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A Systematic Review of Energy Efficient Appliances Adoption in Developing Country

Hafiza Aprilia[1], Yudha Prambudia[2], Husni Amani [3]
[1,3]Department of Industrial engineering, Telkom University, Indonesia
[2]School of Industrial Engineering, Telkom University, Indonesia

ABSTRACT

This research examines the escalating energy demand, particularly driven by household electrical appliances in developing countries, highlighting a critical juncture for sustainable development. Through a systematic literature review, the study analyzes the complexity of energy-efficient appliance adoption with a comprehensive approach. Findings underscore the intricate interplay of economic, cultural, and technological factors shaping the adoption landscape, emphasizing the urgent need for transformative measures. Beyond identifying barriers, the research unveils best practices and success stories from developing countries, providing actionable insights. Technological innovations are explored as beacons of hope, offering tangible solutions to identified barriers. Government policy evaluation emphasizes the pivotal role of governance. The study concludes by underscoring the crucial importance of enhancing the adoption of energy-efficient household appliances in developing countries for sustainable development.

Keyword : Energy efficiency, Household electrical appliances; Adoption

Corresponding Author:
Yudha Prambudia,
Department of Industrial engineering,
Telkom University, Indonesia
Jl. Telekomunikasi. 1, Terusan Buahbatu - Bojongsoang, Telkom University,
Sukapura, Kec. Dayeuhkolot, Kabupaten Bandung, Jawa Barat 40257, Indonesia.
Email : prambudia@telkomuniversity.ac.id

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1. INTRODUCTION

The escalating electricity consumption in the household sector, driven by population growth, can have severe environmental repercussions (Ha & Janda, 2012). The primary cause is the utilization of fossil fuels in power generation, contributing to increased greenhouse gas emissions and global warming (Tan et al., 2017). In this context, this research centers on the significance of adopting Energy-Efficient Appliances (EEA) as a solution to reduce electricity consumption in households (Ha & Janda, 2012). Despite the global recognition of the energy efficiency concept in EEA, their adoption in developing countries still faces significant (B. Wang et al., 2021). Factors such as economic barriers, cultural preferences, and technological considerations are the primary focus of this study to identify effective strategies for enhancing EEA adoption and promoting more sustainable consumption patterns (Wijaya & Tezuka, 2013).

Research on the adoption of Energy-Efficient Appliances (EEA) in developing countries holds the potential to deliver positive environmental impacts (Bhutto et al., 2022). Focusing on the dynamics of household electrical appliance usage, the study provides profound insights into energy consumption patterns influenced by socio-economic factors, cultural nuances, and infrastructural disparities. This understanding serves as a critical foundation for formulating strategies to minimize energy consumption and encourage sustainable practices in the region (Ali et al., 2021).

Furthermore, the identification of barriers such as economic constraints, cultural influences, and technological challenges becomes a primary focus for enhancing EEA adoption using systematic literature review research in other countries. The research not only explores these obstacles but also offers potential solutions, including marketing strategies, price adjustments, and consumer education approaches (Pierce et al., 2010). By detailing energy-efficient technologies, the study outlines the potential for reducing carbon emissions, conserving natural resources, and mitigating environmental pollution (Ehrhardt-Martinez, 2011). Thus, this research goes beyond merely informing about EEA adoption, it significantly contributes to the efforts to create a more sustainable environment in

developing countries. Based on the background presented above, it can be observed that the research problem is formulated as follows:
RQ1 : What factors influence individuals in the selection of energy-efficient household electrical appliances?
RQ2 : What proposed programs are appropriate for promoting the use of energy-efficient household electrical appliances among the public?

2. RESEARCH METHOD

The objective of this literature review is to systematically examine the current status of Energy Efficiency Appliance (EEA) adoption in the country, identifying key components and relationships. Utilizing a systematic literature research method with structured content analysis, the study follows Fisch and Block (2018) purpose of enhancing existing research evidence and pinpointing research gaps. Fisch and Block (2018) recommended a four-step process for structured content analysis includes material collection, descriptive analysis, identification of categories, and material evaluation. The subsequent section details these steps and presents analysis outcomes.

In this phase, the material slated for analysis was delimited, and the unit of analysis was specified. To ensure the inclusion of only rigorous studies in our review, our search was restricted to articles published in English-language impact factor journals. We further refined our search by utilizing keywords related to key constructs derived from our research questions about energy efficiency adoption, and promotion in the country. Our search targeted articles published between 2010 and 2023, a starting point chosen based on the publication dates of pivotal articles on energy efficiency appliances (Dianshu et al., 2010; Turaga et al., 2010, p. 22). Searches were conducted across various databases, including Scopus, Science Direct, and Elsevier using the application publish or perish.

The citation index employed the following keywords: "energy efficient appliance" OR "energy efficient appliances household" OR "energy efficiency" OR “purchase energy efficient" AND "consumer intention". In the Descriptive Analysis stage, the formal characteristics of the submitted articles were scrutinized to establish a foundation for subsequent content evaluation. The assessed formal characteristics for each item included in the review encompassed publication date, publication channel, methodology, data analysis techniques, and theoretical perspectives (Fisch and Block, 2018).

The Category Identification step involved deducing analytical categories in a two-step process that combined deductive and inductive approaches, as recommended by Seuring and Gold (2012). Firstly, basic analytical categories were deduced from the framework for energy consumption sector household developed by Dianshu (2010). This framework, investigates barriers to energy efficiency, explores household electricity consumption patterns, assesses consumer awareness, and provides recommendations for improvement.

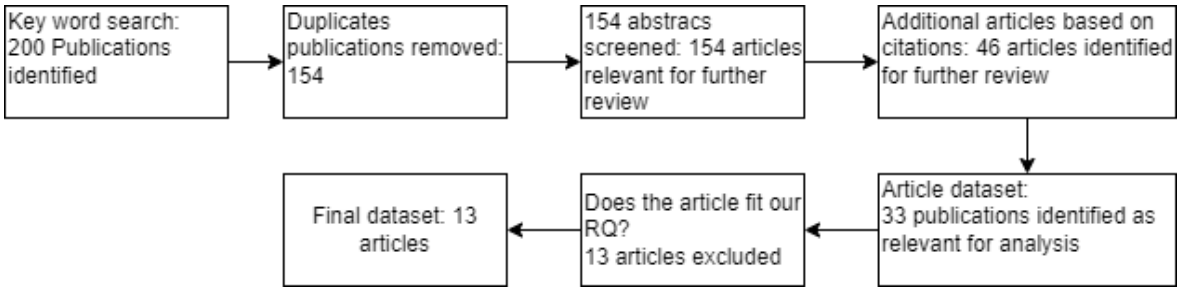

Figure 1 Article Search, Evaluation, and Exclusion Process.

At the material evaluation stage, all items were coded according to the categories identified in the previous stage using convidence application. Adoption energy-efficient appliance outcome measures were coded to reflect each article's focus on environmental, social, or economic dimensions. Once all articles were coded according to the adoption of energy-efficient appliance outcomes, we identified the key factor preference individuals to choose energy-efficient appliances and programs that are appropriate for promoting the use of energy-efficient household electrical appliances. For this purpose, each item was coded to reflect the energy consumption in household electricity and the interrelated mechanisms that target to increased use energy energy-efficiency appliances. We also identified existing research gaps that can serve as a guide for future research.

3. RESULTS AND DISCUSSION

Review Finding

This section contains the results of the descriptive analysis, category identification, and material evaluation steps. The results of the descriptive analysis present library and project research data for each object, helping to contextualize the category identification and material evaluation phases. Key elements of the energy efficiency appliances household adoption were identified as a result of the category identification step. In the material evaluation phase, we analyzed the content of the mentioned articles and synthesized these key elements at the highest level.

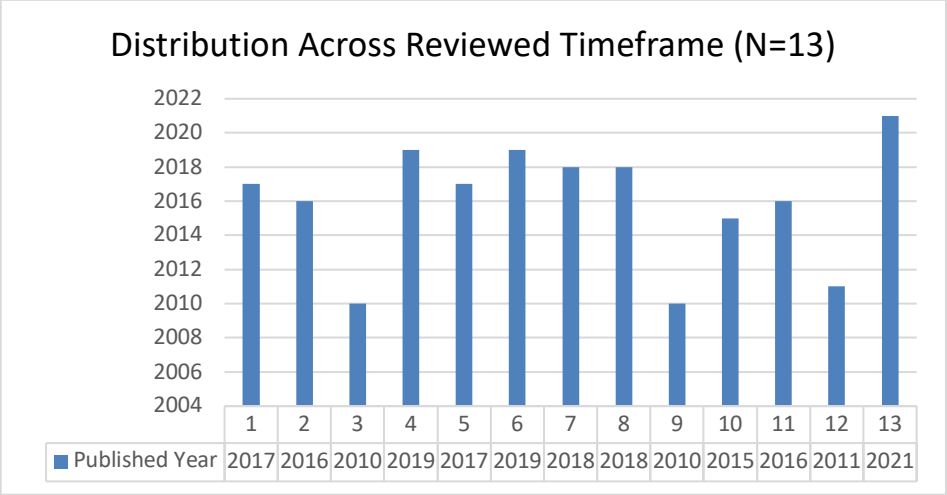

Fig.2 Article Distribution Across Reviewed Timeframe.

A. Descriptive analysis

Release date trends that provide insight into the evolution of energy-efficient appliances research over time in the household all articles were published between 1999 and 2023. The output articles in the dataset help us understand the extent to which energy efficiency in the household is considered by researchers in operational management and other management disciplines. This research aims to analyze the adoption of energy efficiency in households in the country, with a focus on factors influencing consumer decisions (Z. Wang et al., 2017). While evaluating the increasing awareness among academics from various disciplines regarding the research adoption of energy-efficient appliances as a solution to address sustainability challenges, particularly in supporting net zero emissions programs in sector households and the journals in our dataset are displayed in Table 1 below:

Table 1 Identification Journal

Journal	**Article (N=13)**
Ecological Economics	1
Energy	1
Energy Policy	4
Energy Procedia	1
International Journal of Consumer Studies	3
Journal of Cleaner Production	1
Journal of Retailing and Consumer Services	1
Sustainability (Switzerland)	1

Table 2 Identification Journal (Continuing)

Research Method	Number of article (N = 13)
Qualitative	3
Quantitative	10

B. Category Identification
To structure the literature review, follow the conceptual framework proposed about consumer behavior in electricity in households by Dianshu (2010) and the adoption of energy-efficient appliance outcomes. These initial categories are then refined by induction during the material evaluation phase. Therefore, the final analysis categories used to synthesize the content of the reviewed articles were compulsively developed during the literature review.

Table 3 Category Journal

Category	Desc	**References**
Behavior Intention-based consumer	Describe how consumers significant influencers of behavior intention to change EEA any factors are self-identity, green self-identity, responsibility attribution, personal norm, subjective norm, attitude, behavioral control, label cognition, label distrust, label reference willingness, biospheric values, ethnic, motivational, and cognitive.	Neves (2021); Ma (2011); Baldini (2018); Wang (2019); Li (2019); Nguyen (2016); Tan (2017)
Energy saving and sustainability based on policy	Describe how consumers adopt energy-saving household appliance practices and how they can implement government policies	Stadelmann (2018); Dianshu (2010); Mizobuchi (2016); Geppert (2010); Segev (2015); Nguyen (2017)

In our pursuit to unravel the complexities surrounding the adoption of energy-efficient appliances in developing nations, this study focuses on understanding and addressing key factors influencing consumer decisions. The multifaceted nature of this challenge demands a holistic approach, taking into account economic, cultural, technological, and policy-related considerations.

A. Economic Considerations:
Our research highlights the pervasive influence of income disparities on the adoption of energy-efficient appliances. Lower-income segments face substantial affordability challenges, hindering their ability to invest in such technologies (Neves, 2021). To bridge this gap, policy interventions are recommended to incorporate innovative financial mechanisms, including micro-financing or subsidized loan programs, to broaden accessibility (Li, 2019).

B. Cost-Benefit Analysis:
Engaging consumers in a transparent cost-benefit analysis is identified as a critical factor in driving adoption (MA, 2011). Emphasizing long-term financial savings and potential reductions in electricity bills serves as a compelling motivator. Exploring strategies such as bulk purchase incentives or discounts is imperative to alleviate the upfront cost burden.

C. Cultural Dynamics:
Recognizing diverse cultural preferences revealed by our survey, industry stakeholders are urged to prioritize the customization of energy-efficient appliances (Segev, 2015). This involves tailoring product features, designs, and functionalities to align with local preferences, ultimately enhancing consumer resonance. Collaborations with local designers and cultural experts are essential for product innovation.

D. Technological Advancements:
Regions with limited technological infrastructure require strategic investments to facilitate the widespread adoption of innovative technologies. Improving access to reliable electricity, enhancing internet connectivity, and fostering digital literacy are foundational steps. Quality assurance and

reliability of energy-efficient appliances are addressed through industry-wide initiatives, transparent warranty programs, and publicizing success stories to alleviate consumer apprehensions (Mizobuchi, 2016).

E. Policy Frameworks:
Recognizing the multifaceted nature of barriers, our study advocates for holistic policy approaches. Integrating economic incentives with cultural sensitivity and technological advancements ensures a more comprehensive impact (Stadelmann, 2018). Governments are encouraged to revisit existing policies, seeking iterative improvements based on ongoing research and evolving consumer dynamics.

F. Education Initiatives:
The transformative role of consumer education initiatives is underscored by our survey. Policymakers are urged to prioritize educational campaigns that not only raise awareness but also foster a deeper understanding of the long-term benefits of energy-efficient appliances (Nguyen, 2017);. Educational programs should extend beyond traditional mediums, leveraging digital platforms and community engagement strategies.

G. Intersectionality and Collaborative Approaches:
The interplay of economic, cultural, and technological factors emphasizes the need for integrated approaches. Siloed interventions may yield limited results, necessitating collaborative efforts between government bodies, industry players, and community organizations (Geppert, 2010). Integrated solutions that simultaneously address multiple barriers offer a more sustainable pathway to adoption.

H. Public-Private Partnerships:
Public-private partnerships are identified as pivotal in driving transformative change. Governments are encouraged to collaborate with industry stakeholders to implement large-scale awareness campaigns, subsidized financing programs, and technology-driven solutions (Baldini,2018). Such partnerships foster shared responsibility and capitalize on the strengths of each sector.

In this section, it is explained the results of the research and at the same time is given a comprehensive discussion. In the pursuit of increasing the utilization of Energy-Efficient Appliances (EEA) in residential settings, a comprehensive approach that integrates various action strategies is essential. Firstly, the implementation of a thorough educational campaign serves as the foundational pillar to impart in-depth understanding to the community regarding the benefits of EEA, encompassing energy savings, reduced electricity costs, and positive environmental impacts (Nguyen, 2016). Concurrently, the application of purchase subsidies and financial incentives aids in overcoming economic barriers, making investments in energy-efficient equipment more affordable.

Subsequently, the community partnership and local design strategy are employed to create EEA products aligned with local cultural preferences. Collaboration with local designers and involving the community in product development not only enhances product sustainability but also strengthens community engagement in eco-friendly technology. Simultaneously, the technology infrastructure enhancement program supports restricted access in specific regions, including the installation of reliable electrical systems and digital training for local residents (Tan et al., 2017). To augment public understanding and acceptance, free energy audit and consultation programs are provided to offer personalized recommendations based on the needs and conditions of each household. Initiatives such as collaborative projects involving active community participation, such as bulk purchase incentives, constitute tangible steps towards embracing EEA. Transparent after-sales services and quality assurance complement these strategies to build consumer trust.

In terms of government regulations, public-private partnerships are crucial to supporting the development of EEA infrastructure. Joint investments in research and development projects, along with the implementation of community outreach programs, reinforce private sector involvement. Finally, the development of a digital platform for education, consumer feedback, and community discussions refines this strategy (Li et al., 2019). Through periodic monitoring and evaluation, these action strategies can be optimized according to changes in external conditions, yielding the desired positive impact within the community.

4. CONCLUSION

In conclusion, achieving widespread adoption of energy-efficient appliances (EEA) in developing countries requires a holistic approach. Collaborative efforts should focus on implementing accessible financial models, such as micro-financing and subsidized loans, demonstrated through pilot projects. Industry players should take concrete steps by collaborating with local stakeholders to develop EEA models aligned with diverse cultural preferences. Community-centric campaigns, led by local influencers, can shape positive social norms with real-life success stories.

The pivotal role of technology demands immediate action through investments in electricity infrastructure and quality assurance measures. Infrastructure enhancement projects, launched in specific regions, can showcase the positive impact on reliable electricity access and internet services, laying the foundation for EEA adoption. Adaptive policy frameworks, coupled with educational initiatives, are crucial for navigating the evolving landscape. Governments should reassess and enhance policies based on emerging research, while comprehensive educational programs foster a deeper understanding of the environmental and financial benefits of EEA.

Collaborative global efforts amplify impact and foster a shared commitment to sustainability. Developed nations can support developing countries through knowledge transfer, financial aid, and technology exchange programs. Pilot projects showcasing successful collaborations serve as tangible examples of positive outcomes. By addressing economic, cultural, and technological aspects and implementing tangible actions, stakeholders can pave the way for a more equitable and environmentally conscious future through the widespread adoption of energy-efficient appliances.

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