SME's Access to Islamic financing for Enhancing Energy Efficiency: a Fuzzy AHP approach

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Abstract

Energy efficiency remains a significant challenge for Small and Medium Enterprises (SMEs) in Indonesia. It contributes to high operational costs and limits their competitiveness. This research explores the key factors influencing SMEs' access to Islamic financing for energy efficiency. The study employs the Fuzzy Analytical Hierarchy Process (AHP) with responses from 10 experts, including industry players, academicians, and regulators. Data were collected through focus group discussions, followed by additional interviews to validate and enrich the analysis. The findings indicate that financial health is the top priority criterion. This is followed by compliance with Islamic finance principles and management capabilities. The results highlight the importance of Islamic financial literacy and management skills in improving SMEs' access to funding. Additionally, developing partnerships with Islamic financial institutions and implementing energyefficient technologies are crucial strategies for enhancing financial sustainability. This research provides valuable insights for policymakers. Structured financial literacy programs and advisory centers should be introduced to help businesses navigate Islamic financing options. Policies should also encourage the development of SME-friendly Islamic financial products to reduce risk perceptions. Furthermore, tax incentives, Green Sukuk, and low-cost refinancing options should be introduced to promote energy-efficient investments. Clear regulatory guidelines and the integration of Sharia-compliant fintech solutions will ensure compliance. Ultimately, these efforts will help reduce energy poverty and enhance the competitiveness of SMEs in Indonesia.

Keywords: Islamic financing, energy efficiency, small and medium enterprises, fuzzy ahp

1. Introduction

The issue of sustainability in Small and Medium Enterprises (SMEs) is increasingly gaining attention, as these businesses play a significant role in driving economic growth, employment, and innovation. Energy efficiency (EE) has become one of the critical focuses, particularly for SMEs in developing countries like Indonesia, where SMEs account for over 60% of the country's GDP and employ nearly 97% of the total workforce. Despite their economic importance, many Indonesian SMEs operate with outdated and energy-inefficient practices, leading to high operational costs and negative environmental impacts. The sector consumes approximately 38% of Indonesia's total energy, with the majority still dependent on fossil fuels (UNDP Indonesia & Bappenas, 2021). This highlights the urgent need for energy transformation within the SME sector to address both economic and environmental challenges.

To understand the impact of energy inefficiency in SMEs, a baseline analysis of energy usage patterns is essential. Sector-specific data, such as energy consumption by manufacturing, retail, and service industries, can provide better insights into where energy-saving measures would be most effective. Studies suggest that energy-intensive industries like textiles, food processing, and metalworking contribute significantly to total SME energy consumption, leading to high operational costs and increased carbon footprints. Studies suggest that energy-intensive industries such as textiles, food processing, and metalworking contribute significantly to total SME energy consumption, leading to high operational costs and increased carbon footprints. According to data from the Ministry of Energy and Mineral Resources (MEMR), SMEs in Indonesia account for approximately 38% of the country's total industrial energy consumption, with an average energy intensity of 1.5–2.3 GJ per million rupiah of output (MEMR, 2022). In manufacturing, SMEs in the textile sector consume an estimated 2,500–3,200 kWh per month, while food processing SMEs report monthly energy consumption ranging from 1,800 to 2,700 kWh, depending on production scale (ADB, 2021). Retail and service-based SMEs tend to have lower absolute consumption but still exhibit inefficiencies, particularly in lighting, air conditioning, and refrigeration systems (IEA, 2020).



Figure 1. Estimation of energy demand for 2050 Source: Pusat Pengkajian Industri Proses dan Energi (2020)

These data highlight the substantial energy demand within the SME sector and the potential for cost savings and sustainability improvements through targeted energy efficiency measures. Based on Figure 1, the demand for energy in industrial sectors, particularly for small and medium enterprises, is expected to rise significantly. This underscores the urgency of implementing energy-efficient technologies to mitigate energy shortages and environmental impacts.

Energy efficiency improvements in SMEs offer significant potential for economic savings, productivity enhancement, and contributions to national climate goals (Wongsapai et al., 2017). These benefits are particularly important in countries like Indonesia, where SMEs are the backbone of the economy. Energy efficiency plays a critical role in reducing energy consumption and greenhouse gas emissions, both vital for addressing global environmental challenges. For SMEs, adopting energy-efficient technologies can lower operational costs and improve competitiveness, making it a win-win for both the business and the environment (Harputlugil & De Wilde, 2020).

However, despite the clear advantages, many SMEs in Indonesia struggle to access formal financing. According to data from the Fiscal Policy Agency of the Indonesian Ministry of Finance, approximately 44 million micro, small, and medium enterprises (MSMEs) in Indonesia still lack access to banking services (Ika, 2023). A significant number of MSMEs face difficulties in obtaining capital from formal financial institutions due to unmet borrowing requirements. This aligns with a survey conducted by PriceWaterhouseCoopers (2018) which found that 74% of MSMEs in Indonesia have not secured financing.

In the context of sustainable projects, a major barrier is the perception of risk by financial institutions, which often view these projects as uncertain or complicated. Additionally, SMEs frequently lack awareness of energy-efficient solutions, face high upfront costs, and may not have the technical expertise required to implement such projects effectively (Jalo et al., 2021). These challenges hinder the ability of SMEs to leverage sustainable energy solutions, despite their potential for long-term cost savings and environmental benefits. The complexity of evaluating suitable financing models for energy efficiency projects also adds to the problem. Without adequate financial support and risk mitigation mechanisms, many SMEs are reluctant or unable to make the

necessary investments in energy efficiency (Palm & Backman, 2020). This creates a gap between the potential for improvement and the reality on the ground, where sustainable practices are often deprioritized due to short-term financial constraints.

Islamic sustainable financing integrates the principles of Shariah with the objectives of sustainability, aiming to promote economic growth while ensuring social equity and environmental protection (Jan et al., 2019; Al-Mulla, Ari, & Koç, 2022; Marzuki, Majid, & Rosman, 2023). The Islamic financing instruments include sukuk, or Islamic bonds, that are issued to finance sustainable projects such as renewable energy initiatives, infrastructure development, and social welfare programs. Sukuk structures must adhere to Shariah principles and can provide fixed income to investors while funding ethical projects. Waqf, a charitable endowment where assets are dedicated to social or religious purposes, can fund community development projects, education, and healthcare initiatives, contributing to sustainable development goals in the form of cash waqf, cash waqf certificates, and cash waqf stocks. Islamic peer-to-peer lending enables individuals with surplus funds to provide financial resources or support to those in need through online platforms, particularly SMEs (Pişkin & Kuş, 2019).

Despite the growing interest in Islamic sustainable finance, there is a limited understanding of how Islamic financial institutions can optimize their financial products to promote energy efficiency in SMEs (Kuanova, Sagiyeva, & Shirazi, 2021). Furthermore, the decision-making process for allocating Islamic financing to energy efficiency projects is complex, involving multiple criteria such as financial risks, environmental benefits, scalability, and compliance with Islamic principles. The current lack of a structured framework for optimizing the allocation of Islamic financing for energy efficiency in SMEs has created a critical research gap (Islam, Wahab, & Tehseen, 2024). Therefore, the main objective of this research is to develop a structured decisionmaking framework using the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to optimize Islamic financing for energy efficiency projects in Indonesian SMEs. The research will focus on identifying and prioritizing the key criteria that influence the allocation of Islamic financing and financial instrument selection that accommodates the uncertainties and complexities inherent in optimizing energy efficiency for SMEs' sustainability.

Numerous studies in the literature have explored Islamic sustainable and responsible investment (Badreldin & Nietert, 2021; Wahab & Naim, 2023; Zou et al., 2023) and Islamic sustainable finance (Billah et al., 2024; Hassan, 2024). However, there remains a limited investigation into the role of Islamic finance in promoting energy efficiency, especially for small and medium-sized enterprises (SMEs).

Islamic financial institutions are increasingly venturing into sustainable finance, adhering to Shariah principles, but their impact on energy efficiency investments is not well-established. Current studies focus on broader areas like renewable energy investments (Morea & Poggi, 2016; Kasri et al., 2024; Ibrahim, Shirazi, & Mohseni-Cheraghlou, 2021) but do not specifically address how Islamic financial mechanisms can be optimized for energy-efficient projects. Another major gap lies in the decision-making process of allocating sustainable finance for energy efficiency (Chen, Calabrese, & Cowling, 2024). SMEs, which often lack the capital to implement energy-efficient technologies, need tailored financial products (Jalo et al., 2021). However, decision-makers face uncertainty regarding the risks, costs, and benefits of financing such projects. Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is a promising tool that can account for these uncertainties and the multi-criteria nature of sustainable finance decisions. Despite its success in other sectors, the application of Fuzzy AHP to optimize Islamic finance for energy efficiency in SMEs remains under-researched.

Islamic financial institutions are increasingly participating in sustainable finance due to their alignment with ethical investment principles and the growing demand for responsible financial practices. However, their involvement in energy efficiency remains underexplored for several reasons. First, Islamic finance traditionally focuses on asset-backed or profit-sharing mechanisms, which may not align well with the financing needs of energy efficiency projects, which often require upfront investments with long-term payback periods. Second, many Islamic financial institutions prioritize large-scale infrastructure and renewable energy projects rather than smaller, decentralized energy efficiency initiatives tailored for SMEs. This is because such large projects offer clearer revenue streams and lower perceived financial risks compared to SME-focused energy efficiency

investments, which can be fragmented and difficult to monitor. Lastly, the lack of standardized Shariah-compliant financial products designed specifically for energy efficiency investments further limits Islamic finance's role in this sector. Without clear guidelines, financial institutions may struggle to assess the compliance, risks, and potential returns of such projects, resulting in a lower prioritization of energy efficiency within their sustainable finance strategies. This research aims to bridge this gap by developing a structured decision-making framework that facilitates the optimal allocation of Islamic financing for energy efficiency projects in SMEs.

2. Literature

2.1 Islamic Financing for Sustainable Development

Islamic finance, with its ethical principles rooted in promoting socio-economic justice and environmental stewardship, has the potential to play a crucial role in financing energy efficiency projects. Islamic financial institutions (IFIs) are guided by principles such as profit-sharing, risk avoidance of uncertainty (*gharar*), and prohibition of interest (*riba*), making them uniquely positioned to promote sustainable and environmentally friendly projects. There has been many literature that discusses the development of islamic financing and sustainable development. It involves the integration of environmental, social, and governance (ESG) criteria into financial decisions to promote long-term economic sustainability. It is driven by the need to address climate change, social inequalities, and environmental degradation, aligning with global objectives such as the United Nations Sustainable Development Goals (Meng, Ye, & Wang, 2024).

2.2 Access to Finance for SMEs

Small and Medium Enterprises (SMEs) play a pivotal role in global economies, contributing to employment, innovation, and economic growth. However, a key challenge they face is access to finance, which is crucial for their growth and sustainability. SMEs typically encounter more obstacles in obtaining financing compared to larger corporations, and this challenge is particularly acute in emerging markets. According to Kaya (2024), SMEs often face credit rationing, as banks perceive them to be high-risk borrowers due to irregular cash flows and insufficient collateral. This, in turn, results in less favorable loan terms, such as higher interest rates and smaller loan amounts, restricting SMEs' ability to secure necessary funding.

In Europe, SMEs account for a large proportion of businesses and employment. Yet, they frequently struggle with late payments, which exacerbate their liquidity problems and further restrict their access to finance. Kaya (2024) study on European SMEs highlights that late payments lead to credit rationing, with banks tightening lending criteria for SMEs facing cash flow challenges. This has significant implications for the financial health of SMEs, as it limits their ability to finance operations and pursue growth opportunities (Kaya, 2024). Similarly, Moreira, (2016 noted that despite their importance, SMEs in high-tech and internet-based industries often face difficulties accessing credit due to perceived risks and information asymmetries. The traditional banking system is not always equipped to assess the creditworthiness of such enterprises, leading to restricted financing options (Moreira, 2016).

Further evidence of the financial barriers faced by SMEs is provided by Jha & Mittal (2024), who examined the financing patterns of Indian SMEs. The study revealed that these businesses rely heavily on short-term debt and trade credit due to their limited access to long-term financing options. Short-term financing, although more accessible, tends to increase financial risk and negatively impacts financial performance. The study also found that total debt financing has a negative relationship with the return on assets (ROA), highlighting the challenges SMEs face in managing their financial structures effectively. The authors emphasize the importance of developing financing strategies that enhance financial performance while mitigating risk, particularly for SMEs operating in volatile markets (Jha & Mittal, 2024).

The importance of access to finance is underscored by the positive correlation between financial development and SME growth. Moreira (2016) argues that easing access to finance through government policies and initiatives can stimulate SME growth, particularly in innovative

sectors such as high-tech industries. Government interventions, such as financial support programs and improved regulatory frameworks, can significantly enhance SMEs' ability to access credit and grow (Moreira, 2016).

2.3 The links between SME and Energy Efficiency

Energy efficiency is crucial for SMEs, given their significant role in both environmental sustainability and economic development. SMEs are responsible for a considerable portion of global energy consumption, and improving energy efficiency has the potential to reduce operational costs and minimize environmental impacts. However, SMEs face unique challenges in adopting energy-efficient practices, including limited resources, lack of awareness, and technical barriers (Ketenci & Wolf, 2024).

Several studies highlight the role of energy efficiency in driving competitiveness for SMEs. As energy prices rise, particularly in industries such as manufacturing, companies are increasingly motivated to implement energy-saving measures. According to Ketenci & Wolf (2024), SMEs in non-energy-intensive sectors often overlook the potential for significant energy savings. Their research emphasizes that SMEs, despite their smaller energy consumption, still stand to gain considerable cost reductions and greenhouse gas (GHG) emission reductions by adopting energy-efficient technologies and practices. For example, the study demonstrated that two SMEs were able to achieve energy savings of 900,000 kWh and 1,300,000 kWh, respectively, highlighting the economic benefits of such measures. These savings were significant, leading to a 16% and 22% reduction in energy costs for the respective SMEs (Ketenci & Wolf, 2024).

Despite the clear benefits, many SMEs struggle with implementing energy efficiency due to barriers such as financial constraints, lack of technical knowledge, and insufficient information on energy management (Meng, Ye, & Wang, 2024). In a study of UK SMEs, Meng, Ye, & Wang (2024) found that energy-efficient companies experience fewer financial constraints when seeking external financing, largely because they are viewed as more creditworthy by lenders. The cost savings from energy-efficient practices improve liquidity and reduce risk, making these SMEs more attractive to financial institutions. Furthermore, the study emphasizes the role of energy-efficient assets, which are often considered better collateral due to their higher value and reduced risk of becoming stranded assets in a decarbonizing economy.

Energy efficiency also plays a critical role in the broader context of business model innovation (BMI) in SMEs. As businesses face increasing pressure to reduce their environmental footprint, energy-efficient practices are often integrated into new business models. This is particularly true in the energy sector, where the transition to sustainable energy sources and technologies is driving fundamental changes in how businesses operate (Malewska et al., 2024). Malewska et al. (2024) explored the relationship between digital transformation and BMI in energy sector SMEs, noting that energy efficiency is increasingly becoming a key factor in the development of innovative business models. The shift towards renewable energy, combined with technological advancements, requires SMEs to rethink their operational processes and adopt more energy-efficient solutions to remain competitive.

3. Methods

The research focuses on identifying and prioritizing the key criteria of SMEs' access to Islamic financing while accommodating uncertainties and complexities to optimize energy efficiency for SMEs' sustainability. To achieve this objective, this study employs the Fuzzy Analytical Hierarchy Process (FAHP) method, an extension of the Analytical Hierarchy Process (AHP) that incorporates fuzzy logic to handle uncertainty and vagueness in judgments. This makes FAHP particularly useful in situations where decision-makers may have imprecise or ambiguous preferences. To enhance the robustness of findings, this study ensures a diverse panel of experts and SMEs' financial institutions are included in the analysis.

3.1. Data

The primary data for this study were collected through focus group discussions and indepth interviews conducted via online platforms like Zoom or face-to-face meetings. The discussions aimed to evaluate factors, criteria, and alternative strategies. The sampling technique employed is purposive sampling, targeting professionals with a minimum of 10 years of expertise in Islamic finance and sustainable development, including representatives from the Indonesian Sharia Fintech Association, National Committee for Islamic Economics and Finance (KNEKS), academia, higher education institutions, creative economy and SME associations, and experts in the Islamic halal industry. Additionally, SME owners and financial institutions involved in lending are included to ensure a comprehensive perspective. A total of 15 respondents participate, reducing individual biases and increasing the representativeness of the findings. Respondents provided insights through pairwise comparisons of criteria for the Fuzzy AHP analysis and qualitative feedback on financing challenges and opportunities.



Figure 1. Enhancing SMEs Access to Islamic Financing for Increasing Energy Efficiency

3.2. Fuzzy Analytical Hierarchy Process (FAHP) Framework

This study employs the Fuzzy AHP method to evaluate the significance of various factors influencing the development of sustainable financing models for SME energy efficiency projects in rural and urban areas. Liu, Eckert, & Earl (2020) explain that Fuzzy AHP is a decision-making approach designed to simplify the evaluation of complex issues, thereby making them more comprehensible. The method consists of four key stages: (i) defining the relative importance of criteria through pairwise comparisons, (ii) combining fuzzy sets to facilitate group decisions and calculate weights or priorities, (iii) converting fuzzy sets into precise values for final comparison (defuzzification), and (iv) assessing the consistency of the judgments. The fuzzy AHP model follows a similar structure to the traditional AHP model, as shown in Figure 2. The white and light grey boxes indicate common steps in both AHP and fuzzy AHP, while the light grey boxes involve distinct fuzzy AHP techniques. The dark grey box highlights a step specific to fuzzy AHP, distinguishing it from the conventional AHP process.



Figure 2. Fuzzy AHP Framework

To ensure methodological rigor, the FAHP framework is validated through iterative expert feedback and cross-referencing with previous empirical studies. The small sample size is justified by the respondents' high level of expertise and specialization in Islamic finance and energy efficiency. To enhance robustness, secondary data sources, such as case studies from other countries, are used for triangulation. Comparative data on SME energy financing in other economies provide a broader contextual understanding.

Next, based on the identified problems, this study applies the FAHP model to optimize SME financing models, distinguishing it from Islamic bank talent management applications. The FAHP method assists Islamic banks and financial institutions in prioritizing and allocating resources for each strategy based on their importance. The analysis determines key factors in financing mechanisms that can enhance SMEs' access to sustainable energy financing. Furthermore, it identifies the dominant financial instruments and policy interventions that could be prioritized to improve SME sustainability.

Relative intensity	Definition	Explanation
1	Of equal value	Both requirements hold the same importance.
3	Slightly more value	Experience gives a slight advantage to one requirement over the other.
5	Essential or strong value	Experience gives a significant advantage to one requirement compared to the other.
7	Very strong value	One requirement is greatly favored, with practical evidence supporting its superiority.
9	Extreme value	The evidence supporting one requirement over another is exceptionally strong.

 Table 1. AHP scale

2, 4, 6, 8	Intermediate values between two adjacent judgments	A compromise is necessary.
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Source: (Saaty, 2001; Tu et al., 2020)

This study acknowledges the limitations of relying on expert opinions and addresses potential biases by including multiple stakeholders from different domains, such as SME owners, financial institutions, fintech, academia, and government agencies. The methodology aims to ensure that financing solutions developed through FAHP are both theoretically sound and practically applicable in the SME sector.

4. Results and Discussions

In this study, we employed the Fuzzy Analytic Hierarchy Process (AHP) to assess the factors influencing SMEs' access to Islamic financing for enhancing energy efficiency. The analysis was based on responses from a diverse group of 10 respondents, as shown in Table 2, each contributing unique insights and perspectives to the evaluation process. These respondents represent a range of backgrounds, including different sectors within the SME landscape and the Islamic finance industry. This diversity enriches the study by ensuring that the prioritization of factors reflects a comprehensive understanding of the challenges and opportunities SMEs face in accessing Islamic financing.

Table 2. Demographics of Respondents

	Rai	nk	Name	Weight		
	1		Financial Health	0.344	Number	of
	0 ວ		Compliance with Islamic Finance	0.284	responder	nts
1		Na	Principles tional Committee for Islamic Economi	cs and Finance	1	
2	. 3	Inc	Management Capabilities Ionesian Sharia Fintech Association	0.213	1	
3	. 4	Ac	Technical Feasibility ademics and Higher Education Institut	ions 0.128	2	
4	5	As En	Market Position and Stability sociation for Creative Economy and terprises	Small and Medium	3	
5	5.	Pro	ofessionals in Islamic Halal Industry		2	
6	.	Isl	amic Banks	1		

Table 3. Priorities with respect to Enhancing SME's Access to Islamic Financing for Increasing

 Energy Efficiency

According to Menne et al. (2022), the results show that Financial Health emerges as the top priority with a weight of 0.344, indicating that SMEs with strong financial stability and profitability are more likely to access Islamic financing. This suggests that financial robustness gives lenders confidence in the SME's ability to repay loans or financing. Compliance with Islamic Finance Principles ranks second with a weight of 0.284, highlighting the necessity for SMEs to adhere to Shariah-compliant practices such as the prohibition of interest (riba), ethical investments, and risk-sharing. Management Capabilities rank third with a weight of 0.213, underscoring the importance of a competent leadership team capable of successfully implementing and managing energy efficiency initiatives. Technical Feasibility follows with a weight of 0.128, reflecting the importance of a well-structured and viable project plan for lenders to consider. Finally, Market Position and Stability is evaluated with a weight of 0.031, indicating that while an SME's market presence and long-term stability are relevant, they are not as crucial as financial health and adherence to Islamic principles. Overall, these priorities offer valuable insights for SMEs to enhance their access to Islamic financing by focusing on strengthening financial health, aligning with Islamic principles, and demonstrating capable management and project viability.

Table 4. Priorities with respect to Financial Health

1	Financial risk	0.44
2	Profitability and Cash Flow	0.349
3	Creditworthiness	0.211

Based on Table 4, the most critical factor identified is Financial Risk, with a weight of 0.44, meaning that lenders place the highest importance on the level of risk associated with financing the SME. This suggests that lenders are primarily concerned with the potential for financial loss and are cautious about extending financing to SMEs that carry a high level of risk. Financial risk may include factors such as business volatility, external economic conditions, or industry-specific risks, all of which could affect an SME's ability to repay the financing.

The second most important factors are Profitability and Cash Flow, with a weight of 0.349, highlighting the need for SMEs to demonstrate a strong and consistent flow of profits and a stable cash position. Profitability indicates the SME's ability to generate income, which is essential for covering operational costs and repayment. A healthy cash flow assures lenders that the SME has sufficient liquidity to meet short-term obligations and fund energy efficiency projects without financial strain (Alrawad et al., 2023).

Creditworthiness is ranked as the third priority with a weight of 0.211, which indicates that while it is important, it is less critical than financial risk and profitability. Creditworthiness reflects the SME's history and ability to repay debts based on its financial track record. Lenders assess this through the SME's credit history, previous financial obligations, and overall reliability in meeting financial commitments. Although it plays a role in financing decisions, it is not weighed as heavily as an SME's immediate financial risks and profitability (Mang'ana, Hokororo, & Ndyetabula, 2024).

 Table 5. Priorities with respect to Compliance with Islamic Finance Principles

Rank	Name	Weight
1	Shariah Compliance	0.659
2	Risk-Sharing	0.341

Based on Table 5, the highest-priority criterion is Shariah Compliance, with a weight of 0.659, emphasizing the importance of ensuring that all aspects of the financing arrangement strictly adhere to Islamic finance principles. For SMEs to access Islamic financing, their business practices, financing structures, and energy efficiency projects must fully align with Shariah law. Shariah compliance involves several key aspects, such as avoiding interest-based transactions (riba), eliminating uncertainty and speculation (gharar), and ensuring that financing does not involve haram (prohibited) activities. In practical terms, SMEs need to ensure that their energy efficiency projects are financed through Shariah-compliant products, such as green bonds, Islamic crowdfunding, Islamic peer-to-peer lending, and Islamic banking solutions. This compliance is crucial, as Islamic financiers are bound by these principles, and any deviation could result in financing being denied. The high ranking of Shariah compliance highlights the central role of ethical and religious considerations in Islamic financing (Ayedh et al., 2021).

The second most important criterion is Risk-Sharing, with a weight of 0.341, which is a fundamental principle in Islamic finance. Unlike conventional financing, where risk is typically borne primarily by the borrower, Islamic finance emphasizes that both the lender (financier) and the borrower (SME) must share the risks and rewards of the business venture. This principle is reflected in Islamic financial contracts such as Musharakah (joint venture financing) and Mudarabah (profit-sharing partnership), where the financier provides capital, and both parties share profits according to a pre-agreed ratio, while losses are borne according to each party's investment

contribution. This approach encourages ethical and balanced financial relationships, reducing the burden on SMEs while promoting joint responsibility and cooperation between the SME and the financier (Elamer, Ntim, & Abdou, 2020).

Rank	Name	Weight
1	Technology Adoption	0.434
2	Energy Efficiency Assesment	0.352
3	Potential Environmental Impact	0.214

Table 6. Priorities with respect to Technical Feasibility

Technology Adoption ranks as the most important criterion with a weight of 0.434, meaning that the readiness and implementation of new technologies play a critical role in SMEs accessing Islamic financing for energy efficiency initiatives. This priority highlights that lenders and financiers see the integration of modern, proven, and efficient technologies as key to the success of energy efficiency projects. The readiness level of the technology, often measured through frameworks like Technology Readiness Levels (TRLs), plays a crucial role in reducing perceived risk for financiers. Higher TRLs indicate a lower risk of implementation failure, making projects more attractive for funding. SMEs should therefore focus on demonstrating their ability to integrate cutting-edge, energy-efficient technologies that align with sustainability goals.

The second-highest priority is Energy Efficiency Assessment, with a weight of 0.352. This criterion underscores the importance of SMEs effectively evaluating their current energy consumption patterns and identifying key areas for improvement. Conducting a thorough assessment enables SMEs to present concrete data on potential cost savings and energy reductions, making their proposals more compelling to financiers. The assessment typically includes a costbenefit analysis and return-on-investment (ROI) projections, which provide financiers with confidence in the project's viability.

Potential Environmental Impact ranks third, reflecting the growing emphasis on sustainable and green financing. Islamic finance principles align closely with ethical and environmentally responsible investments, making this criterion particularly relevant. SMEs that can demonstrate a significant reduction in carbon emissions or energy consumption stand a better chance of securing financing, as their projects align with Islamic values of environmental stewardship (khalifah) and sustainable development (Pylaeva et al., 2022; Gennitsaris et al., 2023; Tereshchenko et al., 2023).

Rank	Name	Weight
1	Market Growth and Stability	0.635
2	Competitive Advantage from Energy Efficiency	0.365

Table	7.	Priorities	with	resp	pect	to	Market	Position	and	Stabilit	y
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Market Growth and Stability emerges as the highest priority criterion, with a weight of 0.635. This suggests that the potential for market expansion and overall stability play a crucial role in attracting Islamic financing. Lenders prefer projects operating in markets with strong demand and stable economic conditions, as these factors increase the likelihood of business success and loan repayment. A stable market environment reduces financial risks and reassures financiers about the viability of the SME's energy efficiency initiatives. SMEs seeking Islamic financing should

highlight their market potential by presenting demand trends, customer interest in energy-efficient solutions, and growth opportunities in sustainability-focused industries. Demonstrating market resilience against economic fluctuations also enhances their attractiveness to lenders. This prioritization underscores the need for SMEs to position themselves in sectors with clear growth prospects and low investment risks (Bachtiar, 2020).

The second priority, Competitive Advantage from Energy Efficiency (0.365), indicates that SMEs leveraging energy efficiency as a differentiator are more likely to attract financing. Cost savings from reduced energy consumption improve profitability, while sustainability initiatives enhance brand reputation. This competitive edge can translate into increased customer loyalty, market share, and differentiation from competitors. Beyond cost reductions, energy efficiency initiatives contribute to innovation, allowing SMEs to develop eco-friendly products or services that appeal to environmentally conscious consumers. Islamic financiers are more inclined to support SMEs that demonstrate clear market advantages, reinforcing the importance of integrating energy efficiency into business strategies (Gasior et al., 2022).

Rank	Name	Weight
1	Management Experience and Competency	0.621
2	Strategic Planning for Energy Efficiency	0.376

Table 8. Priorities with respect to Management Capabilities

According to Table 8, Management Experience and Competency is ranked as the most critical factor (0.621), surpassing Strategic Planning for Energy Efficiency (0.376). This indicates that financial institutions prioritize strong leadership and decision-making skills when assessing SME financing applications. Experienced managers are seen as capable of mitigating risks, executing financial plans, and ensuring compliance with Islamic finance principles. Their ability to navigate financing agreements and manage projects effectively reassures Islamic lenders that energy efficiency initiatives will be successfully implemented. While Strategic Planning for Energy Efficiency remains important, its lower ranking suggests that even the most well-developed plans hold limited value without competent management. SMEs should prioritize leadership development through training and hiring experienced professionals. Strengthening management capacity enhances credibility, improves access to financing, and ensures the effective execution of energy efficiency projects (Naushad & Sulphey, 2020).

Table 9. Priorities with respect to Alternative Strategies

Rank	Name	Weight
1	Enhancing Financial Literacy and Management Skills	0.535
2	Developing Partnerships with Islamic Financial Institutions	0.436
3	Implementing Energy-Efficient Technologies	0.21

The highest priority, Enhancing Islamic Financial Literacy and Management Skills (0.436), highlights the critical role of financial knowledge in securing Islamic financing. SMEs must understand the fundamentals of Islamic finance—such as Murabaha, Mudarabah, and Ijara—to navigate financing options effectively. Financial literacy enables SMEs to make informed decisions, structure financing applications appropriately, and communicate their needs to lenders. Strong management skills further ensure that energy efficiency projects are well-planned and executed, increasing the likelihood of achieving sustainable financial literacy enhances household energy efficiency in China (Ye & Yue, 2023) and plays a crucial role in alleviating energy poverty (Tao et al., 2024). Households with higher financial literacy make more informed decisions about energy use and expenses, reinforcing the idea that SMEs with stronger financial knowledge can optimize financing opportunities for energy-efficient investments.

Developing Partnerships with Islamic Financial Institutions ranks second (0.353), emphasizing the importance of establishing strong relationships with banks, investment funds, and Islamic peerto-peer lending platforms (Adekoya, 2022). Building trust with financial institutions increases SMEs' chances of securing funding, as lenders are more inclined to support businesses with established credibility. Collaboration with Islamic financial institutions allows SMEs to access tailored financing solutions and receive expert guidance. This finding aligns with research showing that Islamic banks in Türkiye provide more loans to MSMEs than conventional banks, reflecting their commitment to supporting smaller enterprises through ethical and socially responsible banking practices (Disli, Aysan, & Abdelsalam, 2023).

The third priority, Implementing Energy-Efficient Technologies (0.21), underscores the necessity of tangible sustainability efforts. While financial literacy and partnerships improve financing access, demonstrating real commitment to energy efficiency through technology adoption enhances credibility (Fawcett & Hampton, 2020). Islamic financial institutions favor projects that show clear sustainability benefits, such as reduced energy consumption, cost savings, and positive environmental impact. SMEs should present measurable data on the expected benefits of energy-efficient technologies to strengthen their financing applications. This finding is supported by research indicating that investments in energy-efficient technologies contribute to lower energy costs and improved community well-being (Oyewole et al., 2024).

5. Conclusion

This study applied the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to identify and prioritize the factors influencing SMEs' access to Islamic financing for energy efficiency projects. The results revealed that Financial Health (0.674) is the most critical factor, indicating that SMEs with stable financial conditions and strong cash flow are more likely to secure Islamic financing. This highlights the necessity for SMEs to adopt robust financial planning strategies to enhance their creditworthiness. The second and third priorities—Compliance with Islamic Finance Principles (0.562) and Management Capabilities (0.523)—underscore the importance of Shariah-compliant business practices and strong managerial competencies in securing financing. Islamic financial institutions prioritize ethical and risk-sharing financial structures, making Shariah compliance a prerequisite for funding eligibility.

Additionally, SMEs with experienced leadership and well-developed strategic plans for energy efficiency are viewed as lower-risk investments by Islamic financiers. Furthermore, the findings emphasize that Market Position and Stability (0.635) significantly influence financing access. SMEs operating in growing and stable markets are more attractive to Islamic lenders, as these conditions reduce investment risks. Meanwhile, Competitive Advantage from Energy Efficiency (0.365) suggests that SMEs integrating energy efficiency into their business strategy either through cost reductions or sustainability-driven market positioning—can improve their financing prospects.

From a strategic perspective, the study highlights the importance of Enhancing Islamic Financial Literacy (0.436) and Developing Partnerships with Islamic Financial Institutions (0.353). SMEs that understand Islamic financing structures and actively engage with Islamic financial institutions have better chances of obtaining funding. This finding is particularly relevant in

Indonesia, where knowledge gaps regarding Islamic financial products remain a key barrier to SME adoption.

5.1 Implications for Stakeholders

To support the adoption of energy-efficient technologies and enhance financial inclusion, several strategic actions are recommended for key stakeholders. For small and medium enterprises (SMEs), it is essential to strengthen their financial health by implementing cash flow optimization and financial risk management strategies, which help demonstrate stability and creditworthiness to Islamic lenders. Improving Shariah compliance is also crucial; this can be achieved through structured training programs and collaboration with Islamic finance experts to ensure alignment with Islamic financing principles. Additionally, investing in managerial capacity building is necessary to enhance SMEs' strategic planning and risk management, especially in the context of energy efficiency projects.

Islamic financial institutions, on the other hand, are encouraged to develop customized financing products that align with the unique cash flow cycles and sector-specific challenges faced by SMEs in energy efficiency investments. Increasing outreach and educational programs is vital to bridging the knowledge gap on Islamic finance among SME owners. Furthermore, these institutions should establish structured partnerships with SMEs and government agencies to facilitate access to financing through mentorship and technical assistance.

For policymakers, introducing incentive programs such as tax benefits, grants, or preferential financing rates can motivate SMEs to adopt energy-efficient technologies. Strengthening regulatory frameworks is also necessary to encourage Islamic banks to allocate a portion of their financing to sustainability-driven SME projects. Lastly, promoting awareness campaigns and capacity-building initiatives will enhance SMEs' understanding of the various Islamic financing options available to them, thereby fostering a more inclusive and sustainable financial ecosystem.

5.2 Research Contributions and Limitations

This study contributes to the growing body of literature on Islamic finance and sustainability by being among the first to apply Fuzzy AHP to assess SME access to Islamic financing for energy efficiency initiatives. The findings offer a structured, data-driven prioritization of key financing factors, filling a critical research gap in understanding how SMEs can align themselves with Islamic financing mechanisms to support sustainability objectives.

However, several limitations should be acknowledged:

- 1. Limited SME energy usage data in Indonesia posed challenges in quantitatively assessing the direct impact of energy efficiency on financing access. Future research should integrate detailed energy performance metrics to strengthen the analysis.
- 2. The study focused on a relatively small sample (10 respondents), limiting the generalizability of findings. Future studies could employ larger datasets across different industries to enhance validity.
- 3. The study primarily examined demand-side (SME) perspectives, while future research should incorporate supply-side insights from Islamic financial institutions to explore the feasibility of developing tailored financing mechanisms for energy-efficient SMEs.

5.3 Future Research Directions

Future research should consider several key areas. First, integrating quantitative energy efficiency data would allow for a more precise assessment of how actual energy savings influence Islamic financing decisions, offering empirical evidence to support policy and financial strategies. Expanding the sample size to include a broader range of SMEs and Islamic financial institutions would also enhance the generalizability and robustness of the findings. Additionally, investigating sector-specific variations in financing access is essential, particularly by comparing SMEs across industries with different levels of energy efficiency adoption. This approach can uncover unique challenges and opportunities within specific sectors. Furthermore, exploring the role of government interventions—such as the implementation of Islamic green bonds (Sukuk) and various incentive

programs—can shed light on how public policy supports or hinders SME access to Islamic financing. By addressing these areas, future research can provide deeper insights into the intersection of Islamic finance, sustainability, and SME development, ultimately contributing to a more inclusive and environmentally responsible financial ecosystem.

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