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THE RELATIONSHIP BETWEEN ENERGY EFFICIENCY IN HALAL MSMES AND BUSINESS PROFITABILITY AND SUSTAINABILITY: A CASE STUDY IN BANDUNG CITY, 2021–2023

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Abstract

This study investigates the relationship between energy efficiency practices and their impact on profitability and business sustainability among halal micro, small, and medium enterprises (MSMEs) in Bandung City, Indonesia, during 2021–2023. As energy costs represent a significant share of MSMEs' operational expenditures, improving energy efficiency is expected to enhance both financial outcomes and long-term resilience, aligning with Sustainable Development Goals (SDGs). Using a mixed-method approach, the research combined survey data from 120 halal MSMEs with in-depth interviews and financial performance analysis. Quantitative data were analyzed using regression modeling to examine the correlation between energy-saving interventions and profitability, while qualitative insights explored managerial perspectives on sustainable practices. The results demonstrate a statistically significant positive relationship between energy efficiency adoption and profitability, with enterprises reporting an average reduction of 12–18% in energy costs, contributing to a 9–14% increase in net profit margins. Furthermore, MSMEs with systematic energy management practices exhibited stronger long-term sustainability indicators, including enhanced market competitiveness, customer trust linked to halal and green business practices, and improved compliance with government energy efficiency programs. The study also highlights barriers such as limited access to financing for green technology and lack of technical expertise, which hinder broader adoption. The findings suggest that energy efficiency is not only a cost-reduction strategy but also a pathway to sustainable growth in halal MSMEs. Policy implications emphasize the need for integrated support mechanisms combining financial incentives, capacity building, and regulatory frameworks tailored to small businesses.

INTRODUCTION

The rapid growth of micro, small, and medium enterprises (MSMEs) has been widely recognized as a cornerstone of economic development in both developed and emerging economies. In Indonesia, MSMEs account for more than 60% of the gross domestic product (GDP) and absorb nearly 97% of the labor force, positioning them as essential drivers of inclusive and sustainable growth (Ministry of Cooperatives and SMEs, 2022). Within this sector, halal MSMEs play a particularly significant role, reflecting Indonesia's status as the world's largest Muslim-majority country and its strategic ambition to become a global halal hub. However, despite their socio-economic contributions, halal MSMEs often face structural challenges related to efficiency, competitiveness, and sustainability, particularly in managing energy resources.

Energy costs represent one of the largest components of operational expenses in MSMEs, accounting for 20–40% of total production expenditures in energy-intensive industries (Zhang et al., 2023). In the context of halal MSMEs—such as halal food processing, halal fashion, and halal services—energy use is closely linked not only to production costs but also to compliance with both Sharia principles and environmental sustainability standards. This dual requirement reflects the intersection of Islamic economic values with the Sustainable Development Goals (SDGs), particularly Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), and Goal 12 (Responsible Consumption and Production) (United Nations, 2015). Although extensive research has been conducted on energy efficiency in large industries and multinational corporations, empirical studies on its implications for MSMEs, especially halal-certified ones, remain scarce. Previous studies have primarily addressed technological innovation in energy systems (Hirsch et al., 2021), corporate environmental performance (Del Río et al., 2022), and energy efficiency policies at national and regional levels (Tanaka, 2023). These works, while insightful, often overlook the unique constraints faced by small enterprises, such as limited capital, lack of technical know-how, and restricted access to financing. Furthermore, the specific context of halal MSMEs introduces additional layers of complexity, including religious compliance, customer trust linked to halal certification, and integration with green supply chains.

The novelty of this research lies in examining the *dual impact* of energy efficiency—on profitability and on sustainability—within halal MSMEs in Bandung City, Indonesia. Unlike prior studies that focused solely on environmental or financial outcomes, this study bridges the two perspectives, aligning financial performance with sustainability outcomes. Moreover, it situates the analysis in a local urban context, thereby contributing granular insights that can inform both local policy and broader Islamic economic frameworks. Bandung City, one of Indonesia's major urban centers, is home to a vibrant ecosystem of halal MSMEs, particularly in food, fashion, and creative industries. These enterprises not only cater to domestic demand but also have strong export potential, especially with the government's strategic roadmap for Indonesia as a global halal economy hub (Indonesia Halal Economy Report, 2021). However, escalating energy prices, combined with climate-related challenges, have put pressure on their operational models. At the same time, there is increasing consumer awareness of sustainability issues, which affects purchasing decisions and brand loyalty.

Against this backdrop, the rationale for this research is threefold. First, to provide empirical evidence on the extent to which energy efficiency practices translate into tangible financial benefits for halal MSMEs. Second, to analyze how such practices contribute to long-term business sustainability, measured not only by profitability but also by competitiveness, stakeholder trust, and

resilience. Third, to position halal MSMEs within the discourse of sustainable Islamic economics, thereby offering policy recommendations that align with both national development goals and the SDGs.

This study builds on the Resource-Based View (RBV) theory, which posits that enterprises can achieve sustained competitive advantage by leveraging unique resources and capabilities (Barney, 1991). In the context of MSMEs, energy efficiency can be conceptualized as a strategic capability that reduces operational costs while simultaneously enhancing environmental performance. From an Islamic economics perspective, energy efficiency is also aligned with the principle of *maslahah* (public good) and the prohibition against *israf* (wastefulness), reinforcing the ethical dimension of sustainable business practices (Satria, 2025).

Empirical studies have demonstrated that energy efficiency initiatives improve both environmental outcomes and financial performance. For instance, a recent study in the *Journal of Cleaner Production* found that SMEs adopting energy-saving technologies reported a dual improvement in cost efficiency and brand competitiveness (Zhang et al., 2023). Similarly, Del Río et al. (2022) highlighted that firms integrating energy efficiency into their operations experienced higher returns on investment compared to those that did not. However, these studies are largely based in developed-country contexts and rarely explore the intersection with halal compliance or Islamic business ethics. In Indonesia, research on MSMEs has primarily focused on access to finance, digitalization, and market expansion (Hidayat & Setiawan, 2022). While these factors are undoubtedly critical, the role of energy efficiency as a determinant of profitability and sustainability remains underexplored. This study, therefore, contributes to filling this gap by integrating insights from both sustainability science and Islamic economic principles, offering a holistic lens for analyzing MSME development in Muslim-majority contexts. Recent scholarship has emphasized the transformative role of digital technologies—particularly digital twins, artificial intelligence (AI), and Industry 4.0/5.0 frameworks—in advancing sustainability. For example, Arsiwala et al. (2023) demonstrated how machine learning-driven digital twins can predict CO2 emissions from existing buildings, enhancing carbon monitoring and energy efficiency. Similarly, Cui et al. (2023) and Liu et al. (2021) reviewed digital twin technologies for electromechanical systems and manufacturing, highlighting their potential for lifecycle optimization and efficiency gains. Ivanov (2023) extended this discussion to supply chains, proposing intelligent digital twins for stress-testing and resilience, while Ma et al. (2022) showed their application in energy-intensive industries. These studies collectively underscore the relevance of digital technologies in sustainable energy management, though their primary focus has been on industrial or large-scale systems rather than MSMEs.

Parallel to this technological trajectory, scholars have investigated the socio-political and economic dimensions of sustainable energy transitions. Bhatia (2023) analyzed India's state-led electricity transition, emphasizing the interplay of techno-economic and political perspectives. Brodny et al. (2023) assessed regional progress on SDG 9 in Poland, demonstrating how infrastructure development fosters industrial innovation. Clement et al. (2023) connected smart city strategies with SDG localization, while Pandey et al. (2022) examined energy and environmental sustainability in South Asia. These works affirm that energy efficiency is not only a technological issue but also deeply embedded in governance, policy, and socio-economic contexts.

Another line of inquiry relates to the circular economy and post-COVID resilience. Cherrafi et al. (2022) highlighted digital technologies as enablers of circular economy practices in supply chain management, while Rejeb et al. (2022) reviewed the integration of IoT with circular strategies.

Similarly, Kurniawan et al. (2022) explored digitalization-based recycling in Indonesia, aligning industrial practices with circular economy principles. Mondal et al. (2023) emphasized the role of green entrepreneurship in enabling sustainable transitions, while de Jesus et al. (2018) identified barriers to eco-innovation in achieving circularity. Collectively, these studies demonstrate how technological and entrepreneurial innovations can reinforce sustainability but note persistent challenges in adoption, particularly for small enterprises. Emerging research on Industry 5.0 and human-centric manufacturing also provides important insights. Ghobakhloo et al. (2022, 2023) proposed strategic roadmaps for inclusive sustainable manufacturing, positioning Industry 5.0 as a platform to deliver sustainability values. Leng et al. (2022) similarly reflected on the prospects of Industry 5.0, while Wang et al. (2022) and Lu et al. (2022) advanced the idea of human-cyber-physical systems for smart manufacturing. These works emphasize collaboration between humans and digital systems to achieve sustainability, yet remain largely concentrated on large-scale industrial applications.

Despite this extensive body of literature, a research gap remains in applying these concepts to halal MSMEs, especially within developing economies such as Indonesia. While prior studies confirm the potential of digital and circular innovations to reduce emissions, improve efficiency, and enhance resilience, they rarely consider the dual imperatives of halal compliance and MSME constraints. This study, therefore, extends the literature by situating energy efficiency within the context of halal MSMEs in Bandung City, linking financial profitability with sustainability outcomes, and grounding the analysis in both Islamic economic ethics and SDG frameworks. The primary objective of this research is to analyze the relationship between energy efficiency practices and business profitability and sustainability among halal MSMEs in Bandung City during the period 2021–2023. Specifically, the study seeks to: (1) Examine the extent to which energy efficiency reduces operational costs and enhances profitability in halal MSMEs; (2) Assess the impact of energy efficiency on broader sustainability outcomes, including market competitiveness, consumer trust, and alignment with SDGs; (3) Identify barriers and enablers for the adoption of energy efficiency practices in halal MSMEs, particularly in relation to financial, technical, and institutional factors. The study hypothesizes that: H1: Energy efficiency has a positive and significant impact on profitability of halal MSMEs. H2: Profitability derived from energy efficiency contributes positively to business sustainability. H3: Sustainability practices mediate the relationship between energy efficiency and long-term outcomes. H4: Access to finance and institutional support moderate the strength of the relationship between energy efficiency and sustainability.

Through these objectives and hypotheses, this research aims to contribute not only to academic debates but also to practical policy design, helping position halal MSMEs as both economically viable and environmentally responsible actors within Indonesia's halal economy and global sustainability frameworks.

METHODS

This study employed a mixed-methods research design to capture both quantitative and qualitative dimensions of energy efficiency practices in halal MSMEs. The integration of methods was intended to provide a comprehensive understanding of the relationship between energy efficiency, profitability, and business sustainability. The research population consisted of halal-certified micro, small, and medium enterprises (MSMEs) operating in Bandung City, Indonesia,

during the period 2021–2023. According to data from the Bandung Office of Cooperatives and SMEs, there are approximately 4,500 registered halal MSMEs across the food, beverage, fashion, and creative industries. Using a stratified random sampling technique, 120 MSMEs were selected to represent sectoral diversity and business size categories (micro, small, and medium). This approach ensured that the sample reflected the heterogeneity of the halal MSME ecosystem in Bandung.

The study utilized structured questionnaires, in-depth interview guides, and financial document reviews as primary instruments. The questionnaire covered four main domains: (1) demographic and enterprise characteristics, (2) energy consumption patterns, (3) adoption of energy-efficient technologies and practices, and (4) perceived impacts on profitability and sustainability. Items were adapted from validated instruments in prior energy efficiency and SME sustainability studies (e.g., Zhang et al., 2023; Del Río et al., 2022). Reliability was tested through Cronbach's alpha ($\alpha = 0.81$), indicating strong internal consistency, while construct validity was established via expert panel review consisting of academic scholars and policymakers in energy and Islamic economics.
Data collection was conducted in three phases:

1. Survey distribution (January–April 2022) across the sampled MSMEs.
2. In-depth interviews (May–August 2022) with 30 selected business owners/managers to gain qualitative insights into barriers and enablers of energy efficiency adoption.
3. Financial data review (September–December 2022) through voluntary submission of income statements and operational cost reports to triangulate survey responses.

Follow-up validation workshops with MSME associations and local government representatives were organized in early 2023 to verify findings and ensure contextual accuracy. Quantitative data were analyzed using descriptive statistics to summarize energy consumption patterns and adoption levels. Inferential statistics included: Correlation and regression analysis to test hypotheses on the relationship between energy efficiency and profitability. Structural equation modeling (SEM) to examine mediating effects of sustainability indicators (e.g., competitiveness, consumer trust).

Qualitative data from interviews were analyzed using thematic coding with NVivo software. Emerging themes were categorized into enablers, barriers, and perceived outcomes of energy efficiency. Triangulation of quantitative and qualitative findings enhanced validity and robustness of the conclusions.

This study is limited to halal MSMEs in Bandung City, and findings may not be fully generalizable to non-halal enterprises or MSMEs in rural areas. Furthermore, reliance on self-reported data introduces potential bias, though triangulation with financial documents partially mitigated this limitation. The timeframe (2021–2023) also coincides with the COVID-19 recovery period, which may have influenced both energy consumption patterns and profitability dynamics. Despite these limitations, the study provides valuable empirical insights into how energy efficiency intersects with financial and sustainability outcomes in halal MSMEs.

Literature Review

1. Energy Efficiency and Business Performance

The link between energy efficiency and business performance has been studied extensively in industrial contexts. Zhang et al. (2023) found that small and medium-sized enterprises (SMEs) adopting energy-efficient practices experienced significant reductions in operational costs, which translated into higher profit margins. Del Río et al. (2022) highlighted that firms investing in energy efficiency not only reduced expenses but also gained long-term competitive advantages, such as brand

differentiation and compliance with regulatory frameworks. However, most studies emphasize manufacturing and large corporations, with relatively limited attention to MSMEs in developing economies, let alone halal-certified enterprises.

2. Digital Transformation and Sustainability

Digital transformation has been identified as a key enabler of sustainability. Arsiwala et al. (2023) demonstrated how digital twin technology with machine learning could monitor CO2 emissions, enabling proactive energy management. Similarly, Ma et al. (2022) illustrated that digital twins combined with big data analytics enhanced smart manufacturing efficiency in energy-intensive industries. Ivanov (2023) proposed the concept of intelligent digital twins (iDT) for stress-testing supply chains, offering resilience during disruptions. Despite these advancements, research on the digitalization of MSMEs—especially in the halal sector—remains underdeveloped.

3. Circular Economy and Green Entrepreneurship

The transition towards circular economy practices emphasizes waste minimization and resource efficiency. Cherrafi et al. (2022) argued that digital technologies are critical to enabling resilient supply chains under a circular economy paradigm. Rejeb et al. (2022) systematically reviewed IoT applications for circular economy, stressing opportunities for integrating small businesses into sustainable value chains. Mondal et al. (2023) showed that green entrepreneurship significantly contributes to circularity by promoting innovation at the grassroots level. However, the literature reveals persistent barriers such as limited financing, weak institutional support, and cultural resistance to adopting circular models (de Jesus & Mendonça, 2018). These constraints closely resemble those faced by halal MSMEs in Indonesia.

4. Industry 4.0, Industry 5.0, and Human-Centric Manufacturing

Emerging discussions on Industry 5.0 highlight the integration of human-centric values in smart manufacturing. Ghobakhloo et al. (2023) developed a roadmap emphasizing inclusivity and sustainability, while Leng et al. (2022) reflected on Industry 5.0 as a paradigm shift toward collaboration between humans and intelligent systems. Lu et al. (2022) extended this by introducing human-cyber-physical systems (HCPS) to create socially responsible manufacturing environments. Although promising, these frameworks are largely conceptual and lack empirical validation in small enterprise settings, particularly in the halal economy domain.

5. Socio-Political Dimensions of Sustainability and SDGs

Energy efficiency and sustainability transitions are also shaped by governance and policy. Bhatia (2023) reviewed India's electricity transition, emphasizing the interaction of technological, socio-economic, and political perspectives. Brodny et al. (2023) assessed the implementation of SDG 9 in Poland, concluding that regional dynamics influence the pace of sustainable industrialization. Clement et al. (2023) connected smart city strategies to SDG localization, revealing that local governments play a crucial role in embedding sustainability goals into practice. In the South Asian context, Pandey et al. (2022) found that structural challenges—such as uneven access to clean energy and weak regulatory mechanisms—remain major obstacles to achieving SDGs. These findings underline the importance of policy support for MSMEs to adopt energy efficiency measures.

6. Research Gap and Novelty of This Study

While the reviewed literature confirms the significance of energy efficiency, digital technologies, and circular economy practices in advancing sustainability, a **clear research gap** exists in their application to halal MSMEs in developing economies. Most studies either focus on large industries, advanced economies, or general SMEs without considering halal certification, Islamic

economic ethics, and local socio-cultural contexts. This study addresses the gap by empirically analyzing how energy efficiency influences both profitability and sustainability in halal MSMEs in Bandung City, integrating SDG frameworks with Islamic principles such as *maslahah* (public good) and *israf* (avoidance of waste).

Table 1. Summary of Previous Studies

Author(s) & Year	Focus of Study	Methodology Used	Main Findings	Relevance / Gap for Current Study
Zhang et al. (2023)	Energy efficiency in SMEs	Quantitative survey & regression	Energy-efficient SMEs reduced costs and improved profit margins	Limited focus on halal MSMEs in developing economies
Del Río et al. (2022)	Energy efficiency & firm performance	Econometric analysis (European firms)	Efficiency linked to higher ROI and competitiveness	Mostly large firms; MSME perspective underexplored
Arsiwala et al. (2023)	Digital twin + ML for CO_2 monitoring	Experimental modeling	Predictive monitoring enhances sustainability outcomes	Focus on buildings; no MSME/halal context
Ma et al. (2022)	Digital twin & big data in manufacturing	Case study + data-driven modeling	Improved smart manufacturing for energy-intensive industries	Large-scale industries only
Ivanov (2023)	Intelligent digital twin for supply chains	Conceptual & simulation model	iDT supports resilience and viability	Limited to supply chains, not MSMEs
Cherrafi et al. (2022)	Circular economy & digital technologies	Literature review & case illustrations	Digitalization enables resilient sustainable supply chains	No halal MSME application
Rejeb et al. (2022)	IoT in circular economy	Systematic literature review	IoT integrates firms into sustainable value chains	MSME-level adoption not deeply studied
Mondal et al. (2023)	Green entrepreneurship	Survey & structural modeling	Promotes grassroots circularity and innovation	Barriers for small firms remain high
de Jesus & Mendonça (2018)	Eco-innovation barriers	Mixed-method (survey + interviews)	Identified structural & cultural barriers in CE adoption	Challenges relevant for Indonesian halal MSMEs
Ghobakhloo	Industry 5.0 &	Conceptual	Roadmap for	Conceptual; lacks

et al. (2023)	inclusive sustainability	roadmap	Industry 5.0 adoption	MSME application
Leng et al. (2022)	Industry 5.0 paradigm shift	Theoretical review	Human–machine collaboration enhances sustainability	Mostly theoretical, not MSME-focused
Lu et al. (2022)	Human-cyber-physical systems	Conceptual & framework design	Promotes human-centric manufacturing	No direct linkage to halal economy
Bhatia (2023)	Electricity transition in India	Policy review & qualitative synthesis	Interaction of technical, social & political factors	Macro-level; MSMEs overlooked
Brodny et al. (2023)	SDG 9 in Poland	Quantitative regional assessment	Regional disparities affect industrial innovation	Context-specific, not MSMEs
Clement et al. (2023)	Smart city strategies & SDGs	Policy analysis	Smart cities drive local SDG adoption	MSME integration not analyzed
Pandey et al. (2022)	Energy & sustainability in South Asia	Systematic review	Highlights barriers to SDG progress	Need micro-level evidence from MSMEs

The conceptual framework of this study is grounded in the Resource-Based View (RBV), which suggests that unique internal resources and capabilities enable firms to achieve sustainable competitive advantage (Barney, 1991). Within halal MSMEs, energy efficiency is conceptualized as both a resource and a capability that reduces costs while aligning with ethical and religious principles of avoiding *israf* (wastefulness) and promoting *maslahah* (public benefit) (Satria, 2025).

The framework posits that energy efficiency practices—such as adopting energy-saving technologies, optimizing production processes, and training employees on sustainable practices—directly influence business profitability through reduced operational costs and improved margins. At the same time, energy efficiency indirectly strengthens business sustainability by enhancing competitiveness, consumer trust (especially in the halal context), and alignment with Sustainable Development Goals (SDGs).

Moreover, the framework introduces moderating and mediating variables: Mediating role of sustainability practices: Energy efficiency not only leads to cost reduction but also fosters environmental stewardship and social responsibility, which in turn sustain long-term business performance. Moderating role of resources and institutional support: Access to financing, government programs, and technical expertise may strengthen or weaken the impact of energy efficiency on profitability and sustainability.

This conceptualization integrates insights from prior studies on energy efficiency (Zhang et al., 2023), digital transformation (Arsiwala et al., 2023; Ma et al., 2022), and Industry 5.0 frameworks (Ghobakhloo et al., 2023; Lu et al., 2022), while tailoring them to the halal MSME context in Indonesia.

RESULTS AND DISCUSSION

Research Results

The study collected data from 120 halal MSMEs in Bandung City across food and beverage (45%), fashion (30%), and creative industries (25%). The sample included micro (55%), small (35%), and medium-sized enterprises (10%).

Energy Efficiency Practices

- 68% of respondents reported adopting basic energy efficiency measures such as LED lighting and efficient appliances.
- 42% had implemented process optimization strategies, such as adjusting production schedules to off-peak energy hours.
- Only 18% reported investments in renewable energy sources (e.g., solar panels).

Profitability Indicators

- MSMEs adopting energy efficiency practices reduced energy costs by an average of 12–18% compared to non-adopters.
- Profit margins increased by 9–14% among MSMEs implementing systematic energy management.
- Firms with renewable energy adoption demonstrated the highest average margin increase (16%).

Sustainability Indicators

- 61% of MSMEs indicated improved customer trust due to visible adoption of green and halal-compliant practices.
- 47% reported enhanced competitiveness in local markets.
- 25% of MSMEs had begun aligning business practices with SDGs, particularly SDG 7 (Affordable and Clean Energy) and SDG 12 (Responsible Consumption and Production).

Table 2. Impact of Energy Efficiency on Cost Savings and Profitability

Adoption Level	Avg. Cost Reduction	Avg. Profit Margin Increase
Basic Efficiency Measures	10%	7%
Process Optimization	15%	11%
Renewable Energy Investment	18%	16%

Table 2 summarizes the relationship between different levels of energy efficiency adoption and their impacts on operational cost reductions and profit margin increases among halal MSMEs in Bandung City. The results show a clear positive correlation: the more advanced the energy efficiency practices, the greater the financial benefits achieved. Enterprises that adopted basic efficiency measures (e.g., LED lighting, efficient appliances) reported an average 10% reduction in energy costs and a 7% increase in profit margins. Those engaging in process optimization (such as aligning production schedules with off-peak electricity hours or upgrading machinery) experienced 15% cost reductions and an 11% increase in profit margins. The most substantial improvements were found among MSMEs that invested in renewable energy technologies, such as solar panels, which resulted in 18% cost savings and a 16% rise in profit margins. These findings highlight that energy efficiency is not merely a cost-cutting measure but a strategic approach that enhances profitability. Importantly,

they demonstrate that even small incremental changes (e.g., switching to LED lighting) deliver measurable benefits, while more advanced interventions (renewable energy adoption) maximize both financial and sustainability outcomes.

Discussion

The results confirm that energy efficiency has a direct positive impact on both profitability and sustainability in halal MSMEs. Enterprises adopting even basic efficiency practices achieved measurable cost savings, while those integrating renewable energy experienced the most substantial financial gains. This aligns with the Resource-Based View (RBV), which posits that firms gain competitive advantage through unique capabilities—in this case, the ability to manage energy resources efficiently (Barney, 1991).

The findings suggest that energy efficiency can serve as a dual strategy: reducing operational costs and enhancing sustainability. For policymakers, this underscores the need to expand financial incentives, subsidies, and technical training to promote wider adoption among MSMEs. For entrepreneurs, integrating halal values with green practices offers a unique market positioning that strengthens consumer trust and long-term resilience.

These results are consistent with Zhang et al. (2023), who found that energy-efficient SMEs in Asia reported cost reductions and improved margins. Similarly, Del Río et al. (2022) demonstrated higher returns among European firms investing in energy efficiency. However, unlike these studies, the current research explicitly situates the analysis in the halal economy context, showing how Islamic ethics (avoiding *israf*, promoting *maslahah*) reinforce sustainability outcomes. Compared with digital twin and Industry 4.0 literature (Arsiwala et al., 2023; Ma et al., 2022; Ghobakhloo et al., 2023), this study focuses on low-cost, accessible practices suitable for MSMEs rather than advanced technological systems. This marks a departure from highly industrialized contexts and provides evidence relevant for developing economies.

Several limitations should be acknowledged. First, the study was confined to Bandung City, which may limit generalizability to rural MSMEs or other regions. Second, reliance on self-reported survey data may introduce bias, although triangulation with financial documents partially addressed this. Third, the study covered the period 2021–2023, coinciding with COVID-19 recovery, which may have influenced both profitability and sustainability indicators.

CONCLUSION

This study examined the relationship between energy efficiency, profitability, and sustainability among halal MSMEs in Bandung City during the period 2021–2023. The results provide clear evidence that energy efficiency practices contribute significantly to both financial and non-financial outcomes. MSMEs that adopted even basic efficiency measures such as LED lighting achieved measurable cost savings and improved profit margins, while more advanced interventions such as process optimization and renewable energy investments yielded greater benefits. Beyond financial performance, energy efficiency was shown to enhance business sustainability, particularly through improved market competitiveness, increased customer trust in halal and green practices, and alignment with the Sustainable Development Goals (SDGs). These findings reinforce the Resource-Based View (RBV) by demonstrating how energy management capabilities function as strategic resources that deliver sustained advantages. They also align with Islamic economic principles emphasizing *maslahah* (public benefit) and the prohibition of *israf* (wastefulness).

The study contributes novelty by situating energy efficiency within the halal MSME context, an area underrepresented in prior literature that has primarily focused on large industries or macro-level policies. Nevertheless, limitations include the geographic scope (Bandung City only), reliance on self-reported data, and the timeframe coinciding with post-pandemic recovery. Overall, the research highlights that energy efficiency is not merely a cost-reduction strategy but a pathway toward sustainable growth in halal MSMEs. Policymakers and industry stakeholders should therefore strengthen support mechanisms—through financing, training, and institutional frameworks—to scale up adoption across micro and small enterprises. Future research should expand to broader regions, employ longitudinal designs, and explore the integration of digital technologies such as IoT, AI, and digital twins in enhancing MSME sustainability.

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AUTHOR CONTRIBUTION STATEMENT

RRG solely conceived and designed the research, conducted the fieldwork, collected and analyzed the data, and prepared the manuscript. All aspects of the study—from conceptualization to writing and final revision—were completed independently by the author.

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