Sustainable Energy Transition among SMEs: Conceptualizing Determinants of Intention to Adopt Solar Energy Technology

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ABSTRACT

The accelerating impacts of climate change underscore the urgency of transitioning to sustainable energy sources, with solar energy emerging as a promising option due to its abundance, cost efficiency, and environmental benefits. Despite Malaysia's abundant solar potential and favorable policy environment, the adoption of Solar Energy Technology (SET) among small and medium-sized enterprises (SMEs) remains limited. Given SMEs' critical role in driving economic growth and sustainability, understanding the determinants of their adoption intention is essential. This conceptual study examines multiple factors influencing SMEs' intention to adopt SET. Specifically, it considers technical and economic factors (perceived usefulness, perceived ease of use, perceived level of competition pressure, and perceived price), dispositional and organizational factors (perceived relative advantage, entrepreneur's awareness, entrepreneur's technology readiness, and SMEs' readiness), as well as an environmental factor (government's support and initiative). Furthermore, the study examines two mediating effects, where perceived usefulness mediates the relationship between relative advantage and adoption intention, and perceived ease of use mediates the relationship between technology readiness and adoption intention. The findings are expected to advance theoretical perspectives on technology adoption in the renewable energy context and provide practical insights to guide policymakers, industry stakeholders, and SME owners in accelerating solar adoption and supporting Malaysia's energy transition.

Keywords: Solar energy technology (SET), Small and medium-sized enterprises (SMEs), Adoption intention, Sustainable energy, Technology adoption.

INTRODUCTION

The accelerating impacts of climate change have intensified global efforts to transition toward sustainable energy sources, particularly renewable energy technologies that reduce dependence on fossil fuels and mitigate greenhouse gas emissions. Among these options, solar energy stands out for its abundance, cleanliness, and cost efficiency, making it one of the most promising solutions worldwide (Alam et al., 2021; Md-Mehedi, 2023). Malaysia, strategically located near the equator, receives high annual solar irradiance of 1,575 to 1,812 kWh/m², offering significant potential for solar power generation (Kow, 2023; Sustainable Energy Development Authority [SEDA], 2021). Despite these advantages, adoption of Solar Energy Technology (SET) remains relatively low, particularly among small to medium-sized enterprises (SMEs), which are vital to Malaysia's economic growth and sustainability agenda (Hassan et al., 2023). This underutilisation underscores the need to understand the determinants of SMEs' adoption intention to accelerate the country's renewable energy transition.

Since renewable energy was introduced as Malaysia's "fifth fuel" in 1999, the government has implemented several strategic initiatives, including the Malaysia Renewable Energy Roadmap (MyRER), which aims to increase the share of renewable energy to 31% by 2025 and 40% by 2035 (SEDA, 2021). These policies align

with Malaysia's commitments under the Paris Agreement and its pledge to achieve net-zero emissions by 2050 (Malaysian Investment Development Authority [MIDA], 2022). Solar photovoltaics (PV) is prioritised due to its scalability, low environmental impact, and declining costs (Hsbollah et al., 2023). However, barriers such as limited financial resources, low awareness of available incentives, and uncertainty over return on investment continue to hinder broader adoption (Lau et al., 2020). These challenges are particularly critical for SMEs, which typically operate with constrained budgets but could benefit substantially from the long-term cost savings, energy independence, and reputational gains associated with SET adoption (Abdullah et al., 2019).

Despite favourable geographic conditions and supportive policy frameworks, the slow adoption of SET among SMEs continues to constrain Malaysia's progress toward renewable energy targets (Kow, 2023; SEDA, 2021). SMEs, which account for 97.4% of business establishments and contribute significantly to the nation's GDP and employment (SME Corp Malaysia, n.d.), represent a powerful yet underutilized driver of the country's energy transition. Their widespread adoption of SET could meaningfully reduce carbon emissions and enhance energy security, while non-adoption risks exposing them to rising operational costs and reduced competitiveness due to escalating electricity tariffs (Abdullah et al., 2019). Addressing these barriers requires a comprehensive understanding of the factors influencing SMEs' intention to adopt SET, enabling targeted strategies to unlock their potential in Malaysia's energy transition.

The purpose of this study is to examine the factors influencing SMEs' intention to adopt solar energy technology (SET). Specifically, it investigates technical and economic factors, including perceived usefulness, perceived ease of use, perceived level of competition pressure, and perceived price, along with dispositional and organizational factors, such as perceived relative advantage, entrepreneur's awareness, entrepreneur's technology readiness, and SMEs' readiness. The study also evaluates an environmental factor– government support, and initiative. Furthermore, it considers the mediating effects, where perceived usefulness is expected to mediate the relationship between perceived relative advantage and adoption intention, and perceived ease of use is anticipated to mediate the relationship between entrepreneur's technology readiness and adoption intention. This study contributes theoretically by advancing knowledge of technology adoption in the renewable energy context, and practically by providing actionable insights for policymakers, industry stakeholders, and SME owners to promote solar adoption, strengthen competitiveness, and support Malaysia's pursuit of sustainable growth and net-zero emissions.

LITERATURE REVIEW

Underpinning Theories

This study is anchored on three theoretical perspectives that collectively explain the adoption of Solar Energy Technology (SET) among small and medium-sized enterprises (SMEs): the Technological-Organisational-Environmental (TOE) framework (Tornatzky & Fleischer, 1990), the Diffusion of Innovation (DOI) theory (Rogers, 1962), and the Technology Acceptance Model (TAM) (Davis, 1989). The TOE framework, proposed by Tornatzky and Fleischer (1990), posits that technological adoption in organizations is influenced by three dimensions: technological, organisational, and environmental. This framework is well-suited for renewable energy research as it encompasses drivers such as relative advantage, organisational readiness, managerial support, regulatory pressures, and infrastructure availability (SEDA, 2021). For SMEs in Malaysia, these factors are particularly relevant, as adoption decisions are shaped not only by the perceived characteristics of solar technology but also by the firms' internal resources and external institutional support (Hassan et al., 2023).

While TOE provides a broad contextual understanding, the DOI theory adds an innovation-specific lens by focusing on attributes that influence adoption (Piaralal et al., 2015; Yahya et al., 2014). Rogers (1962) identified five perceived attributes (relative advantage, compatibility, complexity, trialability, and observability) that explain how innovations spread within a system (Nair et al., 2023). In the case of solar photovoltaics, prior studies show that relative advantage is the most relevant determinant, reflecting entrepreneurs' assessment of SET benefits compared to conventional energy sources (Hassan et al., 2023). In contrast, attributes such as complexity, trialability, and observability are less applicable, since solar

installations are typically handled by third-party providers and their performance outcomes are guaranteed through warranties (Li et al., 2022). By emphasising relative advantage, DOI highlights how entrepreneurs evaluate SET primarily in terms of cost savings, energy independence, and sustainability, which are decisive in shaping adoption intention.

Complementing these perspectives, TAM introduces the cognitive and perceptual dimensions of technology adoption. According to TAM, perceived usefulness (PU) and perceived ease of use (PEOU) are central predictors of adoption intentions, shaping both attitudes and behavioural outcomes (Davis, 1989; Hubert et al., 2019). For SMEs, PU reflects the expectation that solar energy can improve operational efficiency and reduce long-term electricity costs, while PEOU concerns whether the technology is perceived as simple to integrate and manage within existing operations. By integrating TOE, DOI, and TAM, this study combines organisational and environmental readiness, the innovation attribute of relative advantage, and entrepreneurs' perceptions of usefulness and ease of use. Together, these frameworks provide a comprehensive foundation for examining the multifaceted antecedents that influence SMEs' intention to adopt SET in Malaysia.

Intention to Adopt Solar Energy Technology

The intention to adopt solar energy technology (SET) is a crucial determinant of its actual implementation, as it reflects both individual and organizational willingness to transition towards renewable energy solutions. In line with the Technology Acceptance Model (TAM), perceived usefulness and perceived ease of use strongly shape positive attitudes that drive adoption intention (Alam et al., 2021). Several studies have demonstrated that positive attitudes towards renewable energy, coupled with greater environmental awareness, significantly enhance the intention to adopt solar technologies (Irfan et al., 2021; Alam et al., 2021). Moreover, the declining costs of solar photovoltaic (PV) systems and supportive policy frameworks are increasing the perceived value of SET, making adoption more attractive to households, organizations, and SMEs (Hsbollah et al., 2023). As solar energy adoption not only reduces operational costs but also strengthens environmental credentials, the intention to adopt is increasingly aligned with both economic rationality and sustainability objectives (Hassan et al., 2023).

For SMEs in particular, intention to adopt SET is strongly influenced by financial considerations, social pressure, and government incentives. While smaller firms are generally more agile in responding to technological changes, high initial investment costs, knowledge gaps, and risk perceptions remain critical barriers that weaken adoption intention (Yu & Schweisfurth, 2020; Abdullah et al., 2023). Research in developing countries indicates that external drivers, such as peer influence, customer demand, and regulatory pressures, can positively influence SMEs' adoption intentions by framing solar PV not only as an environmental responsibility but also as a competitive advantage (Aziz et al., 2021; Irfan et al., 2021). In Malaysia, despite supportive programs such as Net Energy Metering (NEM), the actual adoption rate remains low, suggesting that intention does not always translate into action due to structural and contextual barriers (Lau et al., 2020; Hsbollah et al., 2023). Thus, understanding the determinants of adoption intention is pivotal, as intention serves as the mediating link between awareness, policy initiatives, and the actual uptake of solar energy technologies, especially within the SME sector.

Technical and Economic Factors

Perceived Usefulness

Perceived usefulness is defined as the degree to which potential users believe that adopting a particular technology will provide benefits or improve outcomes (Davis, 1989). In the TAM, perceived usefulness plays a pivotal role in shaping attitudes and behavioural intention toward adoption, as technologies seen as beneficial are more likely to be embraced (Nagadeepa & Mohan, 2019; Sentosa et al., 2011). In the renewable energy context, Zahari and Esa (2019) highlighted that perceived utility of solar technologies positively affects adoption, even when perceived risks are present. Similarly, recent studies have shown that users' perception of the usefulness of solar photovoltaic (PV) systems, such as lowering electricity costs, reducing environmental impact, and enhancing energy independence, significantly predicts their adoption intention

(Md-Mehedi et al., 2023; Schulte et al., 2022; Hassan et al., 2023). At the organizational level, Hsbollah et al. (2023) revealed that firms perceive solar adoption as enhancing economic sustainability by reducing operational costs, improving return on investment, and strengthening competitiveness. As individuals and organisations increasingly acknowledge these tangible utilities, they are more inclined to install or switch to solar PV technology. Therefore, this study proposes the following hypothesis:

H1: Perceived usefulness has a positive effect on the intention to adopt solar energy technology (SET).

Perceived Ease of Use

Perceived ease of use is defined as the extent to which an individual believes that using a technology will be free of effort, encompassing ease of installation, operation, and maintenance (Davis, 1989). Technologies that are simple and user-friendly are more likely to be adopted, as users perceive fewer barriers to learning and applying them (Nagadeepa & Mohan, 2019). In the context of solar or photovoltaic (PV) technology, perceived ease of use reflects how decision makers, managers, or entrepreneurs evaluate the simplicity of adopting and maintaining solar systems within their organizations. Prior research has established that ease of use significantly predicts adoption intention for renewable energy technologies. For instance, Alam et al. (2021) confirmed that residents were more likely to use PV systems when they perceived them as easy to operate, while Fleiß et al. (2024) found that convenience and effortlessness increased adoption likelihood among individuals. Similarly, Qamar et al. (2022) demonstrated that potential adopters evaluate usability and maintainability before making investment decisions, particularly when technical knowledge is limited. These findings highlight the importance of examining perceived ease of use in different contexts, such as Malaysian SMEs, where technical unfamiliarity and resource limitations may affect adoption decisions. Therefore, this study proposes the following hypothesis:

H2: Perceived ease of use has a positive effect on the intention to adopt solar energy technology (SET).

Perceived Level of Competition Pressure

Within the TOE framework, perceived level of competition pressure refers to the extent to which a firm believes that its competitive environment compels it to adopt new technology in order to sustain or improve its market position. Competitive pressure often drives firms to imitate their rivals' technological initiatives, particularly when adoption can enhance productivity, efficiency, or reputation (Shahzad et al., 2023). Prior research has consistently shown that firms facing intense competition are more likely to adopt new technologies, as confirmed in studies on supply chain management (Lin, 2014), Industry 4.0 adoption in Malaysian SMEs (Shahzad et al., 2023), social media marketing adoption (Abbasi et al., 2023), and digitalisation among European SMEs (Kwarteng et al., 2024). In the renewable energy context, Qamar et al. (2022) found that both high operational costs and competitive pressure significantly shape micro, small, and medium-sized enterprises' (MSMEs) intention to adopt solar energy technology (SET). Firms that perceive competitors gaining cost savings and reputational benefits from solar adoption may feel pressured to follow suit to avoid falling behind. As solar PV systems become more affordable, this competitive dynamic strengthens, pushing SMEs to adopt SET as both a strategic and financial necessity. Therefore, this study proposes the following hypothesis:

H3: Perceived level of competition pressure has a positive effect on the intention to adopt solar energy technology (SET).

Perceived Price

Perceived price is defined as potential customers' subjective evaluation of the monetary, effort, time, and risk-related costs associated with acquiring and using a product or service, beyond its actual market price (Zeithaml, 1988). In the context of SET, perceived price reflects SMEs' assessment of adoption costs, typically comprising high upfront installation expenses along with ongoing maintenance and operational costs, which

are usually perceived as lower than those of conventional energy sources. Prior studies consistently highlight cost perceptions as a barrier to renewable energy adoption: Emon et al. (2023) found that cost was a significant obstacle to adopting SET, while Zahari and Esa (2019) similarly reported that high expenses negatively influenced renewable energy adoption intentions. Elahi et al. (2022) also observed that photovoltaic water pump adoption among farmers was hindered by cost perceptions. Despite declining solar installation prices in recent years, many potential adopters still perceive solar technology as expensive, especially in the absence of subsidies or financing options (Sovacool, 2017). Druckman and Jackson (2008) noted that a lack of awareness regarding long-term savings and available incentives often amplifies these perceptions, while Othman et al. (2021) found that both knowledge and perceived price significantly shaped residents' willingness to adopt renewable energy in Malaysia. Similarly, Almrafee and Akaileh (2024) confirmed that perceived price and renewable energy knowledge significantly influence purchase intentions in Jordan. Collectively, these findings suggest that while SET offers long-term financial and environmental benefits, high perceived costs remain a critical adoption barrier. Therefore, this study proposes the following hypothesis:

H4: Perceived price has a negative effect on the intention to adopt solar energy technology (SET).

Dispositional and Organisational Factors

Perceived Relative Advantage

Relative advantage, a key attribute in the DOI theory, is defined as the degree to which a new idea or technology is perceived as better than the one it supersedes (Hsbollah & Kaushik, 2022). In practice, it refers to the extent to which entrepreneurs perceive solar energy technology (SET) as offering superior benefits compared to conventional energy sources such as grid electricity, fossil fuel, or natural gas, with assessments often based on cost savings, environmental sustainability, reliability, and overall utility (Alam et al., 2021; Hassan et al., 2023; Elahi et al., 2022). When users recognize clear advantages of SET, such as lower long-term energy costs or reduced environmental impact, they are more likely to form positive adoption intentions (Alam et al., 2021; Hassan et al., 2023). Past studies consistently confirm this relationship: Alam et al. (2021) found that residents' perceived relative advantage significantly influenced adoption of solar energy in Malaysia, Hassan et al. (2023) demonstrated that managers' perceptions of SET benefits positively affected adoption intention in businesses, and Elahi et al. (2022) observed that farmers' perceived relative advantage drove their intention to adopt photovoltaic water pumps. These findings underscore that entrepreneurs' perception of SET's relative superiority over conventional energy strongly motivates adoption behavior. Therefore, this study proposes the following hypothesis:

H5: Perceived relative advantage has a positive effect on the intention to adopt solar energy technology (SET).

Entrepreneur's Awareness

Awareness plays a pivotal role in shaping adoption intention, especially in SMEs that often lack resources to hire consultants and therefore rely heavily on decision makers' understanding of available technologies (Zeng et al., 2022). In the context of renewable energy, several studies have demonstrated that awareness significantly influences adoption. For instance, Bilal and Andajani (2023) reported that household awareness positively affected the intention to adopt rooftop solar panels in Indonesia, while Alam et al. (2021) identified awareness as the strongest predictor of photovoltaic (PV) adoption intention in Malaysia, emphasizing that promotional strategies should focus on awareness-building. Similarly, Vaka et al. (2022) and Emon et al. (2023) highlighted the lack of awareness as a major barrier hindering the adoption of SET, whereas Hsbollah et al. (2023) stressed that decision makers' awareness and understanding are critical for future adoption. Beyond individual knowledge, broader awareness campaigns, community-based initiatives, and media involvement have also been identified as essential for enhancing public understanding and acceptance of solar energy (Ibegbulam et al., 2023; Emon et al., 2023). Interestingly, while technical knowledge is sometimes considered less relevant, awareness of the importance and advantages of solar energy is sufficient to drive adoption intention (Qamar et al., 2022). Thus, entrepreneur's awareness emerges as a key dispositional factor

influencing SMEs' adoption of solar energy technology. Therefore, this study proposes the following hypothesis:

H6: Entrepreneur's awareness has a positive effect on the intention to adopt solar energy technology (SET).

Entrepreneur's Technology Readiness

Entrepreneur's technology readiness refers to the willingness and predisposition of decision makers to embrace and implement new technologies for achieving both organisational and professional goals (Parasuraman & Colby, 2015). It encompasses both the emotional and mental preparedness of entrepreneurs, which is critical since decision-making in SMEs is often centralised in the hands of these leaders (Hassan et al., 2023; Ibrahim et al., 2025). Technology readiness not only influences individual attitudes but also shapes organisational capacity to innovate, overcome resistance, and enhance operational efficiency in increasingly competitive and digitalised markets (Jansen et al., 2009). Past studies have highlighted that higher levels of technology readiness encourage greater openness to adopting renewable energy solutions, as entrepreneurs act as change agents who can eliminate institutional barriers and drive sustainable initiatives within their organisations (Hassan et al., 2023; Parasuraman & Colby, 2015). As SET offers significant advantages in energy efficiency, cost savings, and environmental sustainability, the extent to which entrepreneurs are ready to adopt such innovations strongly determines their firms' adoption intention. Therefore, this study proposes the following hypothesis:

H7: Entrepreneur's technology readiness has a positive effect on the intention to adopt solar energy technology (SET).

SMEs' Readiness

SME readiness refers to the extent to which a business is internally prepared, in terms of resources, capabilities, and infrastructure, to adopt and implement new technologies successfully (Shahzad et al., 2023). Within the TOE framework, organisational readiness is a critical determinant, encompassing factors such as firm size, capital, technological infrastructure, and operational capacity that enable or hinder innovation adoption (Sun et al., 2018; Habiba et al., 2019; Nair et al., 2019). Empirical studies have consistently shown that larger firms with stronger financial and technological resources are more capable of adopting innovations such as big data and digital accounting systems, compared to smaller firms that face greater resource limitations (Kava et al., 2024). In the context of SET, organisational readiness is particularly crucial because successful adoption often requires long-term financial commitment, technical expertise, and managerial support to ensure smooth integration into business operations (Qamar et al., 2022). While some studies confirm its significant role, others report inconclusive or insignificant effects, possibly due to differences in firm size and financial strength within sampled SMEs (Hassan et al., 2023; Hsbollah et al., 2023). Nonetheless, organisational readiness remains a pivotal factor that can determine whether the adoption of SET is sustainable and effective. Therefore, the following hypothesis is proposed:

H8: SME readiness has a positive effect on the intention to adopt solar energy technology (SET).

Environmental Factor

Government's Support and Initiative

Government's support and initiative refer to the extent of policies, incentives, and facilitative actions taken by public authorities to encourage the adoption of new technologies, including renewable energy solutions such as SET (Pandak et al., 2024; Raj et al., 2020). Such support can be provided through subsidies, tax incentives, regulatory frameworks, awareness campaigns, infrastructure development, or the removal of adoption barriers (Raj et al., 2020). Previous studies have highlighted that government initiatives significantly drive adoption intention of solar energy; for example, positive effects were reported among households in Indonesia (Bilal &

Andajani, 2023) and residents in Malaysia (Alam et al., 2021). These findings demonstrate that proactive government actions not only increase awareness but also reduce financial and regulatory constraints, thereby motivating adoption. Nonetheless, mixed results have emerged in the literature, with some studies finding that incentives or policies had limited or no significant impact, especially when they were narrowly applied or insufficient to address SMEs' unique challenges (Hassan et al., 2023; Shahzad et al., 2023). Despite these inconsistencies, the prevailing evidence suggests that government involvement plays a vital role in shaping the adoption environment. Therefore, this study proposes the following hypothesis:

H9: Government's support and initiative have a positive effect on the intention to adopt solar energy technology (SET).

The Mediating Role

In the context of SET adoption, perceived usefulness may serve as a mediator between perceived relative advantage and adoption intention. Relative advantage, defined as the degree to which a new technology is perceived as better than existing alternatives (Hsbollah & Kaushik, 2022), directly influences entrepreneurs' recognition of SET's benefits. However, the perception that SET is useful, such as providing cost savings, environmental sustainability, or operational efficiency, may be the mechanism through which relative advantage translates into actual adoption intention. Wang et al. (2011) demonstrated that relative advantage fully mediates the effect of perceived usefulness of existing technology on the intention to use a new technology, and partially mediates the effect of perceived usefulness of the new technology on the intention to use it. This underscores the importance of perceived usefulness in influencing adoption decisions, particularly when users perceive a relative advantage in adopting new technologies. Therefore, it is hypothesized that:

H10: Perceived usefulness mediates the relationship between perceived relative advantage and the intention to adopt solar energy technology (SET).

Perceived ease of use, defined as the extent to which a technology is perceived to be easy to learn, operate, and maintain (Davis, 1989), can function as a mediator between entrepreneur's technology readiness and adoption intention of SET. Entrepreneurs who are ready and willing to embrace new technologies may still hesitate to adopt SET if they perceive it as complicated or difficult to implement. Perceived ease of use has been shown to mediate the relationship between technology readiness and the intention to adopt new technologies. Mahgfiroh et al. (2025) found that perceived ease of use mediates the effect of technology readiness on the decision to use technology. This suggests that an individual's readiness to embrace new technologies can influence their perception of ease of use, which in turn affects adoption intentions. Thus, it is hypothesized that:

H11: Perceived ease of use mediates the relationship between entrepreneur's technology readiness and the intention to adopt solar energy technology (SET).

Conceptual Framework

This study's conceptual framework, illustrated in Figure 1, integrates the Technological-Organisational-Environmental (TOE) framework, the Diffusion of Innovation (DOI) theory, and the Technology Acceptance Model (TAM) to examine SMEs' intention to adopt solar energy technology (SET). Adoption intention is influenced by technical and economic factors (perceived usefulness, perceived ease of use, perceived level of competition pressure, and perceived price), dispositional and organizational factors (perceived relative advantage, entrepreneur's awareness, entrepreneur's technology readiness, and SMEs' readiness), and the environmental factor of government support and initiative. The framework also considers mediating effects, with perceived usefulness mediating the relationship between perceived relative advantage and adoption intention, and perceived ease of use mediating the relationship between entrepreneur's technology readiness and adoption intention. This integrated framework provides a comprehensive understanding of the internal, technological, and external determinants shaping SMEs' intention to adopt SET.

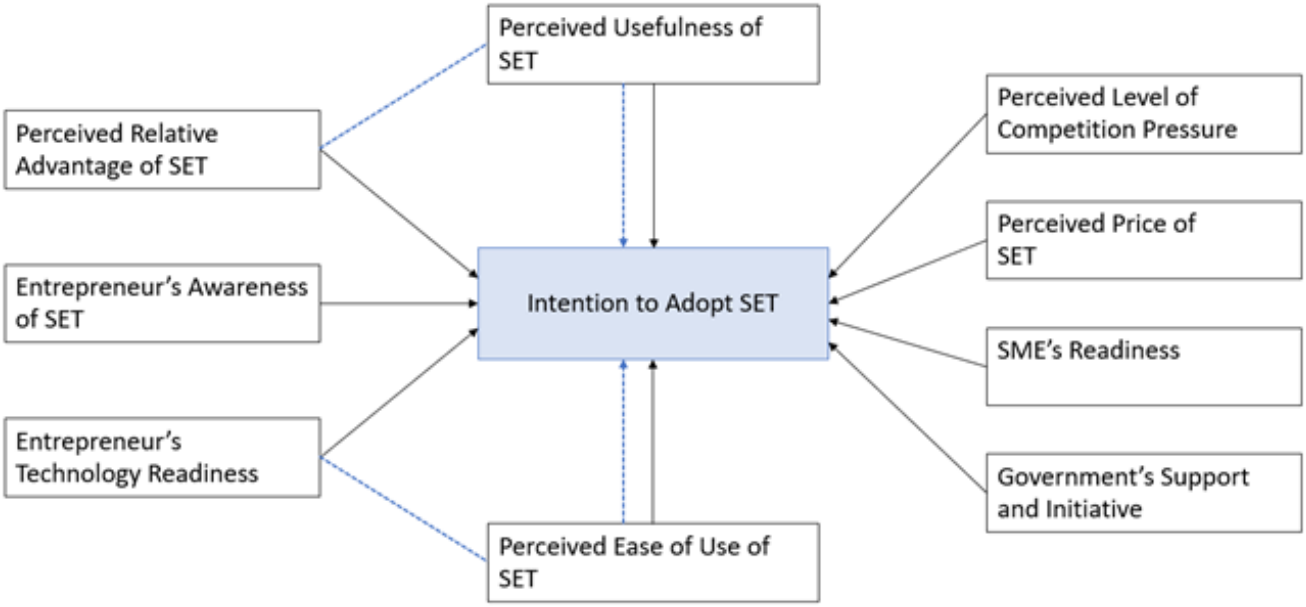

Figure 1. Conceptual Framework

METHODOLOGY

Procedures and Participants

This study adopts a conceptual research design to propose and justify the factors influencing SMEs' intention to adopt solar energy technology (SET). The design provides a structured framework to systematically examine technical and economic factors, dispositional and organizational factors, environmental factor, and their potential interactions in shaping adoption intention. The population of interest is small and medium enterprises (SMEs) in Malaysia, excluding micro enterprises, due to resource limitations that may hinder SET adoption. Entrepreneurs are selected as the unit of analysis, as they are directly involved in decision-making and possess deep insights into organizational operations, resources, and strategic priorities. Data for this conceptual study are proposed to be collected through a structured questionnaire covering key factors influencing SET adoption, including perceived relative advantage, entrepreneur's awareness, entrepreneur's technology readiness, SME's readiness, government support and initiative, perceived level of competition pressure, perceived price, perceived usefulness, and perceived ease of use. A multi-stage sampling approach is recommended, targeting approximately 700 entrepreneurs across selected states and federal territories in Malaysia, with an anticipated response rate of 40%, yielding around 280 usable responses. This strategy is expected to provide a robust dataset for empirical testing in future research, enabling validation of the proposed research framework and hypotheses.

Measure and Measurement

A structured questionnaire serves as the research instrument for this conceptual study, adapted from prior literature on technology adoption and solar/photovoltaic energy adoption. The questionnaire is organized into three sections: Section A collects demographic information of the entrepreneur, including gender, age, position, and years of experience; Section B gathers SME characteristics, such as industry type, enterprise size, and year of establishment; Section C addresses the study constructs. The instrument comprises ten variables: perceived usefulness (6 items; Teng et al., 2009), perceived ease of use (5 items; Qamar et al., 2022; Alam et al., 2021), perceived level of competition pressure (4 items; Qamar et al., 2022), perceived price (3 items; Qamar et al., 2022), perceived relative advantage (6 items; Alam et al., 2021; Qamar et al., 2022; Hassan et al., 2023), entrepreneur's awareness (4 items; Alam et al., 2021), entrepreneur's technology readiness (5 items; Hassan et al., 2023), SME readiness (6 items; Hassan et al., 2023; Qamar et al., 2022), government support and initiatives (3 items; Alam et al., 2021), and intention to adopt SET (7 items; Alam et al., 2021; Qamar et al., 2022; Hsbollah et al., 2023). All items are measured using a five-point Likert scale ranging from

'Strongly Disagree' (1) to 'Strongly Agree' (5), facilitating interval-level analysis of respondents' perceptions and attitudes. The questionnaire is conceptually designed to ensure content validity, reliability, and practical relevance, offering a solid foundation for future empirical investigations into factors influencing SMEs' adoption of solar energy technology.

Data Analysis

For this conceptual study, the proposed data analysis plan involves the use of SPSS and SmartPLS software to evaluate the relationships among the constructs in the research framework. Descriptive statistics will be applied to examine demographic profiles of entrepreneurs and SMEs. Reliability of the measurement scales will be assessed using Cronbach's Alpha to ensure internal consistency, with higher values closer to 1 indicating greater reliability (Hair et al., 2014; Sekaran, 2003). SPSS will also be used for outlier detection and verification of regression assumptions. SmartPLS will be employed to assess the measurement model, including factor loadings of all indicators, composite reliability, average variance extracted (AVE), and discriminant validity using the Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratios. The structural model will be analyzed using PLS-SEM within SmartPLS to test the hypothesized relationships. Additionally, mediation effects will be evaluated through the bootstrapping approach in SmartPLS to determine whether constructs such as perceived usefulness and perceived ease of use significantly mediate the proposed relationships between selected independent variables and SMEs' intention to adopt SET. This approach also allows for a visual representation of the research framework as a path model, illustrating latent variables, indicators, and hypothesized paths, thereby providing a comprehensive strategy for analyzing the conceptual relationships proposed in this study.

CONCLUSION

This study aims to investigate the factors influencing small and medium-sized enterprises' (SMEs) intention to adopt Solar Energy Technology (SET) in Malaysia, focusing on technical, economic, dispositional, organizational, and environmental dimensions. By integrating constructs such as perceived usefulness, perceived ease of use, perceived level of competition pressure, perceived price, perceived relative advantage, entrepreneur's awareness, entrepreneur's technology readiness, SME's readiness, and government's support and initiative, the study provides a comprehensive conceptual framework for understanding SET adoption. The research highlights the critical mediating roles of perceived usefulness and perceived ease of use, offering deeper insights into how entrepreneurs' perceptions and readiness translate into adoption intentions. The significance of this study lies in its potential to guide policymakers, renewable energy providers, and SME owners in designing strategies and interventions that facilitate the uptake of solar energy technologies. Policymakers can use the findings to develop targeted incentives and supportive policies, while SME entrepreneurs can better understand the key factors that drive successful adoption. Moreover, renewable energy providers can tailor their products, services, and educational campaigns to meet SMEs' needs effectively. Overall, this study contributes to the advancement of sustainable energy adoption among SMEs, promoting environmental sustainability, operational efficiency, and long-term competitiveness in the Malaysian business landscape.

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