Journal of Sustainability Science and Management
Volume 19 Number 3, March 2024: 69-85
eISSN: 2672-7226

SENIOR MANAGERS' PERCEPTIONS OF ENERGY EFFICIENCY INVESTMENT: EVIDENCE FROM MALAYSIAN SMEs

HELEN LEE SIEW HENG

School of Social Sciences, Universiti Sains Malaysia, 11800 Minden, Pulau Pinang, Malaysia.

**Corresponding author: helenlsh@usm.my*
http://doi.org/10.46754/jssm.2024.03.005
Submitted final draft: 10 November 2023 *Accepted: 15 November 2023* *Published: 15 March 2024*

Abstract: Energy efficiency is undeniably an important contributor to energy sustainability. It mirrors the 'low hanging fruit' in which energy efficiency is one of the easiest ways to lessen the energy demand. Small and medium-sized enterprises (SMEs) can make a major positive contribution to energy sustainability and community well-being, given the extent of their involvement in the economy. This research attempts to explore SMEs' perceptions towards energy efficiency investment. Specifically, this research examines the effects of senior managers' perceived benefits, perceived costs and personal norms on their support for energy efficiency investment. A survey was conducted to collect data and empirically test the research model. The estimated results suggest senior managers' perceived benefits and costs significantly affect their support for energy efficiency investment. In addition, the results show that personal norms are an important mediator variable in influencing energy efficiency investment by SMEs. Several notable implications can be drawn from this research. The findings demonstrate the undeniable significant effects of perceived benefits and costs on firm investment decision-making and do not neglect the importance of personal norms.

Keywords: Perceived benefits, perceived costs, personal norms, energy efficiency investment, energy sustainability.

Introduction

Energy resources that were once available in abundance are becoming increasingly scarce due to production and consumption practices across economic sectors. High energy consumption in business activities can threaten energy security and environmental sustainability through rising greenhouse gas emissions. It is of utmost importance to safeguard the environment during economic development. One of the strategies for a sustainable energy platform is to lower energy consumption and reduce carbon emissions through energy efficiency. According to Oikonomou *et al*. (2009), energy efficiency can be defined as a microeconomic situation that measures the technical, quantitative relation between the quantity of energy used and the amount of energy services derived. In other words, it refers to the capacity to use less energy to perform the same task or function. Energy efficiency should be considered an equally if not more significant target than renewable energy. Justifiably, energy efficiency should be the top priority before being too ambitious about renewable energy.

It cannot be denied that small and medium-sized enterprises (SMEs) have great potential to improve energy efficiency within the scope of their business activities or operations. Given their contributions to employment and economic growth, SMEs have become a vital component of most economies with strategic significance. Individually, the amounts of energy SMEs consume may be small, but collectively their energy demand is vast. Hence, SMEs are no exception as an essential target group besides the large organisations to enhance energy efficiency. They can improve energy efficiency through energy efficiency investment. There are many benefits of energy efficiency investment to firms and businesses (Pye & McKane, 2000), such as higher productivity and profitability, reduced exposure to rising energy prices, and enhanced competitiveness (Murray, 2011). However, issues of costs faced by SMEs

may hinder investment in energy efficiency. Senior managers of SMEs may perceive energy efficiency investment as costly and uncertain in its financial return.

Another important concern is that decision-makers of SMEs may not feel obliged to improve energy efficiency. Individuals' sense of moral obligation or personal norms may impact their decision-making and behaviour. The decision to invest in energy efficiency can be deemed as a pro-environmental behaviour. Harland *et al*. (2007) showed that personal norms significantly influenced pro-environmental behaviour. Likewise, de Groot *et al.* (2012) indicated that the sense of moral obligation impacts various environmental behaviours of individuals. In this context, decision-makers of SMEs may or may not personally feel responsible for improving energy efficiency. Some SMEs may not think it necessary to undertake energy efficiency investments or play a prominent role in corporate social responsibility. As such, there is a considerable need to examine the effect of personal norms on SMEs' support for energy efficiency investment.

The share of SMEs in the energy consumption of commercial and industrial sectors is greater than 50% in some countries (Department of Energy and Climate Change, 2015). In Malaysia, the final energy consumption by the industrial sector was 18,921 ktoes in 2019 as compared to 10,277 ktoes in 1999 (Energy Commission, 2023). SMEs' energy consumption was estimated to hit approximately 13% of the total global energy demand in 2015 (Southernwood *et al.*, 2021). The government of Malaysia launched the National Energy Efficiency Action Plan (NEEAP) to improve energy efficiency in the industrial, commercial, and residential sectors, with a target to reduce electricity demand by 8% by 2025 (Ministry of Economy, 2023). The perceptions of SMEs towards energy efficiency and sustainability have come to be seen as vital in the supply and demand management of energy. However, little is known about how SMEs embrace the idea of energy efficiency investment in their business activities. SMEs may strongly support energy efficiency investment despite not undertaking it in practice. Therefore, this research aims to gain a deeper understanding of SME senior managers' norms, perceived benefits and perceived costs towards energy efficiency investment. In this study, the context of energy efficiency investment refers to investment undertaken by SMEs to achieve lower energy consumption in deriving the same output level, be it goods or services, in their business activities or operations.

Literature Review

Most of the past studies that examined firm-level energy efficiency revolved around the question of whether to adopt or not adopt energy efficiency measures (DeCanio, 1998; Thollander *et al.*, 2007; Kounetas & Tsekouras, 2008; Abadie *et al.*, 2012; Blass *et al.*, 2014; Cagno & Trianni, 2014; Hrovatin *et al.*, 2016; Arens *et al.*, 2017). As such, binary variables were applied as indicators to measure the energy efficiency measures undertaken. The dependent variables used in past empirical studies to measure energy efficiency varied with common proxies such as participation, implementation and energy consumption. Thollander et al. (2007) highlighted that the most common energy efficiency measures implemented by firms were related to lighting, ventilation, generic processes, space heating, and compressed air. The scope of energy efficiency improvement in a firm can be reflected by investment in new energy-efficient technology processes, incremental progress or an upgrade of existing processes and the adoption of energy management systems. In addition, past studies focused on identifying or examining the barriers and enablers of improving energy efficiency (Cagno & Trianni, 2013; Cagno & Trianni, 2014; Arens *et al.*, 2017; Agrawal *et al.*, 2023).

The potential benefits of improving energy efficiency are tremendous and the positive outcomes can be reaped at different levels of the economy, ranging from individual to international levels (Ryan & Campbell, 2012). Specifically, the benefits of energy efficiency

to firms include improving their profit margins, creating better productivity, improving product quality, elevating customer satisfaction and improving the working environment or safety at work (Worrell *et al.*, 2003; Hasanbeigi *et al.*, 2010; Ryan & Campbell, 2012; Hrovatin *et al.*, 2016). Pye and McKane (2000) pointed out that energy efficiency investment influenced a firm's productivity and profitability, in which industrial decision-makers derived a range of productivity benefits from investing in energy-efficient technologies. Likewise, Worrell *et al*. (2003) showed that energy efficiency investment significantly boosted overall industrial productivity. Most enterprises were attracted to energy-efficient technologies that could improve their long-term competitiveness and benefits (Cagno & Trianni, 2013). Hrovatin *et al*. (2016) found that enhancing workplace safety was a significant factor in determining a firm's investment in energy efficiency. Despite the potential benefits that can be gained from improving energy efficiency, many firms, large or small, may still choose not to undertake profitable energy efficiency improvement, a phenomenon described by the literature as the energy efficiency paradox (DeCanio, 1998; van Soest & Bulte, 2001; Kounetas & Tsekouras, 2008). In general, any decision-making on whether to undertake a new project or investment in a firm depends on the cost of implementation and other financial aspects. Cost factors such as the initial cost of implementation, payback period or financial return, the need to spend on maintenance, and long-term budgeting may influence firms' undertaking of energy efficiency investment. Anderson and Newell (2004) have shown in their study that managers were more concerned about the initial costs of adopting energy efficiency projects than the possible annual savings generated. Blass *et al*. (2014) highlighted that payback time and investment costs influenced the adopting of energy efficiency practices. Arens *et al*. (2017) also found that access to capital and payback period were important factors affecting the firm's decision to invest in energy-efficient technologies. Besides, access to capital, investment costs and payback time were noted as the determinants of energy efficiency investment by DeCanio (1998) and Abadie *et al.* (2012). Cagno and Trianni (2013) indicated that SMEs had budget concerns regarding allowances or public financing for firms adopting energy efficiency practices. Similarly, Apeaning and Thollander (2013) proved that limited budget funding and access to capital impeded energy efficiency improvement. Agrawal *et al.* (2023) reported that one of the major barriers to energy efficiency for SMEs in Ireland, Romania and Italy was the lack of finance. In addition, firms may perceive energy efficiency investment as risky. In their investigation, Rohdin and Thollander (2006) identified one of the factors that inhibited energy efficiency improvement as the risk associated with production disruptions. Thollander and Ottosson (2008) also reported that technical risks and cost of production inconvenience were barriers to energy efficiency investment. As highlighted by Banks *et al*. (2012), the perception of risk was one of the reasons for the energy efficiency paradox.

The standard neoclassical investment theory argues that a firm's investment decision depends on achieving cost minimisation and profit maximisation (DeCanio & Watkins, 1998). The idea aligns with the rational choice perspective in which firms and individuals attempt to maximise expected utility. In other words, firms portray an optimising behaviour focusing on benefits and costs in decision-making. However, the process of decision-making is complex (McCormack & Schwanen, 2011), given the challenges of alternative assumptions with respect to the nature of the firm. In a broader sense, the decisions of firms may not be solely bounded by the neoclassical model, acknowledging that people's perceptions have behavioural implications for decision-making. Therefore, the perspective from a perception-based view or approach can be drawn as a good alternative to analyse real people's behaviour. In this context, how owners or senior managers of SMEs perceive the benefits and costs of energy efficiency investment may impact their decision to invest in energy efficiency.

On another note, personal normative factors may influence firms' investment in energy efficiency. The ambition or willingness of firms' decision-makers to invest in energy efficiency can be deemed as pro-environmental behaviour. According to Steg and Vlek (2008), moral and normative concerns impact environmental behaviour, in which individuals with greater altruistic values tend to support environmental movements. Past studies that focused on the effect of personal norms in explaining pro-environmental behaviour were mostly based on the norm activation theory or the theory of values beliefs norms (Schwartz, 1977; Stern, 2000). Personal norms are the feelings or moral obligation to act in certain behaviours (Abrahamse & Steg, 2009; Brosch *et al*., 2014).

In a study examining people's willingness to take action in favour of or against nuclear energy, de Groot and Steg (2010) found that personal norms were a significant predictor. Furthermore, they found a mediating effect of subjective norms on the relationships between the dependent variable and perceived risks and benefits. Harland *et al*. (2007) also reported that the variable personal norms significantly mediated the connection between pro-environmental behaviour and both awareness of need and situational responsibility. Drawing insights from psychological theories, Huijts *et al*. (2012) derived a framework to investigate the factors influencing public acceptance of sustainable energy technologies. Based on the framework, they claimed that perceived benefits and perceived costs influenced personal norms, and subjective norms influenced the intention to accept sustainable energy technologies.

In summary, firm-level energy efficiency has garnered the attention of many researchers. However, not much is known about how firms, especially SMEs, embrace or support energy efficiency investment in their business activities. Besides, little attention has been paid to understanding SMEs' perceptions and personal norms towards energy efficiency. In addition, there is limited evidence about the possible mediating effects or interconnections between these factors as it was rarely established in the literature. Therefore, this study aims to explore SMEs' support for energy efficiency investment, focusing on senior managers' perceived benefits and perceived costs with the integration of personal norms.

Methodology

Research Model and Hypothesis Development

The context of energy efficiency investment in this study refers to investment undertaken by SMEs to achieve lower energy consumption in their business activities or operations. Energy consumption may cover all forms of energy the firm uses, such as lighting, space conditioning, ventilation, water heating, motor systems, insulation, steam production, chiller plants, boilers, refrigeration, printing, and other applicable forms of energy consumption. Based on the purpose of this study, a research model of SMEs' support for energy efficiency investment integrating the perspectives of personal norms, perceived benefits, and perceived costs is constructed, as illustrated in Figure 1.

Support for energy Efficiency Investment (EE) is the endogenous construct or dependent variable in the research model. It denotes to what extent SMEs support energy efficiency investment in their business operations or activities. In contrast, Perceived Benefits (PB) and Perceived Costs (PC) are the independent or explanatory variables. The research model also includes Personal Norms (PN) as a mediator variable to examine the potential mediating influence of PN on the relationships between the dependent variable and explanatory variables.

This study focuses solely on examining the variables within the research model, not denying the possible existence of a non-exhaustive list of predictors beyond the scope or coverage of the research. EE refers to a scenario in which SMEs support investing in energy efficiency in their enterprises. In this context, the construct EE is measured by using reflective dimensions, namely SMEs' support for investing in new energy-efficient technologies (ee1), SMEs'

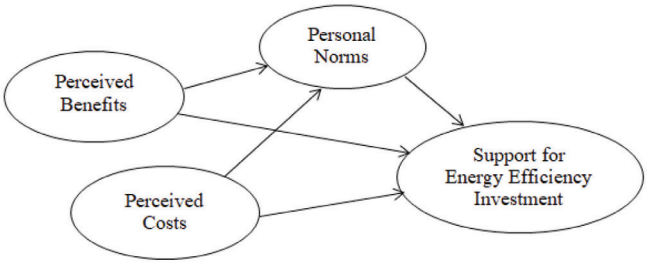

Figure 1: Research model

support for investing in upgrades of their existing process to be more energy efficient (ee2), and SMEs' support for investing in the energy management system (ee3).

PB represents SMEs' senior managers' perceptions of the benefits of energy efficiency investment. The development of the variable PB is based on the scope of potential benefits or the multiple gains from investing in energy efficiency. The indicators that reflect PB of energy efficiency investment include increasing the company's profitability (pb1), enhancing the company's productivity (pb2), elevating customer satisfaction (pb3), improving the company's product quality (pb4), and improving the company's working environment (pb5). It is postulated that owners or senior managers of SMEs tend to support energy efficiency investment if they perceive it will lead to large gains or benefits to their businesses. As such, this perspective has led to the following hypothesis:

Hypothesis 1: PB has a direct relationship with EE

On the other hand, the variable perceived costs (PC) measures SME senior managers' perceptions of energy efficiency investment costs. The unstable PC is formed based on the indicators associated with costs in energy efficiency investment such as high initial cost of investment (pc1), risk of investing in energy efficiency (pc2), the burden of maintenance cost (pc3), the aspect of financial return (pc4) and budget concern (pc5). PC of energy efficiency investment may hinder SMEs' investment decisions. In other words, the more owners or senior managers of SMEs perceive energy efficiency investment as costly, the more likely they will not support such action. Hence, the following hypothesis is derived:

Hypothesis 2: PC has an inverse relationship with EE

The inclusion of PN in the research model is based on the assertion that an individual's feeling of moral obligation can influence the decision-maker of SMEs to perform certain behaviours. PN of SMEs' senior managers may reflect their business priorities or interest towards supporting energy efficiency investment. It is postulated that decision makers or senior managers of SMEs who are personally more obliged to enhance energy efficiency and sustainability tend to support energy efficiency investment in their business activities. Hence, the following hypothesis is formed:

Hypothesis 3: PN has a direct relationship with EE

The variable PN is also posited to mediate the relationships between EE and the explanatory variables PB and PC. In other words, PN was integrated into the research model as the mediator or intervening variable between the explanatory variables (PB and PC) and the dependent variable (EE). Consequently, the following hypotheses are derived:

Hypothesis 4: PB has a relationship with PN

Hypothesis 5: PC has a relationship with PN

Hypothesis 6: PN mediates the relationship between PB and EE

Hypothesis 7: PN mediates the relationship between PC and EE

Each construct (EE, PB, PC and PN) is measured by indicators or items, represented by statements to assess SME senior managers' responses or perceptions. Using a five-point Likert scale, the respondents were asked to state to what extent they support energy efficiency investment (ee1 to ee3), from 1 indicating 'strongly oppose' to 5 showing 'strongly support'. Likewise, the respondents were required to show whether they agreed or disagreed with statements measuring the constructs PB (pb1 to pb5) and PC (pc1 to pc5), with a Likert scale from 1 representing 'strongly disagree' to 5 representing 'strongly agree'. Indicators with emotional content reflecting SME senior managers' moral obligation to invest in energy efficiency were applied to measure the variable PN in the research model. Statements such as "I feel obliged to use energy efficiently" and "I am concerned about energy sustainability" are among the items in the questionnaire, measured by a Likert scale from 1 representing 'strongly disagree' to 5 representing 'strongly agree'.

Sample and Data

A survey using a structured questionnaire was conducted to collect primary data for this research. The questionnaires were distributed to randomly selected SMEs located in Malaysia. Only firms that fulfil the specified criteria for SMEs were targeted as respondents in the survey. A firm or enterprise will be classified as an SME if it meets the set number of employees or annual sales turnover definition (SME Corporation Malaysia, 2013). The survey of this study applied a self-administered questionnaire in which the respondents completed the distributed questionnaires themselves without an interviewer. The data collection process opted for a single respondent approach (Avlonitis & Salavou, 2007), selecting only certain individuals whose opinions or views can represent the entire enterprise to participate in the survey. As such, SME owners or senior managers were targeted as the survey respondents. They can provide clear and accurate information about their businesses, and their views may represent those of the whole enterprise.

In this study, the sample size was decided based on the recommended sample size by Hair *et al*. (2022), which is in accordance with the analyses by Cohen (1992). Cohen (1988) emphasised the statistical power within a power analytical framework to estimate the required sample sizes for multiple regression models. For example, when the highest quantity of arrows directed at a latent variable in the structural model is 5, the least sample size required to mark R^2 values of 0.25 with a 5% probability of error is 70 observations (Hair *et al.*, 2022). The sample size for this study consists of a total of 103 SMEs. The participation of respondents in the survey was voluntary. Some SMEs declined the invitation to participate in the survey even though they were assured confidentiality and anonymity. The survey responses consist of SMEs from different business activities.

Data Analysis and Results

The PLS-SEM path model comprising the measurement and structural models can be seen in the research model. In this case, the measurement model demonstrates the links between the variables (EE, PB, PC, and PN) and their respective indicators while the structural model describes the connections between these research variables. In the research model, the variables PB and PC serve only as the explanatory variables with solely single-headed arrows pointing out them, as shown in Figure 1. On the other hand, the variables EE and PN are the endogenous or dependent variables, with PN also the mediator variable.

This study intends to explore to what extent SME senior managers support energy efficiency investment. Given the exploratory nature of this study, Partial Least Square Structural Equation modelling (PLS-SEM) was chosen as the statistical method of this research. PLS-SEM can give a more comprehensive analysis of the measurement and structural models (Hair *et al*., 2022). Compared to other regression techniques, PLS-SEM demands less on the data distributions and sample size (Chin & Newsted, 1999). This

research applies the SmartPLS software (Ringle *et al*., 2005) to data analysis.

Demographic Profile of SMEs

Out of the 103 surveyed SMEs, 64 employed not more than 75 employees. In terms of length of business operation, more than 50% of the surveyed SMEs reported more than 10 years. In addition, most SMEs recorded an annual sales turnover of RM3 million (USD0.66 million) but not more than RM15 million (USD3.3 million). The SMEs that participated in the survey were from different business activities. The top three business activities of SMEs that responded to the survey were food products and beverages (25%), machinery and equipment (19%), and rubber and plastic products (14%).

Descriptive Statistics

Table 1 shows the descriptive statistics of the research variables. Most variables recorded mean or average values above 3.00 and standard deviation values above 0.50. The indicators (ee1, ee2, ee3) for the variable EE recorded average values between 2.99 to 3.25. Judging from this, the extent of SMEs' support for energy efficiency investment can be regarded as rather weak. As for the explanatory variables, the average values for PB ranged from 3.11 to 3.38. The average values for the PC variable ranged from 3.33 to 3.53, while the average values for the PN variable ranged from 3.45 to 3.95.

Testing the Measurement Model

The measurement model was assessed by convergent validity. Convergent validity refers to the extent to which a measure or item correlates positively with alternative measures of the same latent variable (Hair *et al.*, 2022). The results of factor loadings, average variance extracted (AVE) and composite reliability are shown in Table 2. According to the estimated results, the factor loadings of all the items

Table 1: Descriptive statistics of variables

Variable	Item	Mean	Standard Deviation	Minimum	Maximum
EE	ee1	3.09	0.56	2	4
	ee2	3.25	0.52	2	4
	ee3	2.99	0.51	2	4
PB	pb1	3.16	0.62	2	4
	pb2	3.11	0.67	2	4
	pb3	3.15	0.65	2	4
	pb4	3.20	0.57	2	4
	pb5	3.38	0.49	3	4
PC	pc1	3.36	0.54	2	4
	pc2	3.33	0.62	2	4
	pc3	3.43	0.55	2	4
	pc4	3.53	0.62	2	4
	pc5	3.45	0.56	2	4
PN	pn1	3.48	0.58	3	5
	pn2	3.56	0.68	3	5
	pn3	3.45	0.62	2	5
	pn4	3.63	0.73	3	5
	pn5	3.95	0.71	3	5

Table 2: Factor loadings and reliability

Item	Loadings	AVE	Composite reliability
ee1	0.83	0.60	0.82
ee2	0.79		
ee3	0.69		
pb1	0.76	0.60	0.88
pb2	0.78		
pb3	0.80		
pb4	0.78		
pb5	0.77		
pc1	0.81	0.58	0.87
pc2	0.70		
pc3	0.82		
pc4	0.67		
pc5	0.79		
pn1	0.89	0.79	0.95
pn2	0.92		
pn3	0.92		
pn4	0.94		
pn5	0.77		

Note: Recommended threshold values: 0.70 for loadings; 0.50 for AVE; 0.8 for composite reliability.

surpass or are close to the minimum required cut-off value of 0.70 (Hair *et al*., 2022). This shows that the measurement items or indicators contribute sufficiently to their assigned variables. Furthermore, the composite reliability values of 0.8 and above indicate that all variables or constructs in the research model have acceptable levels of internal consistency reliability. In addition, the values of AVE for each variable are greater than the suggested value of 0.50. This implies that the research variables explain above half of the variance of the indicators (Hair *et al*. 2022), thus establishing convergent validity of the research model.

Besides convergent validity, the measurement model was tested by discriminant validity. It is based on the inter-construct correlation between variables about the Fornell-Larcker criterion as recommended by Fornell and Larcker (1981). Table 3 presents the inter-construct correlation between variables of the research model. The results show that the square root of the AVEs in the matrix diagonals was more than the non-diagonal elements across columns and rows in all cases. Therefore, the measurement model demonstrates sufficient discriminant validity.

Table 3: Inter-construct correlation.

	EE	PB	PC	PN
EE	**0.77**			
PB	0.57	**0.77**		
PC	-0.73	-0.60	**0.76**	
PN	0.70	0.75	0.62	**0.89**

Note: Diagonal values are the square root of the AVE of constructs, while the non-diagonal values are the correlations between constructs.

Testing the Structural Model

The structural model was tested for collinearity before conducting the standard model estimation. The variance inflation factor (VIF) values for the research variables were found to be less than the threshold value of 5 (Hair *et al*., 2022), suggesting that collinearity is not an issue in the research model. The bootstrapping procedure under PLS-SEM was applied to determine the significance levels of the factor loadings and path coefficients.

The estimated results (see Figure 2 and Table 4) show that the research variables PB, PC and PN were statistically significant in explaining EE. In addition, all variables were positively related to EE except PC, as hypothesised. The evidence was stronger for the effect of PC on EE as compared with the impact of PB and PN on EE, respectively. The results showed that both PB and PC significantly affected PN. In addition, the empirical results show that the research model explained approximately 52% and 67% of the differences in the variables EE and PN, respectively. In considering the level of predictive accuracy of the research model, the values of R^2 = 0.521 (EE) and R^2 = 0.674 (PN) can be described as moderate and satisfactory.

In the research model, PN is postulated to mediate the relationships between PB, EE, and PC and EE. Before assessing the mediating effect, the significance of the direct effect between the dependent and explanatory variables was first established (Preacher & Hayes, 2008). The value of variance accounted for (VAF) is needed to determine the level of the indirect effect between the dependent variable and explanatory variable (Hair *et al*., 2022). For an outcome in which the value of VAF is more than 0.2 but below 0.8, the mediating effect can be considered partial mediation. Based on the estimated results, the mediating effect of PN on the linkage between PB and EE is statistically significant. Likewise, PN also significantly mediates the relationship between PC and EE. The values of VAF derived from the data analysis indicate that the mediating effects of

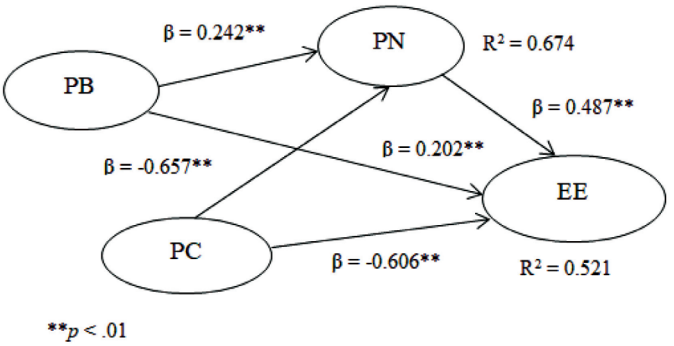

Figure 2: Results of the structural model

Table 4: Results summary of the structural model

Hypothesis	Description	Path Coefficient	Standard error	*t*-Value	Results
H1	PB→EE	0.202	0.070	2.885**	H1 confirmed
H2	PC→EE	-0.606	0.069	8.839**	H2 confirmed
H3	PN→EE	0.487	0.114	4.279**	H3 confirmed
H4	PB→PN	0.242	0.078	3.096**	H4 confirmed
H5	PC→PN	-0.657	0.068	9.623**	H5 confirmed

Note: **p < .01

PN are partial for both the hypotheses, H6 (VAF = 0.508) and H7 (VAF = 0.634). Table 5 depicts the summary of the results of the mediating effect.

Further Analysis

In the survey, the respondents were asked a binary question on their opinion about whether the benefits of energy efficiency investment outweigh its costs. It was found that approximately 73% of the total number of respondents answered yes to this question. However, the number of surveyed SMEs that invested in energy efficiency in practice is less than 50%. Since additional information on whether the surveyed SMEs invested or not invested in energy efficiency in training was also gathered, a *t*-test was carried out to determine if there were significant differences between the responses from these two groups, focusing on their perceived benefits and perceived costs of energy efficiency investment. As shown in Table 6, the mean values for all the constructs are significantly different. Based on the results, SMEs that invested in energy efficiency in practice have greater support for energy efficiency investment than their counterparts that did not invest in energy efficiency. Both groups have different levels of PB and PC towards energy efficiency investment. The group of SMEs that did not invest in energy efficiency denotes a higher PC level than the other group with a greater PB level.

Discussion of Findings

The extent of SMEs' support for energy efficiency investment can be considered low based on the survey responses of this research. Specifically, the surveyed SMEs were not keen on investing in new energy-efficient technology or energy management systems in their business activities. This could be that these SMEs were not ready to accept change or implement new ideas. The investment in energy efficiency may require steering a new course for the SMEs in their businesses. Nevertheless, based on the descriptive statistics, the mean value of ee2 under the construct EE is the highest compared to the other two indicators (ee1 and ee3). This shows that the SMEs expressed stronger support for upgrading their firms' existing processes through investment to be more energy efficient.

According to the estimated results, the variable PB has a significant direct effect on EE. The direct or positive relationship between PB and EE indicates that senior managers of SMEs tend to support energy efficiency investment if they perceive such action as beneficial to their companies. The highest mean value

Table 5: Results summary of mediating effect

Hypothesis	Description	*t*-Value	VAF	Results
H6	PB→PN→EE	2.571*	0.508	H6 confirmed; Partial mediation
H7	PC→PN→EE	-3.563**	0.634	H7 confirmed; Partial mediation

Note: *p <.05; **p < .01

Table 6: Test of differences between invested and not invested in energy efficiency

Construct	Invested (n=49)		Not invested (n = 54)		*t*-Value
	Mean	Std. dev.	Mean	Std. dev.	
EE	3.429	0.304	2.821	0.248	11.034**
PB	3.543	0.394	2.885	0.259	9.904**
PC	3.086	0.358	3.722	0.231	-10.595**

Note: **p < .01

scored by item pb5 under the variable PB in the research model suggests that improving the company's working environment is the strongest perceived benefit of energy efficiency investment compared to the other indicators. The finding of a significant relationship between PB and EE aligns with previous research that demonstrated the important connection between energy efficiency investment and its potential benefits (Pye & McKane, 2000; Hasanbeigi *et al.*, 2010; Hrovatin *et al*., 2016). By integrating this 'low hanging fruit' into their operating systems or business activities, SMEs can gain tremendously.

Similarly, a significant relationship was found from the statistical analysis between the variables PC and EE. This finding coincides with past studies by Anderson and Newell (2004), Abadie *et al.* (2012), Blass *et al.* (2014) and Arens *et al*. (2017) on the significance of cost factors in influencing energy efficiency adoption and investment. The results also show that PC is negatively related to EE, giving statistical evidence to an inverse relationship between these two variables, as hypothesised. This negative relationship indicates that the more senior managers of SMEs perceive energy efficiency investment as costly, the less tendency they have to invest in energy efficiency. The highest mean value scored by item pc4 suggests that the payback period of energy efficiency investment is crucial to SMEs. This finding echoes Arens et al. (2017), which reported the significant effect of the payback period on adopting energy-efficient technologies. Overall, it is not unexpected that senior managers of SMEs are less likely to support energy efficiency investment if they perceive such action as risky, costly to maintain, and uncertain of its financial return.

This study does not attempt to engage in a cost-benefit analysis but specifically examines the effects of SME senior managers' perceived benefits and perceived costs on their support for energy efficiency investment. Based on the estimated results, the higher direct effect of the variable PC on EE than the variable PB suggests that the surveyed SMEs are more concerned about energy efficiency investment costs than its benefits. Presumably, the firm should not undertake a decision or action of investment unless its benefits outweigh its costs. In the logical sense, it can be considered a systematic way of decision-making. In other words, decision-makers have systematic thoughts on the effects of different courses of action before making the right choice. However, such a perspective on benefits versus costs is debatable when applied to environmental domains such as energy efficiency and sustainability. For example, there may be cases where a certain action or decision might still be worth undertaking even though its costs outweigh its benefits, challenging the decision rule based on the rational approach and economic logic.

Likewise, there may be instances where decision-makers still choose not to take the appropriate action even if its benefits outweigh its costs, as evident by the energy efficiency paradox. This study found that the number of surveyed SMEs that invested in energy efficiency in practice is less than 50%, even though most senior managers (73%) perceived that the benefits of energy efficiency investment outweigh its costs. Hence, it all boils down to decision-makers perceptions, in this case, the senior managers of SMEs, towards energy efficiency investment. Not all firms are trying to maximise their gains, and some are just trying to achieve their desired outcome. While some SMEs may perceive that energy efficiency investment has strategic implications for future competitiveness and success, some SMEs may not feel the growing pressures on resources and thus are not obliged to pursue or practice energy efficiency. In brief, one can speculate or assume that the extent of support for energy efficiency investment is a function of a firm's perceptions, as examined and demonstrated by this study.

The estimated results show that PN has a strong, significant effect on EE. In addition, the research findings indicate the existence of partial mediation of PN on the relationships between EE, PB, and EE and PC. The mediating

effect of PN was stronger between PC and EE than the relationship between PB and EE. As such, PN affects EE directly and mediates the relationships between EE and the explanatory variables, PB and PC. This outcome supports the norm activation theory or the theory of values beliefs, and norms (Schwartz, 1977; Stern, 2000) and demonstrates the mediating role of PN through its intervening effect on SMEs' decision-making. The senior managers of SMEs with a strong sense of moral obligation or personal norms towards energy efficiency and sustainability tend to be more inclined to support energy efficiency investment. In other words, the PN of the SMEs' decision makers is accountable for supporting or opposing energy efficiency investment.

Research Implications

Several notable research implications can be drawn from the findings of this study. In terms of theoretical implications, the findings of this study correspond to the idea of the neoclassical theory of investment as PB and PC were significant factors in explaining EE. This implies that benefits and costs are important in firms' investment decisions. In addition, the significance of PN in influencing EE, as shown in the estimated results, demonstrates that the norm activation theory explains firms' pro-environmental behaviour in the scope of energy efficiency investment. Hence, apart from the managerial perspective of benefits and costs, including the personal normative aspect gives a broader view in examining firm-level energy efficiency investment.

The findings of this study show that most of the surveyed SMEs did not invest in energy efficiency in practice. Although it was not expected that all the SMEs would have undertaken energy efficiency investment, such a finding implies that the energy efficiency paradox is evident. This phenomenon is remarkable, as highlighted by past researchers (DeCanio, 1998; Van Soest & Bulte, 2001; Kounetas & Tsekouras, 2008), in which firms do not welcome energy efficiency in their business operations despite their multiple benefits. Therefore, transforming the perceptions of senior managers towards embracing energy efficiency is necessary. The government should be able to shape SMEs' perception of energy efficiency investment through an effective policy framework and various promotional strategies. A transparent and clear action plan with a well-defined policy instrument is essential to spur energy efficiency. Furthermore, great coordination between the government and industry players is important to create efficiency and integrity in the energy market. There is a need to steer SMEs on a new course towards energy efficiency that is not just about transforming the energy industry but also in the pursuit of environmental sustainability.

The significance of PB in influencing EE implies that the positive perception of SMEs' senior managers towards energy efficiency investment is important. Hence, strategies to promote energy efficiency investment should consider senior managers' perceived benefits towards energy efficiency investment. It is pertinent to promote or campaign on the benefits of energy efficiency investment to SMEs. The multiple benefits or gains from investing in energy efficiency should be widely evident to SMEs to garner their support. More demonstration projects with proper auditing and close monitoring can help to define and convince SMEs of the many benefits of energy efficiency investment. For example, SMEs should perceive investing in new energy-efficient technologies and energy management systems as beneficial and rewarding. It may be fruitful for SMEs to attend workshops or seminars on the various benefits and advantages of energy-efficient technologies and energy management systems organised by the government or key industry players. Large multinational corporations with good exposure and positive experience in adopting new technology and managing energy consumption can share the benefits of energy efficiency investment with their peers and SMEs. Besides, the government can support and assist SMEs with detailed information and consultation to ensure a high success rate of energy efficiency projects. This can help SMEs to gain confidence

and develop a positive impression towards energy efficiency investment.

The results of a significant relationship between PC and EE also have notable implications. As growing firms, financial constraints could challenge SMEs, causing their reluctance to undertake energy efficiency investments. Given their cost-sensitive nature, SMEs may have many concerns about costs when undertaking investments. As such, measures should be conducted to address the concerns of SMEs and encourage them to invest in energy efficiency. Despite the concern that energy efficiency investment may involve some capital outlay initially, SMEs must be convinced that it is still worth undertaking. SMEs need to realise that energy efficiency investment benefits their businesses instead of being perceived as costly and risky. From a policy standpoint, the stimulation of cost-effective energy efficiency investment can be integrated extensively with the national energy security and sustainability strategy. The government can facilitate SMEs financial accessibility for energy efficiency investment via effective fiscal mechanisms. In addition, measures such as setting up expert advisory committees, public information and discussion platforms on available financial schemes, financial returns and incentives for energy efficiency investment can be useful to attract SMEs' participation. Moreover, greater collaboration effort between finance providers is important to assist SMEs in navigating their funds or finances for investments. SMEs will be more receptive towards energy efficiency investment if they have adequate funds or available credit resources.

SMEs need to involve or align themselves with the government's attempts to stimulate energy efficiency so that it is not simply a one-sided effort. However, SMEs need to feel strongly invited to be a vital part of the government's role in spurring energy efficiency. Hence, the government should continue to intensify the work on designing measures and effective strategies in the policy mix that can encourage and motivate SMEs to enhance energy efficiency. The government and SMEs must have a common understanding of energy efficiency and sustainability. There is a rising need to create awareness among SMEs in Malaysia on the importance of enhancing energy efficiency. As long as SMEs are not concerned with improving energy efficiency and sustainability, any legislation or incentives that are in place would not have much impact. Therefore, a deep understanding of SME senior managers' perceptions towards energy efficiency investment is necessary for policymakers to design effective intervention strategies to attract SMEs' participation in energy efficiency investment.

This study integrated the aspect of personal norms into the scope of a firm's energy efficiency with the notion that individuals' subjective norms significantly impact firm-level decision-making. In this case, it is postulated that personal norms can influence SMEs' support for energy efficiency investment directly and indirectly as a mediator. Based on the estimated results of this research, it can be concluded that personal norms influence the pro-environmental behaviour of SMEs regarding their support for energy efficiency investment. Recognising the importance of subjective norms within the firm's energy efficiency gives policymakers further insights into how a better understanding of decision-maker's self-expectations and obligations is essential to designing effective intervention strategies and policies. The reinforcement of normative strategy such as providing information that can influence or alter individuals' PN, is important. The attempts to cultivate people's PN in favour of energy efficiency and sustainability through informational strategies may have a deep and lasting impact if properly executed. It is not merely about information availability but the impact of such information on transforming people's mindset and behaviour. In short, widespread information and knowledge about energy efficiency and sustainability must be intensified.

Overall, this research has shed some light on SME senior managers' perceptions towards energy efficiency investment that may serve as a useful source of information for future research work in the scope of firm-level energy efficiency. This study established firm-level evidence on SME's support for energy efficiency investment and its significant connections with senior managers' perceived benefits, costs and personal norms. In addition, this study contributes to the literature in defining a perception model for SMEs' energy efficiency investment, which not only helps to better understand the perceived benefits, perceived costs and personal norms as the antecedents to energy efficiency investment but also the intervening effects, both directly and indirectly, between these antecedents.

Nevertheless, this study is not without limitations. Given that this study collected data at one point in time, the possibility of endogeneity cannot be ruled out and thus the findings should be interpreted with care. In addition, using a single cross-section of data prevents investigation into the dynamics of the firm decision-making process. Future research might consider using a panel sample or longitudinal data. Despite these limitations, this study provides a deeper understanding of the factors influencing energy efficiency investment from the costs, benefits and personal normative perspectives.

Conclusion

SMEs' perceived benefits, perceived costs, and personal norms are important factors influencing energy efficiency investment. SMEs should prioritise energy efficiency investment to enhance energy security and sustainability. It is sensible for SMEs to invest in energy efficiency, noting that it benefits the firms and the entire economy. SMEs must recognise and realise their potential to enhance energy efficiency and sustainability. They should strive to be well-equipped with the necessary knowledge and make a concerted effort with the government to stimulate energy efficiency. The government is crucial in facilitating SMEs' energy efficiency investment through impactful and strategic action plans. A greater understanding of senior managers' perceptions is necessary for the government to design effective policies and strategies to spur energy efficiency. The government must continually evaluate the effectiveness of its policies and strive for greater heights in energy efficiency initiatives. Overall, there is a dire need to create transformational readiness among SMEs to become essential role players in accelerating energy efficiency.

Acknowledgements

The author would like to thank the survey respondents for their time and insights.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

References

Abadie, L. M., Ortiz, R. A., & Galarraga, I. (2012). Determinants of energy efficiency investments in the US. *Energy Policy, 45*(0), 551-566.

Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *Journal of Economic Psychology, 30*, 711-720.

Agrawal, R., De Tommasi, L., Lyons, P. *et al.* (2023). Challenges and opportunities for improving energy efficiency in SMEs: Learnings from seven European projects. *Energy Efficiency, 16,*17.

Alvonitis, G. J., & Salavou, H. E. (2007). Entrepreneurial orientation of SMEs, product innovativeness and performance. *Journal of Business Research, 60*(5), 566-575.

Anderson, S. T., & Newell, R. G. (2004). Information programs for technology adoption: The case of energy-efficiency

audits. *Resource and Energy Economics, 26*(1), 27-50.

Apeaning, R. W., & Thollander, P. (2013). Barriers to and driving forces for industrial energy efficiency improvements in African industries. A case study of Ghana's largest industrial area. *Journal of Cleaner Production, 53*, 204-213.

Arens, M., Worrell, E., & Eichhammer, W. (2017). Drivers and barriers to the diffusion of energy-efficient technologies: A plant-level analysis of the German steel industry. *Energy Efficiency, 10*, 441-457.

Banks, N., Fawcett, T., & Redgrove, Z. (2012). *What are the factors influencing energy behaviours and decision-making in the non-domestic sector? A rapid evidence assessment.* Centre for Sustainable Energy and Environmental Change Institute, University of Oxford.

Blass, V., Corbett, C. J., Delmas, M. A., & Muthulingam, S. (2014). Top management and the adoption of energy efficiency practices: Evidence from small and medium-sized manufacturing firms in the US. *Energy, 65*, 560-571.

Brosh, T., Patel, M. K., & Sander, D. (2014). Affective influences on energy-related decisions and behaviors. *Frontiers in Energy Research, 2*(11), 1-12.

Cagno, E., & Trianni, A. (2013). Exploring drivers for energy efficiency within small- and medium-sized enterprises: First evidences from Italian manufacturing enterprises. *Applied Energy*, *104*, 276-285.

Cagno, E., & Trianni, A. (2014). Evaluating the barriers to specific industrial energy efficiency measures: An exploratory study in small and medium-sized enterprises. *Journal of Cleaner Production, 82*, 70-83.

Chin, W. W., & Newsted, P. R. (1999). Structural equation modeling analysis with small samples using partial least squares. In Hoyle, R. H. (Ed.), *Statistical strategies for small sample research*, 307-341. Thousand Oaks: Sage.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.

DeCanio, S. J. (1998). The efficiency paradox: Bureaucratic and organizational barriers to profitable energy-saving investments. *Energy Policy, 26*(5), 441-454.

DeCanio, S. J., & Watkins, W. E. (1998). Investment in energy efficiency: Do the characteristics of firms matter? *The Review of Economics and Statistics, 80*(1), 95-107.

De Groot, J. I. M., & Steg, L. (2010). Morality and nuclear energy: Perceptions of risks and benefits, personal norms, and willingness to take action related to nuclear energy. *Risk Analysis, 30*(9), 1363-1373.

De Groot, J. I. M., Steg, L., Keizer, M., Farsang, A., & Watt, A. (2012). Environmental values in post-socialist Hungary: Is it useful to distinguish egoistic, altruistic and biospheric values? *Czech Sociological Review, 48*(3), 421-440.

Department of Energy & Climate Change. (2015). *The Non-Domestic National Energy Efficiency Data-Framework: Energy Statistics 2006-12*. Department of Energy & Climate Change: UK.

Energy Commission. (2023). *Malaysia Energy Statistics Handbook 2021*. Energy Commission, Malaysia.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (3rd ed). SAGE Publications, Inc.

Hasanbeigi, A., Menke, C., & du Pont, P. (2010). Barriers to energy efficiency improvement and decision-making behavior in Thai industry. *Energy Efficiency, 3*, 33-52.

Hrovatin, N., Dolšak, N., & Zoric´, J. (2016). Factors impacting investments in energy efficiency and clean technologies: Empirical evidence from Slovenian manufacturing firms. *Journal of Cleaner Production, 127*, 475-486.

Huijts, N. M. A., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews, 16*, 525-531.

Kounetas, K., & Tsekouras, K. (2008). The energy efficiency paradox revisited through a partial observability approach. *Energy Economics, 30*(5), 2517-2536.

McCormack, D. P., & Schwanen, T. (2011). Guest Editorial: The Space—Times of decision making. *Environment and Planning A: Economy and Space*, *43*, 2801-2818.

Ministry of Economy. (2023). *National Energy Transition Roadmap: Energising the nation, powering our future.* Ministry of Economy, Malaysia.

Murray, S. (2011). *Unlocking the benefits of energy efficiency. An executive dilemma.* The Economist. Economist Intelligence Unit.

Oikonomou, V., Becchis, F., Steg, L., & Russolillo, D. (2009). Energy saving and energy efficiency concepts for policy making. *Energy Policy, 37*, 4787-4796.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in simple and multiple mediator models. *Behavior Research Methods, 40*, 879-891.

Pye, M., & McKane, A. (2000). Making a stronger case for industrial energy efficiency by quantifying non-energy benefits. *Resources, Conservation and Recycling, 28*(3-4), 171-183.

Ringle, C. M., Wende, S., & Will, A. (2005). *SmartPLS 2.0 (Beta)*. www.smartpls.de

Rohdin, P., & Thollander, P. (2006). Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. *Energy, 31*(12), 1836-1844.

Ryan, L., & Campell, N. (2012). *Spreading the net: The multiple benefits of energy efficiency improvements*. Insights Series. International Energy Agency.

Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology, 10*, 221-279.

SME Corporation Malaysia. (2013). *Guideline for new SME definition*. SME Corporation Malaysia.

Southernwood, J., Papagiannis, G. K., Güemes, E. L., & Sileni, L. (2021). Energy efficiency solutions for small and medium-sized enterprises. *The 8th Annual International Sustainable Places Conference (SP2020) Proceedings.* MDPI.

Steg, L., & Vlek, C. (2008). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 20*(30), 309-317.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues, 56*(3), 407-424.

Thollander, P., Danestiq, M., & Rohdin, P. (2007). Energy policies for increased industrial energy efficiency: Evaluation of a local energy programme for manufacturing SMEs. *Energy Policy*, *35*(11), 5774-5783.

Thollander, P., & Ottosson, M. (2008). An energy efficient Swedish pulp and paper industry-exploring barriers to and driving forces for cost-effective energy efficiency investments. *Energy Efficiency, 1*, 21-34.

van Soest, D. P., & Bulte, E. H. (2001). Does the energy-efficiency paradox exist? Technological progress and uncertainty. *Environmental and Resource Economics*, *18*, 101-112.

Worrell, E., Laitner, J. A., Ruth, M., & Finman, H. (2003). Productivity benefits of industrial energy efficiency measures. *Energy, 28*(11), 1081-1098.