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, contributing to high operational costs and limiting competitiveness. This research explored the key factors influencing SMEs' access to Islamic financing for energy efficiency. The study employs the Fuzzy Analytical Hierarchy Process (AHP), drawing on responses from 10 experts, including industry practitioners, academics, 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, followed by compliance with Islamic finance principles and management capabilities. The results highlight the importance of Islamic financial literacy and managerial skills in improving SMEs' access to funding. Additionally, developing partnerships with Islamic financial institutions and implementing energy-efficient 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 promote 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 encourage energy-efficient investments. Clear regulatory guidelines and the integration of Shariah-compliant fintech solutions will help ensure compliance with these regulations. Ultimately, these efforts will contribute to reducing energy poverty and enhancing the competitiveness of SMEs in Indonesia.

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

I. INTRODUCTION

The issue of sustainability in Small and Medium Enterprises (SMEs) is gaining increasing attention, as these businesses play a significant role in driving economic growth, employment, and innovation. Energy efficiency (EE) has become a critical focus, particularly for SMEs in developing countries like Indonesia, where they 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 Despite their economic importance, many Indonesian SMEs operate using outdated and energy-inefficient practices, resulting in high operational costs and adverse environmental impacts. The sector consumes approximately 38% of Indonesia's total energy, with the majority still dependent on fossil fuels (UNDP Indonesia, 2021). This underscores the

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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 offer better insights into where energy-saving measures would be most effective. Studies suggest that energy-intensive industries, such as textiles, food processing, and metalworking, contribute significantly to total SME energy consumption, resulting in high operational costs and increased carbon footprints.

According to data from the Ministry of Energy and Mineral Resources (MEMR) (2022), 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. In contrast, while food processing SMEs report monthly energy consumption ranging from 1,800 to 2,700 kWh, depending on the scale of production (Asian Development Bank, 2023). Retail and service-based SMEs tend to have lower absolute consumption but still exhibit inefficiencies, particularly in lighting, air conditioning, and refrigeration systems (International Energy Agency, 2020).

These data highlight the substantial energy demand within the SME sectors 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 especially significant in countries like Indonesia, where SMEs are the backbone of the economy. Energy efficiency plays a crucial role in reducing energy consumption and greenhouse gas emissions, both of which are vital for addressing global environmental challenges. For SMEs, adopting energy-efficient technologies can reduce operational costs and enhance competitiveness, resulting in a win-win situation 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. 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 by PriceWaterhouseCoopers (2018), stating 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 often lack awareness of energy-efficient solutions, face high upfront costs, and may not possess the necessary technical expertise to implement such projects effectively (Jalo et al., 2021). These challenges hinder SMEs' ability 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

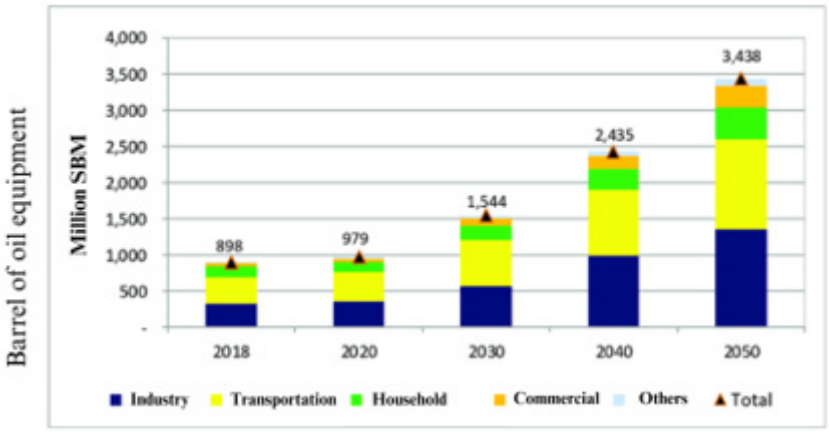

Figure 1 Estimation of energy demand for 2050
Source: Adiarso et al. (2020)

principles of Sharia with the objectives of sustainability, aiming to promote economic growth while ensuring social equity and environmental protection (Jan et al., 2019; Al-Mulla et al., 2022; Marzuki et al., 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 Sharia 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 , via online platforms (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 et al., 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 et al., 2024). Therefore, the main objective of this research is to develop a structured decision-making 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 the selection of financial instruments that accommodate the uncertainties and complexities inherent in optimizing energy efficiency for SMEs' sustainability.

Several studies 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 SMEs. Islamic financial institutions are increasingly venturing into sustainable finance, adhering to Shariah principles. However, their impact on energy efficiency investments remains unestablished. Current research focuses on broader areas, such as renewable energy investments (Morea & Poggi, 2016; Kasri et al., 2024; Ibrahim et al., 2021), but does not explicitly address how Islamic financial mechanisms can be optimized for energy-efficient projects. Another significant gap lies in the decision-making process of allocating sustainable finance for energy efficiency (Chen et al., 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 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.

Islamic finance, grounded in ethical principles that promote socio-economic justice and environmental stewardship, has the potential to play a vital role in financing energy efficiency projects. Islamic financial institutions (IFIs) operate based on principles such as profit-sharing, the avoidance of uncertainty (*gharar*), and the prohibition of interest (*riba*), positioning them uniquely to support sustainable and environmentally friendly initiatives. A considerable body of literature has examined the development of Islamic finance and its connection to sustainable development. This includes the integration of environmental, social, and governance (ESG) criteria into financial decision-making to promote long-term economic sustainability. These developments are driven by the urgent need to address climate change, social inequality, and environmental degradation, aligning with global objectives such as the United Nations Sustainable Development Goals (Meng et al., 2024).

SMEs play a pivotal role in global economies by contributing to employment, innovation, and growth.

However, a persistent challenge they face is access to finance, which is essential for their development and sustainability. SMEs typically face greater obstacles in securing financing compared to larger corporations, especially in emerging markets. Kaya (2024) notes that SMEs are often subject to credit rationing, as financial institutions perceive them as high-risk borrowers due to irregular cash flows and insufficient collateral. This results in less favorable loan terms, including higher interest rates and smaller loan amounts, limiting SMEs' ability to access the capital they need.

In Europe, SMEs represent a significant share of businesses and employment, but they frequently experience cash flow issues due to late payments, which further restricts their access to finance. Kaya's (2024) study on European SMEs found that late payments exacerbate liquidity constraints, prompting banks to tighten lending criteria. These financial pressures reduce SMEs' ability to sustain operations and pursue growth. Similarly, Moreira (2016) observes that SMEs in high-tech and internet-based industries frequently face difficulties in accessing credit due to perceived risks and information asymmetries. Traditional banking systems may lack the tools to properly assess the creditworthiness of such enterprises, thereby restricting their financing options.

Additional evidence of financial barriers is provided by Jha and Mittal (2024), who examine the financing patterns of Indian SMEs. The research reveals that these enterprises heavily rely on short-term debt and trade credit, mainly due to their limited access to long-term financing. While short-term financing is more accessible, it increases financial risk and negatively affects financial performance. The authors also noted a negative correlation between total debt financing and return on assets (ROA), underscoring the need for better financing strategies that enhance performance while mitigating risk, particularly in volatile markets.

The positive correlation between financial development and SME growth underscores the importance of access to finance. Moreira (2016) argues that improved access, supported by government policies and regulatory reforms, can significantly boost SME growth, particularly in innovative sectors such as high-tech industries. Government interventions, such as targeted financial support programs and improved credit assessment frameworks, can be instrumental in expanding access to finance for SMEs.

Energy efficiency is critical for SMEs due to their substantial role in ptomoting environmental sustainability and economic development. SMEs account for a significant portion of global energy use, and adopting energy-efficient practices can reduce operational costs and mitigate environmental impact. However, SMEs face unique challenges in implementing such measures, including limited financial resources, low awareness, and technical constraints (Ketenci & Wolf, 2024).

Several studies have highlighted the importance of energy efficiency in enhancing SME competitiveness. Rising energy prices, especially in manufacturing, have incentivized companies to adopt energy-saving practices. Ketenci and Wolf (2024) state that SMEs in non-energy-intensive sectors often overlook potential savings. The research demonstrates that even SMEs with relatively low energy consumption can achieve substantial cost and emissions reductions by adopting efficient technologies. For example, two SMEs achieve energy savings of 900,000 kWh and 1,300,000 kWh, leading to cost reductions of 16% and 22%.

Despite these benefits, many SMEs continue to face barriers to implementation, such as limited technical knowledge and inadequate access to energy management information (Meng, et al., 2024). In a study of UK-based SMEs, the research finds that firms with energy-efficient practices were more likely to secure external financing, as lenders viewed them as more creditworthy. Improved liquidity and risk profiles associated with energy savings made these SMEs more attractive to financial institutions. Moreover, energy-efficient assets are considered superior collateral due to their higher long-term value and reduced risk of becoming stranded in a decarbonizing economy.

Energy efficiency also plays a vital role in the broader context of business model innovation (BMI) among SMEs. As businesses face growing pressure to reduce their environmental footprint, energy efficiency is increasingly integrated into new and innovative business models. This trend is particularly pronounced in the energy sector, where shifts toward renewable energy and digital technologies are transforming operations. Malewska et al. (2024) examine the intersection of digital transformation and BMI in energy-sector SMEs, finding that energy efficiency is becoming a core component of innovation. The ongoing transition to sustainable energy requires SMEs to rethink their operational strategies and embrace energy-efficient solutions to maintain competitiveness.

II. METHODS

The research focuses on identifying and prioritizing the key criteria affecting SMEs' access to Islamic financing, while accounting for uncertainties and complexities to optimize energy efficiency and support sustainable development (see Figure 2). To achieve this objective, the research applies the Fuzzy AHP, an extension of the Analytical Hierarchy Process (AHP) that incorporates fuzzy logic to address uncertainty and vagueness in expert judgments. Fuzzy AHP is particularly effective in situations where decision-makers express imprecise or ambiguous preferences. To ensure the robustness of the findings, the research includes a diverse panel of experts and representatives from financial institutions involved with SMEs.

Primary data are collected through focus group discussions and in-depth interviews conducted via online platforms (e.g., Zoom) and in-person meetings. These discussions aim to evaluate relevant factors,

criteria, and alternative strategies. The sampling method is purposive sampling, targeting professionals with at least 10 years of experience in Islamic finance and sustainable development. Participants include representatives from the Indonesian Sharia Fintech Association, the 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 representatives from financial institutions involved in lending are included to provide a comprehensive perspective. A total of 15 respondents participated in the research, helping to minimize individual biases and increase the representativeness of the findings. Respondents provide inputs through pairwise comparisons of criteria for the Fuzzy AHP analysis, as well as qualitative feedback on the challenges and opportunities related to financing energy efficiency.

The research applies the Fuzzy AHP method to assess the significance of various factors influencing the development of sustainable financing models for SME energy efficiency projects in both rural and urban contexts. According to Liu et al. (2020), Fuzzy AHP is a decision-making tool designed to simplify complex evaluations, making them more manageable and comprehensible. Decision-makers assess the relative importance of one criterion over another using AHP scale as shown in Table 1. The method comprises four key stages: (1) defining the relative importance of criteria through pairwise comparisons; (2) combining fuzzy sets to support group decision-making and calculate weights or priorities; (3) converting fuzzy sets into crisp values for final comparison (defuzzification); and (4) assessing the consistency of judgments. Fuzzy AHP follows a structure similar to the traditional AHP framework, as shown in Figure 3. The white and light grey boxes indicate common steps in both AHP and Fuzzy AHP, while the light grey boxes represent steps involving specific Fuzzy AHP techniques. The dark grey box highlights a step unique to fuzzy AHP, distinguishing it from the conventional AHP process.

To ensure methodological rigor, the Fuzzy AHP 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, the research applies the Fuzzy AHP model to optimize SME financing models, distinguishing it from Islamic bank talent management applications. The Fuzzy AHP method helps Islamic banks and financial institutions prioritize and allocate resources for each strategy based on its 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.

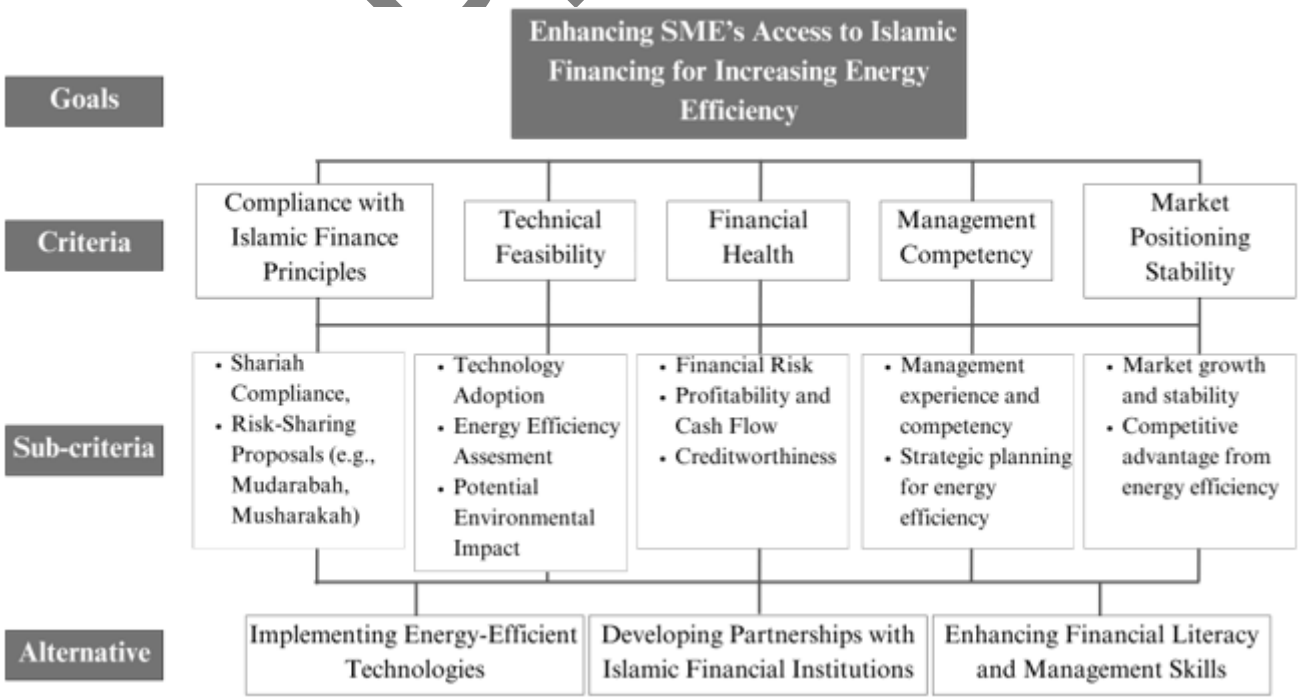

Figure 2 Enhancing SMEs Access to Islamic Financing for Increasing Energy Efficiency

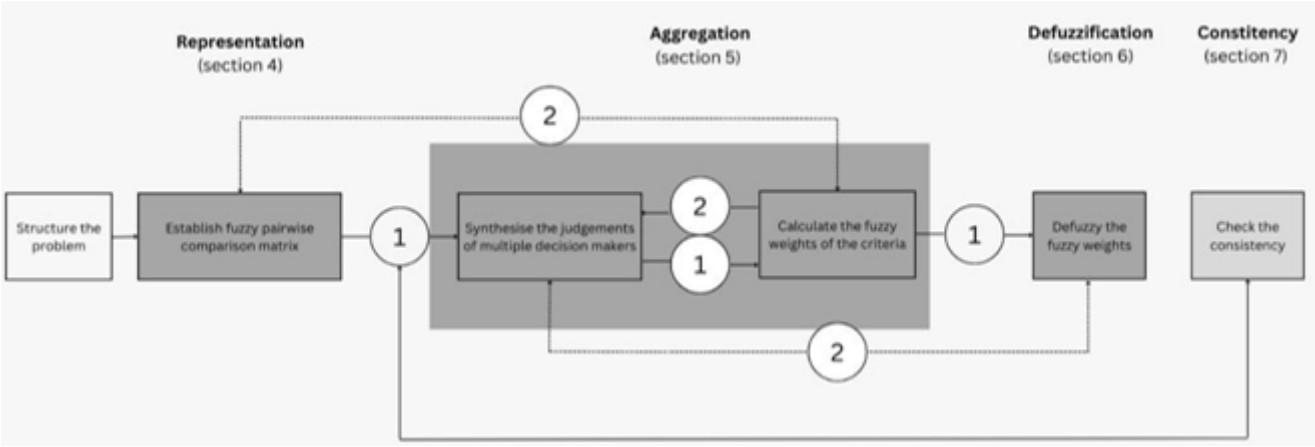

Figure 3 Fuzzy AHP Framework

Table 1 AHP scale

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.
2, 4, 6, 8	Intermediate values between two adjacent judgments	A compromise is necessary.

Source: (Saaty, 2001; Tu et al., 2020)

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

III. RESULTS AND DISCUSSIONS

In this research, the Fuzzy AHP applies to assess the factors influencing SMEs' access to Islamic financing for enhancing energy efficiency. The analysis is based on responses from a diverse group of ten participants (see Table 2), each contributing unique insights and perspectives to the evaluation process. These participants represented various sectors within the SME landscape and the Islamic finance industry. Their diversity enriched the study by ensuring that the prioritization of factors reflected a comprehensive understanding of the challenges and opportunities SMEs face in accessing Islamic financing.

Table 2 Respondent Demographics

No	Respondents	Number of respondents
1.	National Committee for Islamic Economics and Finance	1
2.	Indonesian Sharia Fintech Association	1
3.	Academics and Higher Education Institutions	2
4.	Association for Creative Economy and Small and Medium Enterprises	3
5.	Professionals in Islamic Halal Industry	2
6.	Islamic Banks	1

According to Menne et al. (2022), the results in Table 3 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 an 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 Sharia-compliant practices, such as the prohibition of interest, 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 these factors are relevant, they are not as crucial as financial health and adherence to Islamic principles. Overall, these priorities offer valuable insights for SMEs seeking 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 3 Priorities with respect to Enhancing SME's Access to Islamic Financing for Increasing Energy Efficiency

Rank	Name	Weight
1	Financial Health	0.344
2	Compliance with Islamic Finance Principles	0.284
3	Management Capabilities	0.213
4	Technical Feasibility	0.128
5	Market Position and Stability	0.031

Table 4 Priorities with respect to Financial Health

Rank	Name	Weight
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 0.440. The weight means that lenders place the highest importance on the level of risk associated with financing the SME. 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 an 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. While still 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 does not carry as much weight as the SME's immediate financial risks and profitability (Mang'ana et al., 2024).

Table 5 Priorities with respect to Compliance with Islamic Finance Principles

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

Based on Table 5, the highest-priority criterion is Sharia 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, including avoiding interest-based transactions (*riba*), eliminating uncertainty and speculation (*gharar*), and ensuring that financing does not involve haram activities. SMEs need to ensure 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 these principles bind Islamic financiers, and any deviation could result in financing being denied. The high ranking of Sharia 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. Risk-sharing 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 et al., 2020).

Based on Table 6, 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 consider the integration of modern, proven, and efficient technologies as key to the success of such projects. The readiness level of the technology, often measured using frameworks such as 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. Therefore, SMEs should focus on demonstrating their ability to integrate cutting-edge, energy-efficient technologies that align with their sustainability goals.

Table 6 Priorities with respect to Technical Feasibility

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

The second-highest priority is energy efficiency assessment, with a weight of 0.352 (see Table 6). This criterion underscores the importance of SMEs effectively evaluating their current energy consumption patterns and identifying areas for improvement. 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 cost-benefit analysis and return-on-investment (ROI) projections, which provide 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 significant reductions 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).

Table 7 Priorities with respect to Market Position and Stability

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

Based on Table 7, market growth and stability emerge as the highest priority criterion, with a weight of 0.635. The rank suggests that the potential for market expansion and overall stability plays 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 appeal 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 is the competitive advantage from energy efficiency, with a weight of 0.365 (see Table 7). It 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 (Gąsior et al., 2022).

Table 8 Priorities with respect to Management Capabilities

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

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 prioritise strong leadership and decision-making skills when assessing SME financing applications. Experienced managers are viewed 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 have limited value without competent

management. SMEs should prioritize leadership development through training and the recruitment of 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	0.210

Based on Table 9, the highest priority, Enhancing Financial Literacy and Management Skills (0.535), 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 effectively navigate financing options. Financial literacy empowers SMEs to make informed decisions, structure financing applications effectively, 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 and operational outcomes (Lee, 2021). This finding aligns with research indicating that 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 optimise financing opportunities for energy-efficient investments.

Developing Partnerships with Islamic Financial Institutions ranks second, with a weight of 0.436 (see Table 9). It emphasizes the importance of establishing strong relationships with banks, investment funds, and Islamic peer-to-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 et al., 2023).

The third priority, Implementing Energy-Efficient Technologies (0.210), underscores the necessity of tangible sustainability efforts. While financial literacy and partnerships enhances access to financing, demonstrating real commitment to energy—such as through technology adoption—enhances credibility (Fawcett & Hampton, 2020). Islamic financial institutions favour 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).

IV. CONCLUSIONS

The research applies the Fuzzy AHP to identify and prioritize the factors influencing SMEs' access to Islamic financing for energy efficiency projects. The results indicate that Financial Health (0.674) is the most critical factor, suggesting that SMEs with stable financial conditions and strong cash flow are more likely to obtain Islamic financing. This highlights the importance of SMEs adopting robust financial planning strategies to improve their creditworthiness. The second and third priorities—Compliance with Islamic Finance Principles (0.562) and Management Capabilities (0.523)—highlight 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 perceived as lower-risk investments by Islamic financiers. The findings also emphasize that Market Position and Stability (0.635) significantly influence access to financing. SMEs operating in growing and stable markets are more attractive to Islamic lenders, as these conditions reduce investment risk. Meanwhile, Competitive Advantage from Energy Efficiency (0.365) suggests that SMEs that integrate energy efficiency into their business strategies—whether through cost reductions or sustainability-driven market positioning—can improve their financing prospects.

From a strategic standpoint, the research underscores 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 are more likely to secure funding. This finding is particularly relevant in Indonesia, where knowledge gaps regarding Islamic financial products remain a significant barrier to SME adoption.

To support the adoption of energy-efficient technologies and enhance financial inclusion, several

strategic actions are recommended for key stakeholders. For SMEs, it is essential to strengthen financial health through cash flow optimization and financial risk management strategies, which demonstrate stability and creditworthiness to Islamic lenders. Improving Shariah compliance is also critical and can be achieved through structured training programs and collaboration with Islamic finance experts to ensure alignment with Islamic principles. Additionally, investing in managerial capacity building is necessary to enhance strategic planning and risk management, particularly in the context of energy efficiency projects.

Islamic financial institutions are encouraged to develop customized financing products tailored to the unique cash flow cycles and sector-specific challenges of SMEs investing in energy efficiency. Expanding outreach and educational programs is vital to bridging the knowledge gap on Islamic finance among SME owners. Moreover, 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 encourage SMEs to adopt energy-efficient technologies. Strengthening regulatory frameworks is also necessary to promote the allocation of Islamic financing to sustainability-driven SME projects. Lastly, promoting awareness campaigns and capacity-building initiatives will enhance SMEs' understanding of the Islamic financing options available to them, fostering a more inclusive and sustainable financial ecosystem.

The research 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 with Islamic financing mechanisms to support sustainability objectives.

However, several limitations must be acknowledged. First, the limited availability of SME energy usage data in Indonesia posed challenges in quantitatively assessing the direct impact of energy efficiency on financing access. Future research should incorporate detailed energy performance metrics to enhance the analysis. Second, the research relies on a relatively small sample size (10 respondents), which limits the generalizability of the findings. Future research should involve larger datasets across various industries to improve validity. Finally, the research primarily examines the demand side of SME perspectives. Future research should incorporate supply-side insights from Islamic financial institutions to explore the feasibility of developing tailored financing mechanisms for energy-efficient SMEs.

Future research should explore several key areas. First, integrating quantitative data on energy efficiency would enable a more precise assessment of how actual energy savings impact Islamic financing decisions, providing empirical evidence to inform policy and financial strategies. Expanding the sample to include a broader range of SMEs and Islamic financial institutions would enhance the generalizability and robustness of the findings. Furthermore, sector-specific analysis of financing access—comparing SMEs across industries with varying levels of energy efficiency adoption—can reveal unique challenges and opportunities. Exploring the role of government interventions, such as the implementation of Islamic green bonds (Sukuk) and other incentive programs, can also shed light on how public policy supports or hinders SME access to Islamic financing. Addressing these areas will 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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