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BARRIERS TO RENEWABLE ENERGY ADOPTION IN TOURISM MSMEs AT PANTAI PANJANG, BENGKULU, INDONESIA

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ABSTRACT

This study aims to identify barriers to Renewable Energy (RE) adoption among tourism MSMEs in Pantai Panjang, Bengkulu, where RE utilisation remains low despite its significant potential. Using a qualitative case study design, in-depth interviews were conducted with five MSMEs, including those in the culinary, local fashion, fruit, handicrafts, and souvenirs sectors. The study found that the failure to adopt RE is driven by five key barriers: Economic barriers such as high initial installation costs; social and cultural factors, reflecting pragmatic attitudes; low RE literacy; inadequate infrastructure; and distrust in policies and regulations, all of which create socio-technical lock-in. The study also reveals that the low adoption rate is not due to a rejection of the technology, but rather a rational response from MSMEs facing a conflict between short-term economic needs and the capital-intensive nature of RE investments. This is further reinforced by the absence of a credible, accessible supporting ecosystem.

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Introduction

The global environmental and energy crisis is driving a significant shift toward Renewable Energy (RE) to reduce dependence on fossil fuels and mitigate carbon emissions, with fossil fuel use accounting for over 70% of global greenhouse gas emissions. The tourism industry contributes about 8% of global emissions due to its high energy consumption, presenting a major environmental challenge (Obuseh *et al*., 2025). Encouraging RE adoption, particularly by Micro, Small, and Medium Enterprises (MSMEs) is crucial for mitigating carbon impacts, enhancing energy stability, and fostering local economic growth (Hechmi, 2025). Additionally, RE adoption in tourism can

improve destination competitiveness by promoting environmental sustainability (Olabi *et al*., 2023). In Indonesia, despite an abundant RE potential of 443 GW, only 10% is utilised (Apramadha & Prasetyo, 2025). Barriers such as unclear policies, financial constraints, technical knowledge gaps, and social resistance hinder RE adoption, further exacerbated by reliance on government-provided, fossil fuel-based energy (Halimatussadiah *et al*., 2024; Apramadha & Prasetyo, 2025~~;~~).

Bengkulu Province, specifically Pantai Panjang~~,~~ has abundant RE potential, including an estimated 7.5 GW of solar capacity, along with significant wind and biomass resources. However, only about 259 MW of solar energy is currently utilised, revealing a significant gap between available resources and their actual use (Antara, 2020). As a prominent tourism destination, Pantai Panjang has the opportunity to lead the transition to RE, but adoption remains low. This underutilisation presents environmental challenges and a missed opportunity for sustainable development that could support local economic growth and ensure the long-term sustainability of the tourism sector (BPS, 2020).

Pantai Panjang offers an ideal case study for understanding the barriers to RE adoption in tourism MSMEs, as it is a region with high RE potential but low adoption rates. Despite abundant natural resources, tourism MSMEs in Pantai Panjang face significant barriers in transitioning from conventional to more sustainable energy sources. These barriers include economic constraints, lack of technical knowledge, insufficient infrastructure, and limited policy incentives to promote green technologies. These challenges prevent MSMEs from fully utilising RE opportunities, affecting their operational efficiency and ability to contribute to environmental sustainability. Therefore, this study aims to identify and analyse the key barriers hindering RE adoption by tourism MSMEs in Pantai Panjang, providing a deeper understanding of the gap between available RE potential and its underutilisation (Antara, 2020; BPS, 2020).

Recent studies on RE adoption in tourism MSMEs have identified multidimensional barriers, including technical, economic, social, and policy challenges~~,~~ while emphasising the role of innovation and new business models in overcoming these obstacles (Oyekale *et al*., 2020; Qin *et al*., 2022). In Indonesia, barriers such as policy uncertainty, technical difficulties, and social resistance persist, hindering RE adoption. In tourism MSMEs, adoption is further complicated by dependence on government incentives, cross-sector partnerships, and inconsistent policies. However, there is a significant research gap regarding tourism MSMEs in regions with high RE potential but low utilisation rates. Most studies focus on macro-level RE implementation, leaving local dynamics, perceptions, and challenges largely unexplored. This research aims to fill that gap by examining the specific barriers faced by tourism MSMEs in Pantai Panjang. By focusing on the local level, this study contributes to the literature by highlighting socio-cultural and structural factors that hinder RE adoption and offering targeted policy recommendations (Setiawan *et al*., 2023; Halimatussadiah *et al*., 2024).

This study employs Barrier Adoption Theory to critically analyse the various barriers faced by tourism MSMEs in Pantai Panjang in adopting RE. As an

extension of Diffusion of Innovation (DOI) Theory, the framework identifies both internal and external impediments such as financial constraints, lack of technical knowledge, insufficient infrastructure, and inadequate policy support (Halimatussadiah *et al*., 2024; Lalita *et al*., 2025). By utilising this theory, the study explores how these barriers collectively obstruct the transition from conventional energy sources to more sustainable RE solutions. Additionally, the research contributes to the discourse on RE adoption in Indonesia's tourism sector by offering empirical insights into the socio-cultural and structural challenges MSMEs face in embracing RE technologies (Apramadha & Prasetyo, 2025). Through this, the study contributes conceptually and empirically to the literature on RE adoption in the Indonesian tourism MSME context, while offering practical strategies for fostering RE adoption at the local level (Sambodo *et al*., 2022).

Literature Review

RE Adoption in Tourism MSMEs

The adoption of RE within Micro, Small and Medium Enterprises (MSMEs), particularly in the tourism sector, is critical to mitigating environmental degradation and fostering long-term sustainability. The tourism industry accounts for an estimated 8% of global emissions, largely due to its high energy consumption (Oyekale *et al*., 2020; Lalita *et al*., 2025). As such, transitioning to RE is paramount for reducing carbon emissions, improving energy efficiency and securing a sustainable energy future for the sector. In the context of MSMEs in tourism, RE adoption presents a unique opportunity to not only reduce operational costs but also enhance energy security and improve competitiveness by aligning business practices with global sustainability goals (Obuseh *et al*., 2025).

Despite Indonesia's considerable RE potential, especially in solar, wind, and biomass, its actual utilisation remains limited. Although the country has an estimated 443 GW of renewable energy potential, only approximately 10% of this capacity is currently being utilised (Apramadha & Prasetyo, 2025). The gap between available RE resources and their underutilisation highlights a key research gap, especially in regions like Pantai Panjang, where abundant resources exist but adoption is low. Understanding the barriers faced by tourism MSMEs in these areas is crucial for facilitating the transition to sustainable energy solutions.

Addressing this gap is crucial for sustainable energy transitions in the tourism industry. While existing literature predominantly focuses on manufacturing or mixed-sector MSMEs, it overlooks the sector-specific barriers faced by tourism MSMEs in high-potential regions like Pantai Panjang. Despite the abundant natural resources such as solar and wind, these regions face systemic challenges to RE adoption. Previous studies have shown that MSMEs in tourism sectors face unique constraints such as seasonal revenue patterns, the capital-intensive nature of RE adoption, and the need for cost-effective solutions to energy challenges (Olabi *et al*., 2023; Indriastuty *et al*., 2024; Ernawati *et al*., 2025). Understanding the specific barriers to RE adoption in these tourism MSMEs is essential, as it would not only contribute to advancing the academic literature but also guide practical

interventions to promote sustainable development within the sector.

Barriers to RE Adoption in Tourism MSMEs

Research has consistently identified various barriers to the adoption of RE in MSMEs, especially within the tourism sector, where the adoption of RE technologies remains limited despite clear environmental and economic benefits. These barriers can be categorised into economic-, technical-, social-, and policy-related challenges. Economic barriers, particularly high initial investment costs and limited access to finance, are the most frequently cited obstacles to RE adoption in MSMEs (Wang *et al*., 2021; Hechmi, 2025; Obuseh *et al*., 2025). Many tourism MSMEs, especially in resource-constrained regions like Pantai Panjang, face significant financial hurdles that prevent them from transitioning to RE, despite the long-term savings and operational efficiencies that RE can offer. These barriers are exacerbated by a lack of financing tailored to the needs of MSMEs, as well as the high perceived risks associated with long payback periods and financial uncertainties (Halim *et al*., 2024).

The lack of trained personnel in RE technologies, along with inadequate infrastructure for implementing and integrating RE systems, creates additional challenges, preventing MSMEs from transitioning to RE solutions (Mohite *et al*., 2025). Moreover, social and cultural factors contribute to resistance against adopting RE. Many tourism MSMEs in areas like Pantai Panjang are hesitant to move away from traditional energy sources due to mistrust of new technologies or because of strong cultural practices that favour conventional energy systems. This resistance is worsened by policy uncertainty and inconsistent government incentives, which further hinder adoption. In many developing regions, the absence of clear regulatory frameworks creates an uncertain environment that discourages investment in RE. Without strong policy support, MSMEs are unlikely to prioritise RE despite its potential long-term cost savings and environmental advantages (Tseng *et al*., 2021; Sambodo *et al*., 2022). These economic, technical, social, and policy barriers interact in complex ways, hindering the widespread adoption of RE technologies in tourism MSMEs, especially in regions with abundant resources but low adoption rates.

Theoretical Framework

To analyse the challenges faced by tourism MSMEs in adopting RE, this study integrates Diffusion of Innovation (DOI) Theory and Barrier Adoption Theory. DOI Theory provides a comprehensive framework for understanding the process by which innovations are adopted through five key stages: Knowledge, persuasion, decision, implementation, and confirmation (Rogers, 1964). Each of these stages is influenced by specific barriers, such as economic constraints, which affect the persuasion and decision-making stages; the lack of technical knowledge, which impacts the knowledge and persuasion stages; and social resistance, which can affect all stages of the adoption process. For example, at the persuasion stage, economic constraints such as high initial costs and perceived financial risks can deter MSMEs from developing positive attitudes toward RE technologies. Similarly, at the decision and implementation stages, MSMEs often face competing financial priorities and lack the

necessary infrastructure to adopt RE effectively, leading to further delays in adoption (Franceschinis *et al*., 2017).

While DOI Theory provides a general framework for understanding how innovations are adopted, it does not specifically address the barriers that slow down adoption. Barrier Adoption Theory complements DOI by providing a more focused analysis of the internal and external obstacles that hinder adoption (Apramadha & Prasetyo, 2025). These barriers include financial limitations, lack of technical knowledge, and insufficient infrastructure, all of which directly influence the adoption process in MSMEs. By categorising these barriers into economic, technical, institutional, and social dimensions, Barrier Adoption Theory adds depth to DOI by explaining why favourable perceptions of RE technologies at the micro-level do not always result in actual adoption. The integration of both theories allows for a more nuanced understanding of the adoption process, particularly in tourism MSMEs in high-potential regions with low adoption rates (Franceschinis *et al*., 2017; Situmeang *et al*., 2022).

Research Methodology

This study employed a qualitative case study design to explore the barriers to Renewable Energy (RE) adoption among tourism Micro, Small and Medium Enterprises (MSMEs) in Pantai Panjang, Bengkulu, Indonesia. A case study approach was considered appropriate because it enabled an in-depth investigation of a contemporary phenomenon within its real-life context, particularly when the phenomenon is closely shaped by local economic, social, technical, and institutional conditions (Yin, 2018). In this study, RE adoption was examined not only as a technological decision, but also as a socio-economic and institutional process influenced by MSMEs' financial capacity, operational risks, energy needs, knowledge limitations, infrastructure readiness, and perceptions of policy support. Pantai Panjang was selected as the research site because it represents a tourism destination with considerable RE potential but limited adoption among local MSMEs. This makes the area a relevant case for examining how the gap between RE potential and actual use is reproduced at the level of small tourism enterprises.

Informants were selected using purposive sampling because the study required participants who were directly involved in MSME operations and were able to provide practical insights into energy use, investment priorities, business risks, and perceptions of RE technologies. Five informants were involved in the study, consisting of owners and employees from culinary, local fashion, fruit, handicraft, and souvenir MSMEs. The relatively small number of informants was justified by the exploratory and context-specific nature of the study, which aimed to obtain in-depth insights from information-rich cases rather than statistical representativeness. This is consistent with the principle of information power, which suggests that smaller samples may be sufficient when the study aim is specific, the participants are highly relevant to the research question, and the data provide rich analytical information (Malterud *et al*., 2016).

The selection also followed a maximum variation logic by including MSMEs with different levels of energy dependence and operational characteristics. Culinary and fruit MSMEs were included because their operations require stable

electricity for daily service continuity. Local fashion, handicraft and souvenir MSMEs were included to capture the perspectives of businesses with relatively lower energy intensity but similar exposure to high investment costs, limited technical knowledge, infrastructure gaps, bureaucratic complexity, and uncertainty regarding government support. Thus, sectoral diversity was not treated as a limitation, but as an analytical strategy to capture how similar adoption barriers operate across MSMEs with different energy needs and business characteristics.

Data were collected through semi-structured, in-depth interviews conducted in March and April 2025. Each interview lasted 45 minutes to 60 minutes, and was conducted in person to allow deeper interaction with the informants and to capture the local context of their business operations. The interview guide was developed based on the integration of Diffusion of Innovation (DOI) Theory and Barrier Adoption Theory. DOI Theory was used to understand how MSMEs perceive innovation through stages such as knowledge, persuasion, decision, implementation, and confirmation, while Barrier Adoption Theory helped identify internal and external obstacles that prevent adoption from taking place despite the potential benefits of RE technologies (Rogers, 1964; Situmeang *et al*., 2022; Apramadha & Prasetyo, 2025).

The interviews explored informants' awareness of RE technologies, perceptions of installation and maintenance costs, expected benefits, technical reliability concerns, access to local technicians and suppliers, infrastructure readiness, financing constraints, exposure to government programmes, and trust in policy or external assistance mechanisms. All interviews were audio-recorded with participants' consent, transcribed verbatim, anonymised, and securely stored for analysis.

Data were analysed using thematic analysis, which is suitable for identifying, organising, and interpreting patterns of meaning across qualitative data (Braun & Clarke, 2006). The coding process was primarily deductive, guided by the theoretical framework, and the literature on RE adoption barriers, while still allowing context-specific sub-themes to emerge from the interview data. Initial codes were organised around economic barriers, social-cultural barriers, knowledge and skills barriers, infrastructure barriers, and policy and regulatory barriers. During the analysis, these codes were refined into more specific sub-themes, including high initial investment costs, uncertainty over maintenance expenses, low RE literacy, concerns about technical reliability, lack of trusted local technicians, limited access to RE suppliers, bureaucratic complexity, and distrust of government aid distribution.

Data saturation was assessed through an iterative process of transcription, coding, and theme comparison. Saturation was considered to have been reached when later interviews no longer produced substantially new categories of barriers, but instead confirmed and deepened the themes identified in earlier interviews (Guest *et al*., 2006). To enhance trustworthiness, member checking was conducted by confirming preliminary interpretations with informants, while peer debriefing was used to reduce researcher bias and strengthen the consistency of theme development. Ethical considerations were maintained through informed consent, voluntary participation, confidentiality protection, anonymisation

of informants, and secure storage of interview data.

Results

Destination and Informants Profile

Pantai Panjang is the main coastal attraction and the central hub for tourism in Bengkulu Province, Indonesia. With a 7-kilometre coastline facing the Indian Ocean, the beach is strategically positioned across major city sub-districts, leading to its classification as a Regional Tourism Strategic Area (KSPD) (BPS Kota Bengkulu, 2025). The area is also a vital centre for the local creative economy, hosting a large, and varied number of MSMEs. These MSMEs, which include cafes, restaurants, local fashion shops, souvenirs, and others, form an active tourism ecosystem, ~~and~~ require a substantial, and constant supply of energy to operate. Notably, Bengkulu Province has significant RE resources, with a solar energy potential estimated at over 7.5 GW due to high average daily sunlight of about 4.8 kWh/m² (IESR, 2025).

Table 1: Informants details

No.	Informant Position	Types of Informants	Business's Age	Number of Employees	Interview Schedule
1	Owner	Culinary MSME	11 years	9 persons	March 2025
2	Employee	Local fashion MSME	4 years	3 persons	March 2025
3	Owner	Fruit MSME	8 years	3 persons	March 2025
4	Owner	Handicrafts MSME	7 years	2 persons	April 2025
5	Employee	Souvenirs MSME	6 years	5 persons	April 2025

The study's five informants were chosen to reflect the diversity of MSMEs at Pantai Panjang Bengkulu (Table 1). The group included owners and employees from different sectors with varied levels of energy consumption. This selection provided both strategic and operational viewpoints. The businesses also ranged in maturity (4 years to 11 years) and size (2 employees to 9 employees). This combination enabled an analysis that compared the perspectives of new and financially vulnerable businesses with those of more established businesses that are more resistant to change and innovation.

Economic Barriers

Economic barriers are the predominant challenge faced by tourism MSMEs in Pantai Panjang when considering the adoption of RE. The most significant obstacle identified by informants is the high initial investment required for RE technologies, which is perceived as prohibitively expensive for small businesses (Figure 1). Many MSMEs view the cost as comparable to the capital needed to start a new business unit, making it an unrealistic investment given their limited financial resources. As one Culinary MSME informant noted, *"We would like to use solar panels, but the initial investment*

is too high and we cannot afford it". This reflects the broader concern that the scale of investment required is misaligned with the operational needs and financial capacity of MSMEs, rendering such investments unsustainable.

In addition, MSMEs in Pantai Panjang prioritise short-term operational expenses over long-term investments, with available capital being directed toward maintaining daily business operations. A Local Fashion MSME informant explained, *"Our priority is to maintain daily operations. The existing capital is already stretched thin to keep the business running from month to month. We can't afford to spend money on long-term investments like RE that have uncertain returns".* This highlights the conflict between immediate financial survival and long-term sustainability, where investments in RE are viewed as too risky and unnecessary, given the pressure of day-to-day financial needs. Moreover, the potential for future maintenance costs associated with RE systems adds another layer of concern. A Fruit MSME informant remarked, *"The thought of having to pay for repairs or maintenance of these systems is very worrying. We don't have enough capital to cover these costs, and we're not sure who would be responsible if something breaks".* This apprehension about unforeseen costs significantly discourages MSMEs from investing in RE technologies.

Furthermore, MSMEs expressed reluctance to engage with external financing options due to the complexity of loan application processes. A Handicrafts MSME informant stated, *"Applying for loans is a hassle. It's too complicated and it feels like those schemes are only for larger companies. We don't have the time or resources to go through the process".* This reluctance further reinforces the financial exclusion experienced by MSMEs, limiting their ability to pursue RE investments. While the long-term cost-saving benefits of RE adoption were acknowledged, these benefits were often viewed as insufficient to justify the substantial initial costs. For MSMEs with low energy consumption, the potential savings were perceived as marginal and not commensurate with the financial risks. As a Souvenirs MSME informant explained, *"The potential savings are not enough to justify the high initial cost. It's too much of a financial risk for our business".* This reflects a prevalent cost-benefit analysis among MSMEs, where the long payback period for RE investments deters them from making the necessary financial commitment.

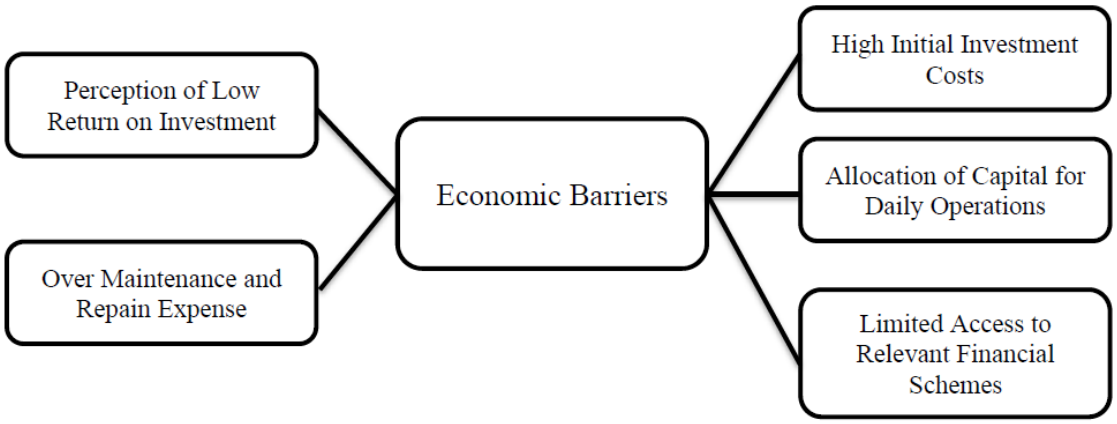


Figure 1: Economic barriers

Social and Cultural Barriers

Social and cultural factors present a significant challenge to RE adoption among tourism MSMEs in Pantai Panjang (Figure 2). These factors are largely shaped by the pragmatic approach of MSMEs, which prioritise daily operational needs over long-term sustainability. Informants indicated that adopting new technologies must directly impact business continuity. As one Culinary MSME informant stated, *"Our business depends on product quality, price, and service. Sustainability, although important, doesn't impact our core operations"*. For sectors like handicrafts with minimal energy needs, adopting RE is often seen as unnecessary. This focus on short-term survival leads to a reluctance to invest in RE, which is viewed as a diversion from more immediate business priorities.

Furthermore, many MSMEs believe their existing systems are sufficient and question the tangible benefits of RE adoption. Despite understanding the environmental benefits, they struggle to see how it could lead to increased profits or customer loyalty. As one Handicrafts MSME informant noted, *"We are aware that consumers might appreciate sustainability, but it doesn't seem to lead to more customers or higher profits"*. The short-term focus on operational continuity excludes consideration of long-term investments like RE, with the perceived costs, risks, and complexities outweighing the potential benefits. As a Fruit MSME informant emphasised, *"The financial benefits of RE just don't seem worth the investment, and we can't afford to gamble on it right now"*. This lack of long-term vision reinforces the practical barriers to RE adoption in the sector.

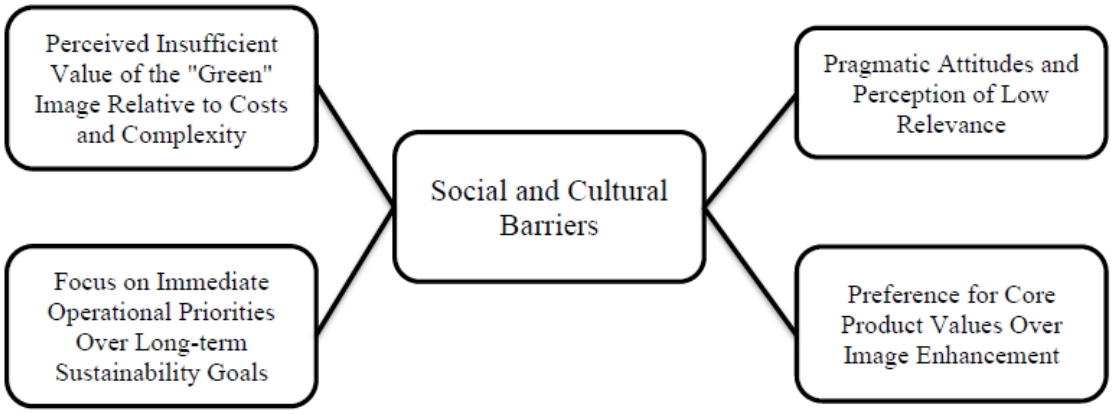


Figure 2: Social and cultural barriers

Knowledge and Skills Barriers

Knowledge and skills gaps create a psychological obstacle that reinforces economic barriers for MSMEs in Pantai Panjang when considering RE adoption (Figure 3). Many MSMEs report low levels of RE literacy, particularly in the culinary and craft sectors, where informants described their knowledge of RE as virtually non-existent. A Culinary MSME informant stated, *"We don't even know where to start with solar panels, it's like a foreign language to us"*. This lack of understanding leads to reluctance to engage with RE technologies, as further exploration is perceived to result only in frustration, given the financial limitations preventing adoption. Technical risks associated with unfamiliar technologies, such as the potential for equipment failure and the resulting financial insecurity, also contribute to this reluctance. As a Handicrafts MSME informant shared, *"We think RE could cause accidents, like short circuits or worse, and we don't have the money to fix that if something goes wrong"*. These concerns reflect a high perceived risk, both in terms of physical and financial security, which exacerbates the hesitation to adopt RE technologies.

In addition, MSMEs expressed scepticism about the effectiveness of capacity-building programmes like training, particularly if the primary financial barriers to RE adoption are not addressed first. While some informants acknowledged the potential value of increasing RE knowledge, they emphasised that such programmes would be futile without addressing the financial constraints preventing adoption. A Local Fashion MSME informant explained, *"Training is nice, but if we don't have the money to implement it, it's just a waste of time"*. MSMEs tend to focus their cognitive resources on core business activities, such as product development and operational needs, rather than on adopting complex technologies like RE. This pragmatic focus leads to the view that RE adoption introduces unnecessary complexity, further widening the gap between knowledge and action, as MSMEs prioritise immediate survival over long-term sustainable technology investments.

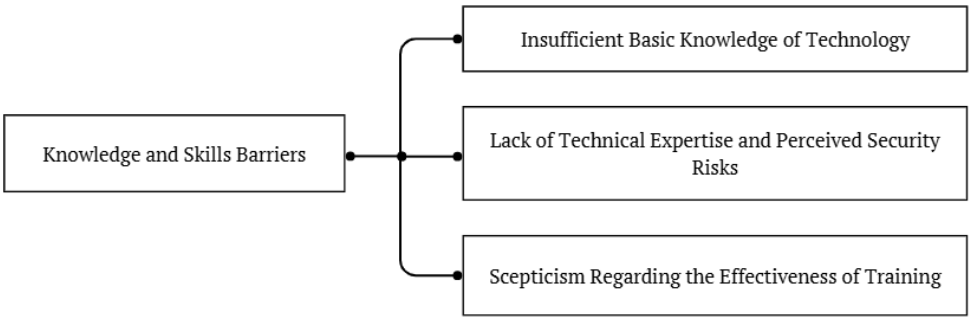


Figure 3: Knowledge and skills barriers

Infrastructure Barriers

Infrastructure barriers refer to the lack of a functional supporting ecosystem at the local level, including product accessibility, availability of skilled labour, and assurance of essential technological reliability (Figure 4). There is a strong perception among MSMEs that RE technology is limited or even non-existent in their local markets. MSMEs reported difficulties in finding suppliers or specialised retail stores near their business areas, leading to the assumption that procurement must be handled from outside the city, a scenario that inherently increases total costs and logistical complexity. The lack of competent and trusted human resources for installation and maintenance is a crucial barrier. This raises concerns among MSMEs about the potential for unavailability of technicians and experts in the event of future maintenance or breakdowns. MSMEs anticipate significant difficulties in finding professional installers, who can guarantee proper and safe installation, an essential prerequisite for making an investment commitment.

Furthermore, for MSMEs whose operations are highly dependent on a continuous and stable electricity supply such as the culinary and fruit sectors, technological reliability is a non-negotiable determining factor. There is an absolute demand that RE systems must be able to provide a higher level of stability than conventional electricity grids, especially in non-ideal conditions such as nighttime or during cloudy weather. The risk of system failure that can cause significant product losses such as damage to frozen food raw materials makes them prefer to remain with existing energy systems rather than switching to RE. MSMEs also explicitly desire technological solutions that are "ready to use" and do not cause post-installation operational complications. The lack of product guarantees and clear after-sales service for available technologies in the market is a factor that increases the perception of investment risk. Uncertainty regarding technical support and spare parts availability is one of the main inhibiting factors in the adoption decision-making process.

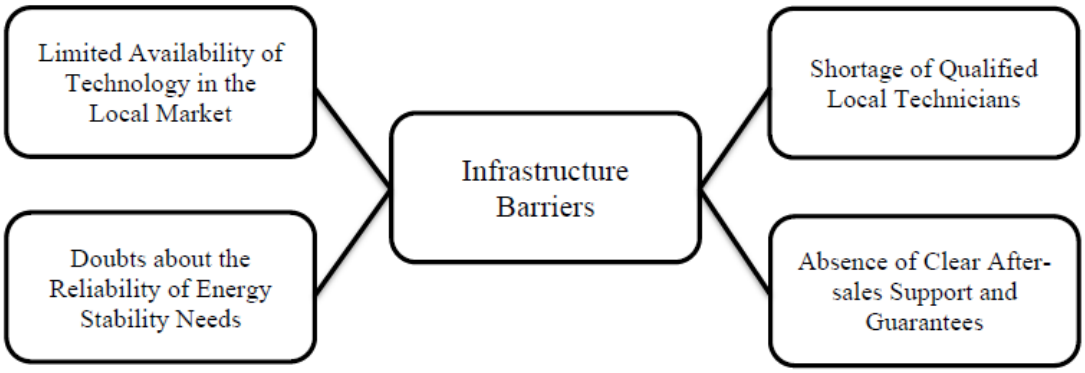


Figure 4: Infrastructure barriers

Policy and Regulatory Barriers

This dimension of barriers highlights a significant disconnect between government policy intentions at the macro level and implementation and perceptions at the grassroots level, characterised by information deficits, negative perceptions of bureaucracy, and mistrust (Figure 5). An extreme information gap exists with MSMEs consistently feeling excluded from government outreach or support programmes. Existing policies are perceived as existing only at the discourse level or "at the top level" and are never effectively disseminated to small-scale business owners in their localities. As a Handicrafts MSME informant shared, *"We hear about government policies, but we never see how they affect us. It's like they only talk about it at the top level, and we're left out of the loop"*.

Consequently, the existing policy framework has no influence on MSMEs' business decision-making due to their lack of awareness of the existence of outreach or guidance on RE installation. Bureaucratic processes are also perceived by MSMEs as daunting and demotivating, particularly the often complex licensing or assistance application processes. This perception is reinforced by MSMEs' unfamiliarity with bureaucratic processes, which are seen as complicated and often met with reluctance to follow them. As a Culinary MSME informant stated, *"The bureaucracy is overwhelming. We don't even know where to start with these forms or who to talk to. It just feels like another barrier"*. This sense of being overwhelmed by the bureaucratic process hinders MSMEs from pursuing available government support programmes.

Limited information regarding government incentive schemes, if any, is considered non-transparent and difficult for MSMEs to access. They consistently find complex and lengthy processes such as subsidy programmes or special financing, to be inaccessible and unclear. A Souvenirs MSME informant explained, *"We know there might be some financial help available, but the process is so confusing and complicated that we give up before even trying"*. This lack of clarity in regulations and aid mechanisms creates an environment of uncertainty, with MSMEs being unaware of the procedures or rules, significantly limiting their ability to participate.

Data indicates a deep and entrenched distrust of the mechanisms and targets for government aid distribution. There is a strong belief among MSMEs that these support programmes are not designed inclusively and tend to be allocated selectively to larger businesses. As a Local Fashion MSME informant stated, *"These programmes, if they even exist, seem to be for bigger businesses. We've never been informed properly about them, and it feels like they are just for the 'big guys'"*. This perception is reinforced by MSMEs' belief that these programmes, if they exist, are exclusive 'projects' about which information is never distributed equitably to all MSMEs.

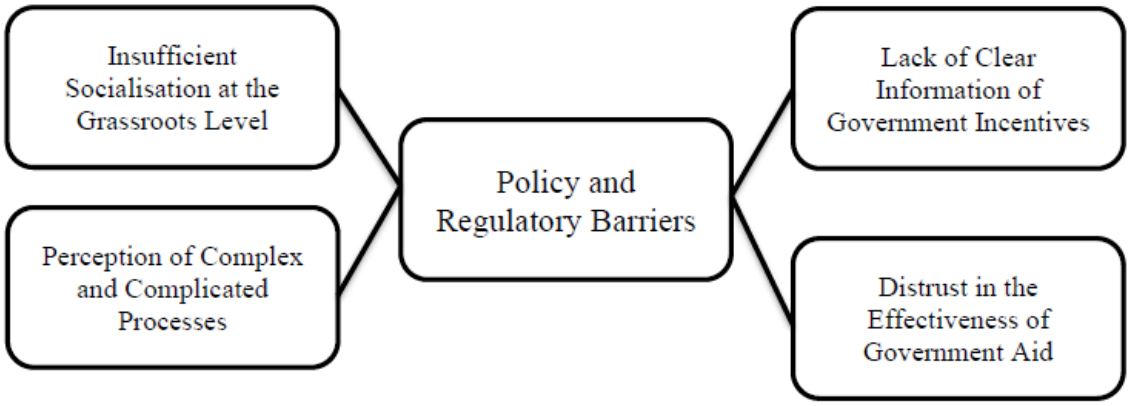


Figure 5: Policy and regulatory barriers

Discussion

The findings show that barriers to RE adoption among tourism MSMEs in Pantai Panjang are interconnected and collectively create a socio-technical lock-in. Economic barriers, especially high initial investment costs and uncertainty over maintenance expenses, weaken MSMEs' willingness to move from awareness to adoption. From the perspective of DOI Theory, these barriers affect the persuasion and decision stages because MSMEs evaluate innovation through immediate business survival, operational risk, and cash-flow stability rather than long-term sustainability benefits (Rogers, 1964). This study therefore extends the application of DOI Theory by showing that low RE adoption is not caused by rejection of RE itself, but by the interaction of financial limitations, low RE literacy, weak infrastructure support, pragmatic business culture, and distrust of policy mechanisms.

Although this study does not conduct a technical feasibility assessment, the findings suggest that RE interventions should be differentiated according to the energy reliability needs of each MSME sector. Culinary and fruit MSMEs require stable electricity; therefore, a stand-alone solar photovoltaic (PV) system may not sufficiently address concerns over nighttime use, cloudy weather, and sudden electricity demand. A hybrid PV-grid-battery system may be more suitable because solar PV can reduce daytime grid dependence, battery storage can provide

short-term backup, and the conventional grid can remain available as a safeguard.

This configuration is consistent with literature on PV-battery and hybrid energy systems, which emphasises the role of storage and hybridisation in improving flexibility, reliability, and system resilience (Zhang *et al*., 2022; Giedraityte *et al*., 2025). Meanwhile, local fashion, handicraft, and souvenir MSMEs may begin with smaller modular options such as rooftop PV, solar lighting, or solar-powered charging systems because their energy intensity is relatively lower. Thus, RE adoption should not follow a one-size-fits-all model, but should be segmented according to energy dependence, business size, risk exposure, and financial capacity.

The technical pathway must also be supported by a local service ecosystem. MSMEs are reluctant to adopt RE not only because of investment costs, but also because they are uncertain about product availability, trusted installers, maintenance responsibility, spare parts, and after-sales services. Without these support structures, RE is perceived as a risky asset rather than a productive investment. Therefore, local RE suppliers, certified technician networks, service guarantees, and accessible maintenance channels are needed to reduce perceived technical risk and increase confidence in adoption. This finding supports previous studies emphasising that infrastructure readiness and institutional support are central to sustainable energy transitions (Sambodo *et al*., 2022; Setiawan *et al*., 2023). In Pantai Panjang, this ecosystem is especially important because MSMEs require not only affordable technology, but also assurance that the system will remain safe, functional, and manageable after installation.

Policy distrust is another critical barrier that requires transparent and locally embedded intervention. MSMEs perceive government assistance as bureaucratic, unclear, and unequally distributed, which reduces their willingness to engage with subsidy or financing schemes. Therefore, RE policy socialisation in Pantai Panjang should be delivered through trusted local intermediaries such as MSME associations, tourism area managers, cooperatives, community leaders, and local business groups. Clear communication, accessible support mechanisms, simplified procedures, transparent eligibility criteria, financing terms, maintenance responsibilities, and complaint channels are essential to reduce distrust and strengthen adoption readiness (Onuh *et al*., 2024; Pereira *et al*., 2025).

A demonstration-based approach, including pilot installations in selected culinary or fruit MSMEs, would allow other business owners to observe system reliability, cost-saving potential, and maintenance requirements before adoption. When combined with leasing, pay-as-you-save schemes, cooperative-based financing, or shared community energy systems, this approach can reduce upfront cost burdens and rebuild trust. Overall, overcoming RE adoption barriers in Pantai Panjang requires an integrated ecosystem approach involving segmented technical solutions, local service capacity, trusted intermediaries, transparent policy mechanisms, demonstration projects, and flexible financing models, consistent with studies emphasising local infrastructure and institutional support in energy transition processes (Sambodo *et al*., 2022; Setiawan *et al*., 2023).

Conclusions

This study concludes that low RE adoption among tourism MSMEs in Pantai Panjang is not driven by rejection of sustainable technology, but by a socio-technical lock-in formed through interconnected economic, knowledge, infrastructure, policy, and socio-cultural barriers. High investment costs, maintenance uncertainty, low RE literacy, weak local technical support, bureaucratic complexity, and distrust of government assistance make RE adoption appear risky and unsuitable for MSMEs prioritising short-term survival and cash-flow stability.

Therefore, adoption strategies should be sector-specific: Culinary and fruit MSMEs require reliability-oriented options such as hybrid PV-grid-battery systems~~,~~ while local fashion, handicraft, and souvenir MSMEs may begin with smaller modular solutions. Policy interventions should be delivered through trusted local intermediaries, supported by pilot installations, simplified procedures, transparent eligibility criteria, clear financing and maintenance responsibilities, complaint mechanisms, local supplier and technician networks, after-sales service guarantees, and flexible financing. Future research should compare tourism destinations and examine the feasibility of sector-specific RE configurations for MSMEs with different energy needs and financial capacities.

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Author Contributions Statement

Rahmat Putra Ahmad Hasibuan carried out the research, wrote, ~~and~~ revised the article, and approved the article submission. Fatmawati Zahroh conceptualised the central research idea and provided the theoretical framework.

Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefit, commercial, or financial conflicts and declare absence of conflicting interests with the funders.

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