multidimensional manufacturing sector, SMEs must adhere to these principles in order to successfully navigate the opportunities and challenges that accompany the implementation of green production methods. When striving for sustainability, the factors of innovation and adaptability become critical determinants that impact financial performance. The integration of green production practices into business models and the capacity for SME innovation and adaptation are of the utmost importance (Teece, 2018). Green innovation, in addition to being in line with worldwide sustainability objectives, can potentially grant SMEs economic advantages, including reduced expenses and enhanced market rivalry.

SME financial performance examinations are further complicated by their resource limitations and operational scope, which are two of their most distinguishing characteristics. Although green production methods offer potential environmental advantages, they can also cause difficulties for SMEs with limited

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resources, owing to resistance and perceived complexity (Arshad et al., 2018). For SMEs, the adoption of green production practices presents both an opportunity and a challenge paradigm. Although there may be initial challenges and opposition during the transition, adopting sustainable practices can result in enduring financial benefits, including reduced expenses and an improved reputation for the organization (Ismail et al., 2018). SMEs that wish to achieve a balance of financial performance and responsibility for the environment must effectively navigate these obstacles and exploit these opportunities (Miroshnychenko et al., 2017).

Research Hypothesis

Based on the prior studies, SMEs operating in a competitive market will feel required to implement green practices in order to remain competitive. This investigation examines whether the adoption of green production practices is influenced by the competitive landscape.

Green production practices are integral to production activities as they embody environmentally sustainable behaviors facilitated by technological innovations. These practices offer significant benefits to SMEs, including substantial cost reduction and the enhancement of competitive advantages. By adopting green innovations, SMEs can develop and implement eco-friendly processes, products, and services, such as waste minimization and recycling initiatives. The perceived relative advantage of green production practices, characterized by their superiority over traditional production methods in terms of cost savings, enhanced competitiveness, improved environmental performance, and reduced resource depletion, is posited to positively influence their adoption by SMEs in the manufacturing sector. This hypothesis aims to investigate the relationship between perceived relative advantage and the adoption of green production practices, providing valuable insights into strategies for promoting sustainability and environmental responsibility within SMEs.

H1: Relative advantage positively influences the adoption of green production practices among SMEs in the manufacturing sector of Malaysia.

The compatibility of green production practices with the preexisting values, systems, and processes of SMEs is crucial for their adoption. These practices, which embody environmentally sustainable behaviors, must align with the current organizational context to facilitate their adoption effectively. This study aims to investigate whether the adoption of green practices is indeed facilitated by their alignment with the current organizational context of SMEs in the manufacturing sector of Malaysia. Compatibility refers to the degree to which green production practices fit seamlessly within the existing values, systems, and processes of SMEs. Factors influencing compatibility may include the availability of resources, organizational commitment to sustainability, employee skills and knowledge related to green practices, and the readiness of the organization to embrace change. This hypothesis aims to explore the relationship between compatibility and the adoption of green production practices, providing insights into strategies for promoting sustainability and environmental responsibility within SMEs in the manufacturing sector of Malaysia.

H2: Compatibility positively influences the adoption of green production practices among SMEs in the manufacturing sector of Malaysia.

The perceived complexity of implementing green production practices, encompassing technological obstacles and operational modifications, is anticipated to pose a significant barrier to SMEs' inclination to embrace these practices. According to the DOI model, the perceived difficulty associated with adopting new practices can impede the adoption process. In the context of Malaysian SMEs in the manufacturing sector, complexity refers to the perceived challenges and obstacles associated with implementing green production practices within their operational environment. These challenges may include the need for significant technological upgrades, changes in production processes, and the allocation of resources for training. Additionally, SMEs may face regulatory compliance issues, supply chain complexities, and uncertainty regarding the return on investment associated with green initiatives. As a result, SMEs may perceive the adoption of green production practices as complex, leading to reluctance in embracing these

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practices. This study aims to investigate whether the perceived complexity of implementing green production practices negatively influences their adoption among SMEs in the manufacturing sector of Malaysia. By examining the relationship between complexity and the adoption of green production practices, the study seeks to provide insights into the challenges faced by SMEs in integrating sustainable practices into their operations.

H3: Complexity negatively influences the adoption of green production practices among SMEs in the manufacturing sector of Malaysia.

The hypothesis suggests that SMEs operating in Malaysia's manufacturing sector will show a greater inclination to adopt green production methods in response to increasing pressure from environmentally aware consumers and the rising demand for sustainable products. As consumer awareness of environmental issues grows, there is a corresponding increase in demand for products that are produced using sustainable and environmentally friendly practices. This increasing consumer demand for sustainable products serves as a significant driver for SMEs to embrace green production methods. In the context of Malaysia's manufacturing sector, customer pressure refers to the influence exerted by environmentally conscious consumers on SMEs' adoption decisions regarding green production practices. SMEs are likely to perceive the adoption of green production methods as a means to satisfy consumer preferences, enhance brand reputation, and capture market opportunities. By aligning their production processes with sustainable principles, SMEs can cater to the preferences of environmentally aware consumers and differentiate themselves in the market. This study aims to examine the impact of customer pressure on the adoption of green production practices among SMEs in Malaysia's manufacturing sector. By investigating the relationship between customer pressure and the adoption decision, the study seeks to provide insights into the factors driving SMEs' adoption of sustainable practices.

H4: Customer pressure positively influences the adoption of green production practices among SMEs in the manufacturing sector of Malaysia.

The hypothesis suggests that as competitive pressure intensifies within the manufacturing sector, SMEs are increasingly motivated to adopt green production practices as a strategic response. Competitive pressure drives SMEs to differentiate themselves, enhance operational efficiency, and comply with regulatory requirements. Green production practices offer viable avenues for achieving these objectives by meeting consumer demands for sustainable products, reducing operational costs, and ensuring compliance with environmental regulations. In the context of Malaysia's manufacturing sector, competitive pressure refers to the challenges and dynamics arising from market competition, technological advancements, and regulatory frameworks. As competition intensifies, SMEs face the imperative to innovate and adapt to changing market conditions in order to remain competitive. Green production practices provide SMEs with opportunities to differentiate their offerings, improve resource efficiency, and enhance their reputation as socially responsible enterprises. This study aims to explore the impact of competitive pressure on the adoption of green production practices among SMEs in Malaysia's manufacturing sector. By examining the relationship between competitive pressure and the adoption decision, the study seeks to provide insights into the drivers and motivations behind SMEs' adoption of sustainable practices.

H5: Competitive pressure positively influences the adoption of green production practices among SMEs in the manufacturing sector of Malaysia.

The hypothesis suggests that SMEs in Malaysia's manufacturing sector will experience enhanced financial performance as a result of their adoption of green production methods. This proposition is based on the belief that integrating environmentally sustainable technologies and procedures into their operations will lead to various financial benefits, including cost savings, increased market competitiveness, and an enhanced corporate image. The adoption of green production practices enables SMEs to reduce costs by improving resource efficiency, minimizing waste, and optimizing energy usage. Additionally, green practices can enhance market competitiveness by meeting the growing consumer demand for sustainable products and services, thereby expanding market opportunities and attracting environmentally conscious customers. Furthermore, embracing green production methods can enhance SMEs' corporate image and reputation as

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socially responsible and environmentally conscious organizations, which can lead to increased customer loyalty and brand value. This study aims to investigate the relationship between the adoption of green production practices and the financial performance of SMEs in Malaysia's manufacturing sector. By examining the impact of green production adoption on various financial indicators such as profitability, return on investment, and market share, the study seeks to provide empirical evidence of the financial benefits associated with sustainability initiatives.

H6: Adoption of green production practices positively influences the financial performance of SMEs in the manufacturing sector of Malaysia.

Research Methodology

Measures

The researchers conducted a structured survey among the target population to validate the proposed research paradigm. The survey utilized a 5-point Likert scale, where respondents could express their agreement or disagreement on a scale from 1 to 5. All measurement items were adopted from existing literature and tailored to fit the specific needs of this study. To ensure the content validity of the questionnaire, the authors conducted separate analyses and made necessary revisions. Following approval after thorough discussion, the finalized questionnaires were distributed to gather data. Constructs were assessed using a lower-order construct (LOC).

Sampling

For data collection, an online survey form will be sent through google form. To ensure representative sampling, a stratified random sampling strategy was utilized in the experimental sample design, aiming to cover key subgroups within the population. Approximately 400 questionnaires were distributed to both executives and non-executives in the manufacturing industry in Klang Valley, Malaysia. However, only 224 responses were received. After screening for non-participating responses, 201 valid responses were retained for data analysis.

In determining the sample size, Cohen's power theory was consulted (Kang, 2021). Additionally, the appropriateness of the sample size was assessed using the post-hoc G-power approach. This analysis considered a significant threshold of 0.05, an effect size of 0.15, and a sample size of 201 for all exogenous variables, including reflecting indicators. The results from the post-hoc G-power analysis indicated that the statistical strength of the gathered sample significantly exceeded the criteria of 0.8 (Kang, 2021).

Data Analysis and Statistical Techniques

To test the proposed model, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed. PLS-SEM is a statistical modeling approach designed to assess the causal impact of exogenous variables on endogenous variables, particularly suited for models with mediating variables and latent constructs measured by multiple indicators (Hair et al., 2019; Siyal et al., 2021). It was chosen for its ability to handle multicollinearity, small sample sizes, complex models with latent components and multiple indicators, and non-normal data better than other econometric models. Utilizing PLS-SEM with SmartPLS4, this study aimed to achieve precise and valid parameter estimations.

Previous researchers have proposed a two-step procedure for testing theoretical models using SEM (Medsker et al., 1994; Siyal, Ding and Siyal, 2019; Siyal, Donghong, Umrani, Siyal and Bhand, 2019). The first step involves examining and validating the measurement model, while the second step tests the structural model and conducts hypothesis tests (Garver and Williams, 2009). Following this approach, confirmatory factor analysis (CFA) was employed to refine and validate the measurement model, as suggested by Garver and Williams (2009). CFA helped evaluate the contribution of each item to the construct (latent variables) and assessed convergent and discriminant validity. The structural model, tested

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in the second step, aimed to determine the strength of the hypothesized relationships between the constructs.

Results

Reliability and Convergent Validity

Table 1 demonstrates both convergent validity and reliability, indicating strong internal consistency in all constructs, with composite reliability (CR) values exceeding 0.7, as recommended by Hair et al. (2017). Each construct exhibits satisfactory Cronbach's alpha values **above 0.7**, ranging from **0.780 to 0.905.** Moreover, the rho A significance levels for each construct **surpass 0.7**, ranging from **0.779 to 0.907** as advised by Dijkstra and Henseler (2015). All constructs meet the threshold of **0.5** for average variance extracted (AVE), as suggested by Fornell and Larcker (1981) and Hair et al. (2012). Additionally, all indicator outer loadings **exceed 0.7**, as indicated by Hair et al. (2017) and Siyal et al. (2020), with statistically significant values (**p < 0.001**), ensuring the diversity of each observed variable. Overall, the results confirm the absence of concerns regarding convergent validity and reliability.

Table 1. Measurement Model (Reflective Model) Results

CONSTRUCT	CRONBACH'S ALPHA	RHO_A	CR	AVE
RA	0.905	0.907	0.904	0.840
C	0.708	0.779	0.872	0.695
COMPL	0.788	0.789	0.876	0.702
CUST	0.877	0.877	0.924	0.803
CP	0.817	0.823	0.891	0.733
GREEN	0.900	0.902	0.926	0.714
FP	0.835	0.849	0.900	0.750

Note: The t-values of all outer loadings were significant (p<0.001)

Discriminant Validity

One well-known prerequisite for examining relationships between latent components is discriminant validity. To assess discriminant validity, three techniques were employed: the Heterotrait-Monotrait ratio (HTMT), the Fornell-Larcker criterion, the cross-loadings criterion (Hamid, Sami & Sidek, 2017; Hair et al., 2018; Henseler et al., 2014), and each technique presented in Table 2,3,4 respectively. First, after extensive bootstrapping, the HTMT correlation ratio results are shown that the correlations between the reflective constructs **were not more than 0.90** (Hair et al. 2018). The values of the Fornell-Larcker criterion test are displayed in Table 3. These values are higher than their similar relationships with any other construct (Hamid et al. 2017). Third, to ascertain the discriminant validity, concept cross-loadings were employed (Hair et al. 2018). The loading of every object needs to exceed the loadings of the constructs that follow it. According to Table 3, the results satisfy the cross-loading criteria. It follows from these results that the study's data are reliable and valid for examining the research hypotheses.

Table 2. Discriminant Validity (HTMT)

Construct	C	COMPL	CP	CUST	FP	GREEN	RA
C							
COMPL	0.816						
CP	0.830	0.860					
CUST	0.805	0.880	0.814				
FP	0.828	0.863	0.826	0.835			

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GREEN	0.843	0.888	0.829	0.841	0.849		
RA	0.897	0.864	0.829	0.859	0.890	0.886	

Table 3. Discriminant Validity (Fornell and Lacker)

Construct	C	COMPL	CP	CUST	FP	GREEN	RA
C	0.834						
COMPL	0.854	0.838					
CP	0.718	0.725	0.856				
CUST	0.681	0.757	0.790	0.896			
FP	0.876	0.839	0.775	0.729	0.866		
GREEN	0.743	0.750	0.835	0.791	0.806	0.845	
RA	0.857	0.814	0.754	0.717	0.816	0.753	0.887

Table 4. Discriminant Validity (Cross Loadings)

	C	COMPL	CP	CUST	FP	GREEN	RA
C1	**0.794**	0.645	0.618	0.553	0.656	0.631	0.657
C2	**0.835**	0.694	0.572	0.591	0.690	0.611	0.727
C3	**0.871**	0.797	0.603	0.556	0.846	0.615	0.758
COMPL1	0.805	**0.875**	0.586	0.635	0.783	0.612	0.735
COMPL2	0.745	**0.830**	0.559	0.547	0.700	0.583	0.677
COMPL3	0.606	**0.806**	0.665	0.706	0.629	0.679	0.634
CP1	0.594	0.605	**0.831**	0.717	0.62	0.652	0.604
CP2	0.622	0.629	**0.845**	0.648	0.652	0.719	0.649
CP3	0.628	0.628	**0.891**	0.671	0.714	0.767	0.680
CUST1	0.580	0.647	0.660	**0.885**	0.610	0.703	0.588
CUST2	0.639	0.706	0.721	**0.914**	0.729	0.716	0.694
CUST3	0.611	0.682	0.742	**0.888**	0.620	0.708	0.645
FP1	0.661	0.652	0.717	0.688	**0.867**	0.802	0.704
FP2	0.776	0.752	0.680	0.634	**0.885**	0.648	0.911
FP3	0.871	0.797	0.603	0.556	**0.846**	0.615	0.758
GREEN1	0.660	0.671	0.835	0.654	0.731	**0.835**	0.683
GREEN2	0.630	0.612	0.683	0.621	0.680	**0.836**	0.659
GREEN3	0.630	0.640	0.704	0.690	0.713	**0.852**	0.665
GREEN4	0.602	0.599	0.620	0.662	0.611	**0.839**	0.563
GREEN5	0.612	0.639	0.666	0.716	0.657	**0.863**	0.599
RA1	0.797	0.746	0.705	0.653	0.791	0.725	**0.907**
RA2	0.781	0.740	0.686	0.683	0.820	0.693	**0.931**
RA3	0.776	0.752	0.680	0.634	0.885	0.648	**0.911**

Note: All factor loadings are significant at the $p<0.001$ level. Bold-faced values represent the item loadings for each factor.

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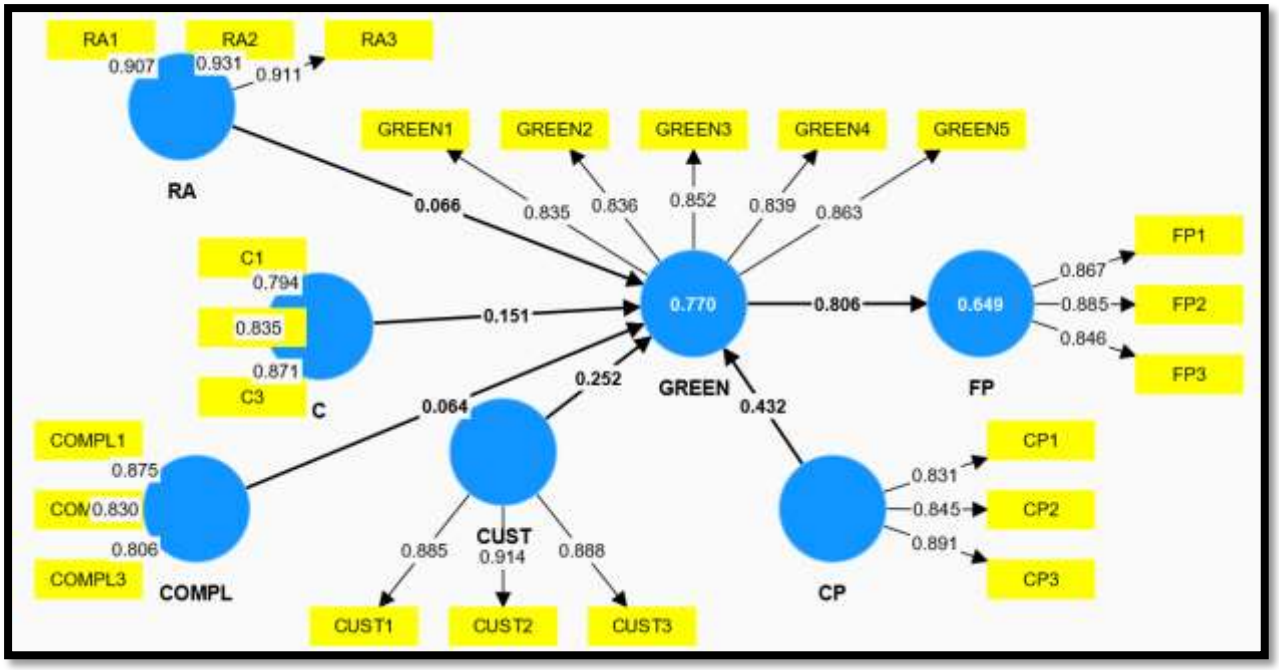

Figure 1

Path Model Results

Structural Model

The dependability, convergence, and discriminant validity of the study model were subsequently validated through the implementation of partial least squares structural equation modelling. Table 5 display the path coefficient values. The significance level for the SEM route was determined through bootstrapping with 5000 sub-samplings.

The explanatory deviation of the results measures the descriptive capability of the proposed model. The findings propose that the **R-squared** (R^2) value for financial performance is **0.649,** which signifies that the factors that were chosen account for **64.9%** of the uncertainty. The adoption of green production practices has an R^2 value of **0.770,** which signifies a variation of **77.0%.** Based on the findings presented, it can be deduced that financial performance and adoption of green production practices possess explanatory capabilities, as suggested by Chin (1998).

In contrast, the **predictive significance** (Q^2) of the model's endogenous constructs was assessed (Geisser, 1974; Stone, 1974), and the findings are presented in Table 4. Therefore, the predictive significance of the path model is indicated by a Q^2 value greater than zero for a particular endogenous reflective construct (Hair et al., 2018). The present study employs endogenous variables financial performance and adoption of green production practices, with respective Q^2 values of **0.726** and **0.755**. These values indicate that the variables possess predictive significance due to the fact that their Q^2 values are greater than zero. This model is therefore predictive with regard to every endogenous component. In the present investigation, the endogenous variables financial performance and adoption of green production practices exhibit predictive significance due to their Q^2 values exceeding zero, with respective values of **0.726** and **0.755**. Therefore, all endogenous components can be predicted by this model.

The beta coefficients for bootstrapping and significant direct influence values are presented in Table 5. The findings indicate that both the t-statistic and p-value exceed the value that was proposed (Hair et al., 2018; Sarstedt et al., 2019). The results presented in Table 5 demonstrate that **H1 (β = 0.266, p = 0.001), H4 (β = 0.252, p = 0.001), and H5 (β = 0.432, p = 0.000) have positively impacts on adoption of green**

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production practices. In a similar vein, **H6 (β = 0.806, p = 0.000) positively impacts on financial performance (β = 0.126, p = 0.037)**. Nevertheless, the findings indicate that **H2 (β = 0.151, p = 0.049), and H3 (β = 0.064, p = 0.230) have no substantial effect on adoption of green production practices**. As a result, every proposed hypothesis is accepted with the exception of H2 and H3, which is rejected statistically.

Table 5. Structural Equation Modeling Analysis

Hypotheses	Beta	Standard Deviation	t-values	p-values
H1: Relative advantage positively influences the adoption of green production practices.	0.266	0.072	3.796	0.001*
H2: Compatibility positively influences the adoption of green production practices.	0.151	0.091	1.659	0.049
H3: Complexity negatively influences the adoption of green production practices.	0.064	0.087	0.738	0.230
H4: Customer pressure positively influences the adoption of green production practices.	0.252	0.079	3.168	0.001*
H5: Competitive pressure positively influences the adoption of green production practices.	0.432	0.075	5.748	0.000*
H6: Adoption of green production practices positively influences financial performance.	0.806	0.035	23.172	0.000*

Importance Performance Map Analysis (IPMA)

The PLS-SEM methodology introduces a novel IPMA approach, which calculates the performance of each construct to offer a better understanding of the PLS-SEM results. IPMA benefits by estimating path coefficients or importance metrics and analyzing the underlying configuration and average of the related performance metrics (Ringle & Sarstedt, 2016). The IPMA approach is based on the idea that the total effect represents a given factor's influence on the target factor and its importance. In this approach,

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construct performance is assessed using the mean of the underlying construct (Akour et al., 2022; Ringle & Sarstedt, 2016).

IPMA, also referred to as 'prioritization analysis,' 'importance-performance matrix,' or 'impact-performance map,' broadens the insights provided by path coefficients (importance) through the incorporation of the average scores of potential constructs (performance). It evaluates the unstandardized overall impact (importance) in the structural model against the mean of the latent structure scores on a performance scale ranging from 0% to 100%. IPMA analysis exclusively focused on endogenous constructs to scrutinize and compare all relevant exogenous constructions (Ringle & Sarstedt, 2016). In Figure 2, the IPMA values for financial performance are presented, showing a performance value of 76.633%. The prioritization of improvements in adoption of green production practices should be considered since both importance and performance values are higher.

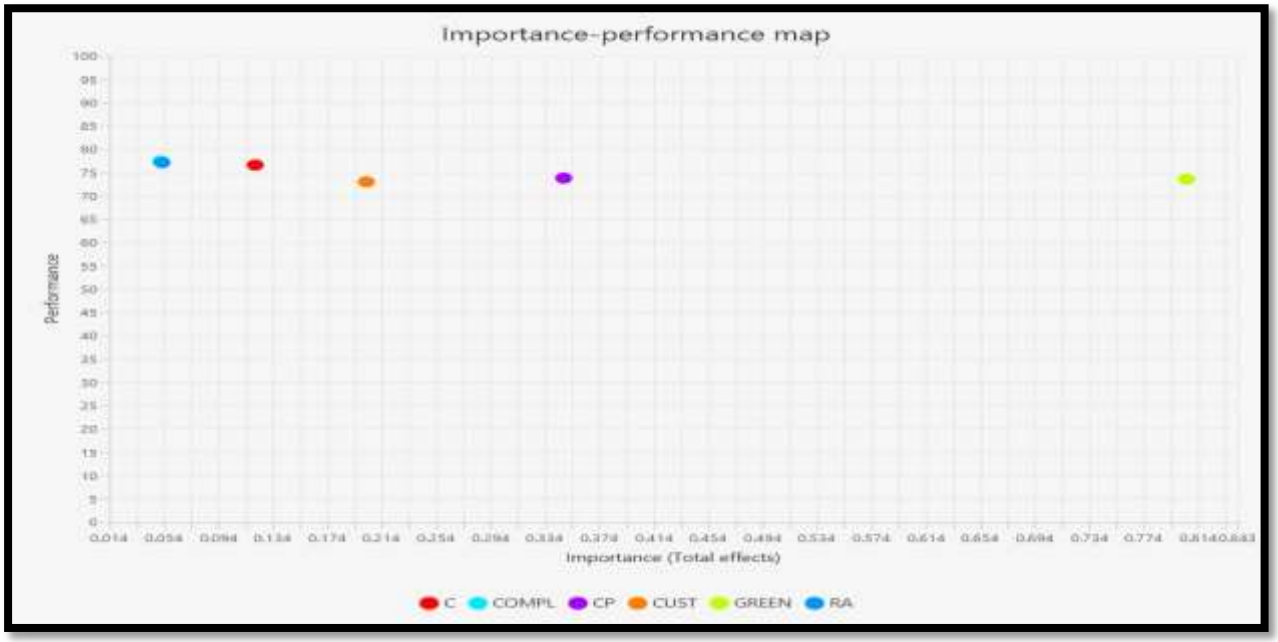

Figure 2. Importance Performance Map Analysis for SME Performance

Results

The purpose of this research is to identify organizational factors influencing the adoption of green innovations, with the aim of guiding SMEs towards green development. Previous investigations have examined individual level research, including the identification of green organizations (Chen & Chang, 2013; Chen, 2011), performance of green products (Chang et al., 2019; Chen et al., 2020), and green creativity (Mittal & Dhar, 2016; Song & Yu, 2018). Therefore, this study has constructed a theoretical framework incorporating fundamental antecedents such as relative advantage, compatibility, customers and competitors' pressure, and green production practices, which influence SMEs to adopt green innovation to enhance their financial performance. The findings validate the acceptability of the research framework and demonstrate its significant contribution to the current body of literature.

H1 also revealed that the relative advantage positively influences the adoption of green production practices. Technological innovation-driven green production behaviors can substantially reduce expenses, enhance competitive advantages, improve environmental performance, and mitigate degradation. For example, SMEs can implement environmentally sustainable procedures, products, and services, such as waste reduction and recycling, through the application of green innovations (X. Li, Dai, He, et al., 2022). Consequently, by enhancing the performance and the capability of the SME network would be strengthened

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(Dong et al., 2023). Theoretical support for these findings is provided through the investigations of (Suganthi, 2019; Asokan et al., 2022; Deng & Ji, 2015; Ghobakhloo, 2020).

H2 is rejected; compatibility positively influences the adoption of green production practices. The results do not support that compatibility prevents business failures caused by incompatible standards and ensures alignment with emerging technologies. Additionally, the findings demonstrate that compatibility may lead to failed integrations and complicated issues. Therefore, SMEs must not necessarily need to assess the success rate of green innovation implementation in partner organizations to bolster confidence and determine integration strategies for improving environmental and financial performance (Dai et al., 2023; Hasan et al., 2023). For instance, green production capabilities may not support in enhancing financial performance among SMEs in Malaysia. These results do not align with theoretical frameworks established by Gao et al., 2020; Pan et al., 2022; Rajaguru and Matanda, 2019; Spelman et al., 2017.

Furthermore, H3 is also rejected; complexity negatively influences the adoption of green production practices. The study results indicate that complexity does prevent SMEs in identifying adopters' potential requirements and maximizing the efficiency of new systems to improve environmental and financial performance. Green production practices aim to enhance the environmental and financial performance of SMEs (Jie et al., 2023). Consequently, chosen technologies must align closely with adopters' experiences, values, and innovation requirements (Kumar et al., 2018). Recent research claimed that complexity may disrupt SMEs' financial performance if adopt green production practices among manufacturing sector, potentially hindering manufacturing cost effective (Asokan et al. 2022; Ghobakhloo, 2020, Xu et al. 2023, and Yu 2022.

H4 and H5 are demonstrated customer pressure positively influences the adoption of green production practices and competitive pressure positively influences the adoption of green production practices respectively. By examining these external pressures as significant predictors of green production practices, the findings take a comprehensive approach. SMEs striving to enhance their financial performance often face pressure from customers and competitors, compelling them to adopt green innovations. In order to meet customer demands for environmentally friendly products and keep up with competitors who have already implemented green practices are key motivators for SMEs (Khodaparasti et al., 2020). Green production practices focus on environmentally friendly raw materials, ensuring the production of secure and sustainable goods (Oke, 2007). SMEs feel compelled to implement green production practices as customer preferences and competitive pressures drive them towards environmentally friendly processes and products in order to enhance financial performance of SMEs in manufacturing sector (Galbreath, 2019). In response to customer and competitor pressures, SMEs may produce ecological goods and implement process innovations and green products (Berrone et al., 2013). Additionally, SMEs may manufacture eco-friendly and cost-effective products by utilizing modern devices. SMEs should respond to customers and competitors by implementing green production practices in order to enhance their financial performance (Acquah et al., 2021). These results are supported by various research studies (Alziady & Enayah, 2019; Aykan & Akcadag, 2020; Marculetiu et al., 2023), providing theoretical support for the findings. In these statistical results does support H4 and H5, despite theoretical support from Clemens and Douglas, 2006; Huang et al., 2021; Huang and Chen, 2023.

By considering the competitive advantages of green production practices in production cost reduction, service innovation, productivity enhancement, and fostering a sustainable market reputation to attract new consumers, H6 is also revealed that adoption of green production practices positively influences financial performance. The research further suggests that the competitive advantages resulting from green production practices could assist SMEs in projecting a green image and exploring new commercial opportunities where it can enhance their financial performance (Gao et al., 2020; Pan et al., 2022). Theoretical support for these findings is provided by Konuk, 2019; Meidute-Kavaliauskiene et al., 2021; Wang, 2022.

Conclusion and Limitation

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Conclusion

In order to preserve the environment and natural resources, SMEs must pursue green innovation. This research investigates how relative advantage, compatibility, complexity, customers pressure, competitive pressure and green production practices influence a comprehensive theoretical framework aimed at reconstructing the behavior of SMEs engaged in enhancing financial performance. The results highlight the importance of embracing relative advantage, customers pressure and competitive pressure through green production practices adoption to promote healthy business performance of SMEs. Green production practices play a vital role in acting as intermediaries between these factors and financial performance benefits. For SMEs striving to foster a more environmentally conscious and sustainable future, this study provides valuable insights.

Theoretical Implications

This study offers several significant theoretical and practical implications. Theoretically, the present study focus on one theory which Diffusion of Innovation (DOI) Model to develop the research framework by highlighting the needs and priorities of specific industry group to enhance the financial performance of SMEs. Exogenous variables ensure that green production practices align appropriately with the financial performance of SMEs. Additionally, establishing the overarching vision of firm and ensuring favorable progress by promptly implementing environmentally friendly innovations that improve financial performance are identified as crucial for SMEs. The adoption of green production practices has reshaped the management perspective of practitioners and revolutionized the manufacturing sector with regard to SMEs green development.

Practical Implications

The findings of this study suggest three practices that influence the adoption of green production practices in a manner that promotes green development. Firstly, it is crucial to minimize employee resistance by ensuring technology compatibility through comprehensive knowledge-sharing sessions, training, and system orientations. This will enable employees to become comfortable with the advantages and disadvantages of the newly implemented technology and contribute optimally to the accomplishment of organizational objectives. For example, in the manufacturing sector, when implementing new sustainable manufacturing processes or technologies, SMEs must educate and train their employees, reducing opposition by providing thorough understanding of the technology.

Secondly, to enhance overall organizational effectiveness through compliance with legal requirements and environmental standards, SMEs should foster environmental consciousness and empower employees to actively participate in their activities. The manufacturing sector places a high value on sustainable supply chain management, ensuring that suppliers adhere to environmental laws, minimize waste, and utilize eco-friendly materials. By nurturing environmental awareness among both suppliers and employees, SMEs can enhance their ecological development and productivity.

Thirdly, SMEs should invest in the professional development of their staff by providing ongoing training on the latest green technologies and practices. SMEs may organize regular seminars and courses on sustainable green production, ensuring that their employees is well-informed about the latest environmentally friendly advancements. This will facilitate the cultivation of a constructive and forward-thinking attitude towards environmental sustainability.

In conclusion, SMEs may consider implementing a framework of green production practices to develop pertinent work designs and allocate sufficient resources to encourage the adoption of green innovations. The implementation of the strategic plan for green production practices would enhance their financial performance while concurrently fortifying and sustaining environmental sustainability.

Limitation and Future Research

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While the study focuses on SMEs in the manufacturing sector, specifically in Klang Valley, Malaysia, it is critical to recognize numerous limitations inherent in its scope. Firstly, the generalizability of the findings may be limited because they are largely applicable to SMEs in this specific geographic and industrial setting. This limitation arises from the distinct characteristics and dynamics of SMEs operating in the Klang Valley, which may differ from those in other regions or industries. Furthermore, while the study makes an effort to account for numerous contextual factors unique to SMEs in the manufacturing sector in Klang Valley, Malaysia, there may be exogenous variables that influence the adoption of green production practices.

Subsequently, there exist numerous potential directions for future investigation in order to rectify these constraints and enhance our comprehension of the implementation of green innovations within SMEs operating in the manufacturing industry. To begin with, an examination of the ways in which the determinants of green production practices adoption differ among various regions in Malaysia or even nations could be conducted through cross-regional research. It suggests conducting comparative analyses of this nature would yield valuable insights regarding the contextual intricacies that influence the sustainability-oriented behavior of SMEs. Furthermore, by augmenting quantitative research with qualitative methodologies, such as focus groups or interviews, more profound understandings of the incentives, obstacles, and tactics pertaining to the adoption of green production practices could be attained. Moreover, an examination of the impact of governmental policies and initiatives on the promotion of SME adoption of green production practices could contribute to the formulation of efficacious support systems and interventions.

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