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ADVANCES IN SOCIAL HUMANITIES RESEARCH

Assessing Electric Water Heater Adoption and Feasibility for Micro-Enterprise Electrification in Banda Aceh

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Abstract

Indonesia's dependence on subsidized liquefied petroleum gas (LPG), coupled with recurring shortages in Aceh, creates cost and supply risks for coffee shops that require hot water for up to 18 hours per day. This study assesses the financial feasibility of electric water heaters (Ie Warm) under the PLN RENCONG program as an alternative to LPG and examines coffee shop owners' intentions to adopt the technology in Banda Aceh. Financial feasibility was evaluated through installation trials at two coffee shops using the payback period, net present value (NPV), internal rate of return (IRR), and profitability index (PI). Adoption intentions were analyzed using an extended Technology Acceptance Model (TAM) incorporating cost affordability and perceived safety, with partial least squares structural equation modeling (PLS-SEM) applied to survey data from 72 valid respondents. Electricity had a lower cost per unit of useful energy than LPG, resulting in savings of 62.1% compared with non-subsidized LPG cylinders and 24.2% compared with subsidized cylinders. All investment scenarios were financially feasible, with payback periods ranging from 5.14 to 23.64 months and positive NPV values. Perceived usefulness was the only belief construct that significantly influenced attitude ($\beta = 0.809$), while attitude strongly predicted behavioral intention ($\beta = 0.785$). Perceived ease of use had no significant effect on attitude ($\beta = 0.016$), whereas perceived safety was the strongest predictor of perceived usefulness ($\beta = 0.700$). However, behavioral intention remained below the neutral point, and 97.2% of respondents had never observed the device in operation. Therefore, this study proposes a segmentation, targeting, and positioning (STP) strategy emphasizing product demonstrations, safety, and supply security, with initial targeting focused on coffee shops that use non-subsidized LPG cylinders and have sufficient electrical capacity.

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INTRODUCTION

Indonesia currently faces a critical challenge in maintaining national energy security due to its heavy reliance on fossil fuels (Gobel et al., 2024). Indonesia's national consumption of liquefied petroleum gas (LPG) reaches approximately 7 million metric tons annually, while domestic production supplies only about 1.8 million metric tons per year (Detik Finance, 2024).

This supply deficit is addressed through imports, placing additional pressure on energy subsidies (Belaïd, 2022). LPG has become a primary source of thermal energy, replacing kerosene following the introduction of the national energy conversion program in 2007. Among the LPG products distributed to consumers, 3-kg LPG cylinders were designated as subsidized commodities under Presidential Regulation of the Republic of Indonesia No. 104 of 2007, primarily targeting households and micro-, small-, and medium-sized enterprises (MSMEs).

Dependence on fossil fuels, combined with supply and distribution constraints, has contributed to LPG shortages in Indonesia, particularly in Aceh Province. Consequently, the price of 3-kg LPG cylinders in Aceh has increased due to supply scarcity and uneven distribution. This situation adversely affects the economic sustainability of MSMEs, particularly coffee shops that rely on LPG as a consistent source of thermal energy for manual coffee brewing (Kompas, 2024).

Banda Aceh, the capital of Aceh Province, has 301 coffee shops among its 682 registered tourism facilities (Dinas Pariwisata Kota Banda Aceh, 2023). These figures indicate that coffee shops account for approximately 44% of the registered tourism facilities. The number of coffee shops increased by 63% in 2024, reflecting growing interest in coffee consumption and related businesses. An initial survey of 30 coffee shops across Banda Aceh found that 78% relied on subsidized LPG for water heating. On average, these establishments required hot water for up to 18 hours per day. This dependence means that LPG shortages can impose considerable economic pressure on coffee shops in Banda Aceh, particularly given the important contribution of MSMEs, whose competitiveness increasingly depends on technology adoption (Purnomo et al., 2024), to the region's gross domestic product (GDP) (Maulana et al., 2024).

Therefore, addressing LPG shortages in coffee shops requires exploring alternative energy sources, particularly electricity. This transition could be facilitated by replacing LPG-based water heating systems with electric water heaters, such as the Ie Warm device. However, assessing the economic viability of this substitution requires a financial feasibility study involving device installation and operational trials at selected coffee shops in Banda Aceh (Hilmiyati-Mas'adah et al., 2024). Coffee shops represent an important segment of MSMEs and contribute significantly to the economic structure of Aceh Province (Rahmaddiansyah et al., 2022). Their continuous demand for thermal energy to support coffee brewing has made LPG a primary energy source. However, shortages of 3-kg LPG cylinders can lead to price increases and supply uncertainty (Metro TV, 2025). These conditions reinforce dependence on fossil fuels and impose additional financial burdens on business owners.

These challenges present an opportunity to promote electrification in the MSME sector. This potential is supported by Aceh's electricity system, which has surplus generation capacity and a relatively high level of supply reliability. According to PLN's electricity system projections for 2025–2029, the reserve capacity margin is estimated at 30% in 2025 and is projected to increase to 39% by 2029. These projections suggest that Aceh's electricity system has the potential to support expanded electrification initiatives in the MSME sector (PT PLN (Persero), 2025). Although previous studies have examined the transition from LPG to electricity at the household level (Hakam et al., 2022, 2025; Hilmiyati-Mas'adah et al., 2024) and the acceptance of renewable energy technologies using the Technology Acceptance Model

(TAM) (Siuda & Gręboszc-Krawczyk, 2025), while extended TAM models continue to be applied to new technologies across sectors (Ali et al., 2025; Casallas-Hernández et al., 2025; Domingo et al., 2025; Gebsombut et al., 2025; Ngo et al., 2025), the integration of financial feasibility assessment and an extended TAM framework for micro-enterprise electrification in regions experiencing fuel shortages remains insufficiently explored. This study addresses this research gap by integrating financial feasibility indicators, including the payback period, net present value (NPV), internal rate of return (IRR), and profitability index (PI), with partial least squares structural equation 1916odelling (PLS-SEM), an approach supported by a growing range of statistical programs (Memon et al., 2021). The proposed framework extends the conventional TAM by incorporating cost affordability and perceived safety, using primary data collected from coffee shops in Banda Aceh. The novelty of this study lies in its integrated financial feasibility and technology acceptance assessment, complemented by a segment-specific adoption strategy. The findings are expected to provide practical insights for PT PLN (Persero) and local policymakers in implementing the RENCONG program by identifying coffee shop segments in which electric water heater adoption is most likely to be financially viable and behaviorally acceptable.

METHOD

This study employed a quantitative research approach to assess the financial feasibility of electric water heater adoption in traditional coffee shops in Banda Aceh using net present value (NPV), internal rate of return (IRR), and payback period analyses. The Technology Acceptance Model (TAM) was integrated with partial least squares structural equation 1916odelling (PLS-SEM) to examine factors influencing technology adoption.

Primary data were collected through a cross-sectional survey covering six variables: cost affordability, perceived safety, perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using, and behavioral intention. Data collection was conducted with respondents' consent and authorization from the National Unity and Political Agency (KESBANGPOL) of Banda Aceh City. The sample was determined using multistage probability sampling and Cochran's formula (Cochran, 1977) ($z = 1.96$, $p = 0.5$, $d = 0.10$). Of the 294 coffee shops in the study population, 73 were selected, yielding 72 valid responses.

The study had two main methodological limitations. First, the sample size was determined using Cochran's formula for population proportion estimation rather than statistical power analysis for PLS-SEM. With 72 respondents, the study had approximately 80% power to detect path coefficients of 0.29 or greater at a 5% significance level. Consequently, nonsignificant coefficients below this threshold could not be interpreted as evidence of no effect. Second, moderation effects were not examined because of the limited sample size. Previous experience, respondent position, and business age were therefore analyzed descriptively.

RESULTS AND DISCUSSION

Investment Cost

Capital expenditure in this study comprises two main components: the procurement and installation of the electric water heating equipment, and the connection or upgrade of electrical

capacity with PT PLN (Persero). The second component is conditional, as it is required only when the existing connected capacity is insufficient to carry the heater load.

Equipment Prices for the Single-Heater Configuration

Equipment prices are organized by heater power rating and consist of three components: the heating unit, the control components, and the installation cost. The price breakdown for the single-heater configuration is presented in Table 1.

Table 1. Equipment Price Breakdown for the Single-Heater Configuration

Component	500 W	1,000 W	1,500 W	2,000 W	2,500 W	3,000 W
Heating unit	500,000	600,000	700,000	800,000	900,000	1,000,000
Control components	500,000	500,000	550,000	550,000	600,000	600,000
Installation	500,000	500,000	650,000	650,000	750,000	750,000
Total	**1,500,000**	**1,600,000**	**1,900,000**	**2,000,000**	**2,250,000**	**2,350,000**

Equipment Prices for the Two-Heater Configuration

The equipment price list also provides a package scheme with two heating units. This configuration is relevant for coffee shops that require two simultaneous hot-water points. The costing principle for this configuration is that the control component is counted once at the higher power rating,

IV.1.3 SK10	Overall my attitude is positive	72	1	7	4.0	4.458	1.363	Somewhat Agree

Structural Model Evaluation (Inner Model)

The structural model is evaluated to assess the relationships among latent constructs, covering collinearity checks, the coefficient of determination, and effect size.

Collinearity Check

Variance inflation factor values across all structural paths range from 1.000 to 1.561, well below the required threshold of 3.3 (Hair et al., 2019). No collinearity among exogenous constructs was found in the structural model.

Following the procedure set out in Chapter III, the risk of common method bias was tested using the full collinearity VIF approach. The check was carried out at two levels because structural path VIF and full collinearity VIF measure different things. The first examines collinearity among predictors within each structural equation, while the second regresses each construct on all other constructs and can therefore capture signs of common method bias (Kock, 2015). Because all constructs were measured from a single respondent at a single point in time using the same response format, the full collinearity VIF test was applied as a separate check, and all values fell below the 3.3 threshold.

Coefficient of Determination (R squared)

The coefficient of determination shows the proportion of variance in an endogenous construct explained by its exogenous constructs. The categories follow R squared thresholds of 0.75 for strong, 0.50 for moderate, and 0.25 for weak (Hair et al., 2019).

Table 3. Coefficient of Determination (R squared)

Endogenous construct	R squared	Adjusted R squared	Category
Perceived Usefulness	0.722	0.714	Moderate, approaching strong
Perceived Ease of Use	0.340	0.321	Weak, approaching moderate
Attitude Towards Using	0.668	0.658	Moderate, approaching strong
Behavioral Intention	0.616	0.611	Moderate, approaching strong

Cost Affordability and Perceived Safety together explain 72.2% of the variance in Perceived Usefulness and 34.0% of the variance in Perceived Ease of Use. Perceived Usefulness and Perceived Ease of Use in turn explain 66.8% of the variance in Attitude Towards Using, and Attitude Towards Using explains 61.6% of the variance in Behavioral Intention. The chain of explanation therefore holds at every stage, and the weakest link is Perceived Ease of Use, whose antecedents account for only about a third of its variance.

Effect Size (f squared)

Effect size is calculated to assess how much each exogenous construct contributes to the R squared of its endogenous construct, using thresholds of 0.02 for small, 0.15 for medium, and 0.35 for large (Cohen, 1988).

Table 4. Effect Size (f squared) of the Main Structural Paths

Path	f squared
Attitude Towards Using → Behavioral Intention	1.607
Perceived Usefulness → Attitude Towards Using	1.472
Perceived Safety → Perceived Usefulness	1.131
Cost Affordability → Perceived Ease of Use	0.291
Cost Affordability → Perceived Usefulness	0.110
Perceived Safety → Perceived Ease of Use	0.003
Perceived Ease of Use → Attitude Towards Using	0.001

Attitude Towards Using is the only determinant of Behavioral Intention tested, with an effect size of 1.607, which falls well inside the large category. Among the two beliefs forming attitude, Perceived Usefulness records an effect size of 1.472, also large, while Perceived Ease of Use records 0.001, which is negligible. Perceived Safety is the strongest determinant of Perceived Usefulness with an effect size of 1.131, whereas Cost Affordability is the strongest determinant of Perceived Ease of Use at 0.291. The contrast between 1.472 and 0.001 in the formation of attitude is the sharpest result in the model and sets the priority for the strategy developed in Section IV.5.

Effects of Perceived Usefulness and Perceived Ease of Use on Attitude

Perceived Usefulness has a significant positive effect on Attitude Towards Using (H6: $\beta = 0.809$; $t = 13.756$; $p < 0.001$), whereas Perceived Ease of Use does not (H5: $\beta = 0.016$; $t = 0.221$; $p = 0.825$). Respondents' attitudes are therefore shaped by the operational benefit they expect from the electric water heater and not at all by how easy they expect it to be to use. This is consistent with the core of the Technology Acceptance Model since its original formulation, which has repeatedly found Perceived Usefulness to be the stronger determinant of attitude and intention (Davis, 1989; Venkatesh & Davis, 2000), and with findings on household cooking energy transitions in Indonesia, where perceived value outweighs cost considerations (Hilmiyati-Mas'adah et al., 2024).

Recent applications of the Technology Acceptance Model to household renewable energy acceptance confirm this pattern. Siuda and Gręboszc-Krawczyk (2025) found that perceived ease of use and the socially relevant dimension of perceived usefulness had a significant effect on intention, whereas the purely economic dimension of perceived usefulness did not. This suggests that the usefulness perceived by the coffee shops in this study is most likely a combination of operational benefit and a sense of security rather than a purely financial calculation. This proposition was not tested directly, because this study treats perceived usefulness as a unidimensional construct; separating the construct into economic and social dimensions is a suggestion for further research.

Because no direct path was specified from Cost Affordability or Perceived Safety to Attitude Towards Using or Behavioral Intention, Perceived Usefulness and Perceived Ease of Use carry the entire effect of these specific beliefs through to attitude and intention. Since Perceived Ease of Use has no significant effect on attitude, the operative route runs almost entirely through Perceived Usefulness. The specific indirect effects confirm this: the chain from Perceived Safety through Perceived Usefulness and Attitude to Behavioral Intention carries 0.445, whereas the chain running through Perceived Ease of Use carries 0.001.

The term full mediation is not used in this study. Full mediation in this model would be a consequence of the specification, since the direct paths from Cost Affordability and Perceived Safety to intention and attitude were simply not estimated. The mediation classification proposed by Zhao et al. (2010) requires direct and indirect paths to be tested together, so a claim of full mediation could only be sustained if an alternative model containing those direct paths were also estimated and the direct paths were shown to be non-significant.

The practical consequence is that an adoption strategy should aim at the perceived usefulness of the device, because it is the only belief that significantly forms attitude and, through attitude, intention. Emphasising ease of use addresses a belief that does not move attitude at all.

Attitude Towards Using and Behavioral Intention

Attitude Towards Using has a significant positive effect on Behavioral Intention (H7: $\beta = 0.785$; $t = 19.347$; $p < 0.001$), and it is the only determinant of Behavioral Intention tested, with an R squared of 0.616 and an effect size of 1.607, which counts as large. This relationship follows the standard Technology Acceptance Model sequence, in which a favorable evaluation of a technology develops before the intention to use it (Davis, 1989; Venkatesh & Davis, 2000).

Improving how coffee shop operators evaluate electric water heaters can therefore be expected to strengthen their intention to adopt them.

A caveat that applied to the initial 60-indicator measurement model has been resolved. Three Attitude Towards Using items leaned towards statements of intention rather than evaluation, and the Attitude–Behavioral Intention pair previously breached the Fornell-Larcker criterion (Fornell & Larcker, 1981) with an HTMT (Henseler et al., 2015) of 0.880. After purification removed SK8, SK9, and SK10, the HTMT for that pair falls to 0.806 and the Fornell-Larcker criterion is satisfied. The coefficient of 0.785 can therefore be read as a relationship between two distinct constructs rather than as an artefact of overlapping item wording.

Business Solution

This section answers the third research question: what business strategy can be applied to encourage the adoption of electric water heaters among coffee shops in Banda Aceh. The answer is built using a segmentation, targeting, and positioning framework, which is then translated into a four-element marketing mix of product, price, place, and promotion. This order was chosen because a marketing mix is meaningful only once the target has been set. Each element of the mix in Section IV.5.5 is therefore designed for the target segment defined in Section IV.5.3 and for the positioning defined in Section IV.5.4.

Every element of the strategy is traced back to the empirical findings in Section IV.4, both the descriptive findings at item level and the relationships found in the structural equation model. Priorities are set according to the size of the total effect on Behavioral Intention and the size of the performance gap at item level, not according to ease of implementation. The strategy can therefore be traced to evidence rather than to general marketing practice.

Competitive Position Quadrant Analysis Against Liquefied Petroleum Gas

The second quadrant analysis positions the electric water heater against the competing energy source respondents currently use. Two axes are used: the type of liquefied petroleum gas in use, which determines the size of the saving, and connected-capacity readiness, which determines the size of the initial investment. Both axes were chosen because they directly determine the payback period calculated in Section IV.2.1.

The savings figures come from the useful energy cost comparison in Table IV.9. Assuming stove efficiency of 45% and heater efficiency of 92%, the useful energy cost of electricity is IDR 1,315 per kilowatt hour, against IDR 3,470 for 12-kilogram liquefied petroleum gas cylinders and IDR 1,735 for subsidized 3-kilogram cylinders. The margin against 12-kilogram cylinders reaches 62.1%, while the margin against subsidized 3-kilogram cylinders is only 24.2%. This difference shows that the cost advantage of the electric water heater depends heavily on which cylinder type is being replaced. Dependence on subsidized cylinders has indeed been recorded as the main obstacle to switching to electric cooking devices in Indonesia, because the subsidized price narrows the very cost gap that would justify switching (Astuti et al., 2019; Hakam et al., 2022).

Table 5. Competitive Position Quadrants and Respondent Distribution

Quadrant	Segment characteristics	Number of respondents	Basis of assessment
I	Users of 12 kg or both cylinder types with adequate connected capacity	18 (25.0%)	Saving of 62.1% with no capacity upgrade; payback of about 5 to 10 months
II	Users of 12 kg or both cylinder types requiring a capacity upgrade	6 (8.3%)	Saving of 62.1% but a higher investment burden; payback of about 12 months
III	Users of subsidized 3 kg cylinders with adequate connected capacity	7 (9.7%)	Saving of only 24.2%; the advantage lies in security of supply rather than cost
IV	Users of subsidized 3 kg cylinders requiring a capacity upgrade	27 (37.5%)	The smallest saving combined with the largest investment burden; payback of about 24 months
	Does not use liquefied petroleum gas or capacity unknown	14 (19.4%)	No substitution need, or incomplete capacity data

The systematic relationship between cylinder type and electrical readiness (chi-square = 14.838, p = 0.0001, phi = 0.506; Section IV.5.2.3) is not repeated here. Its economic explanation is that larger coffee shops tend to use non-subsidized cylinders and to have higher connected capacity. This has a direct implication for target selection. Quadrant IV, the least attractive segment economically, is the largest with 27 respondents, or 37.5%, while Quadrant I, the most attractive, contains only 18 respondents, or 25.0%. Target selection therefore cannot follow market size; it must follow the economics of each segment.

This segment distribution does not explain the low mean Behavioral Intention of 3.076. The tests in Section IV.5.2 show that mean intention does not differ significantly across the four quadrants (Kruskal-Wallis test; Kruskal & Wallis, 1952; p = 0.198), and Quadrant I, with the most favorable economics, records a mean intention of 2.956, slightly below Quadrant IV at 3.041. Low intention is therefore spread evenly across the market and cannot be read as a rational response to each segment's feasibility calculation. The explanation that better fits the data is that the main barriers are limited funds and unfamiliarity, that is, the upfront investment reflected in items KB1 and KB6 and the absence of direct experience among 97.2% of respondents, both of which apply across all segments regardless of payback period.

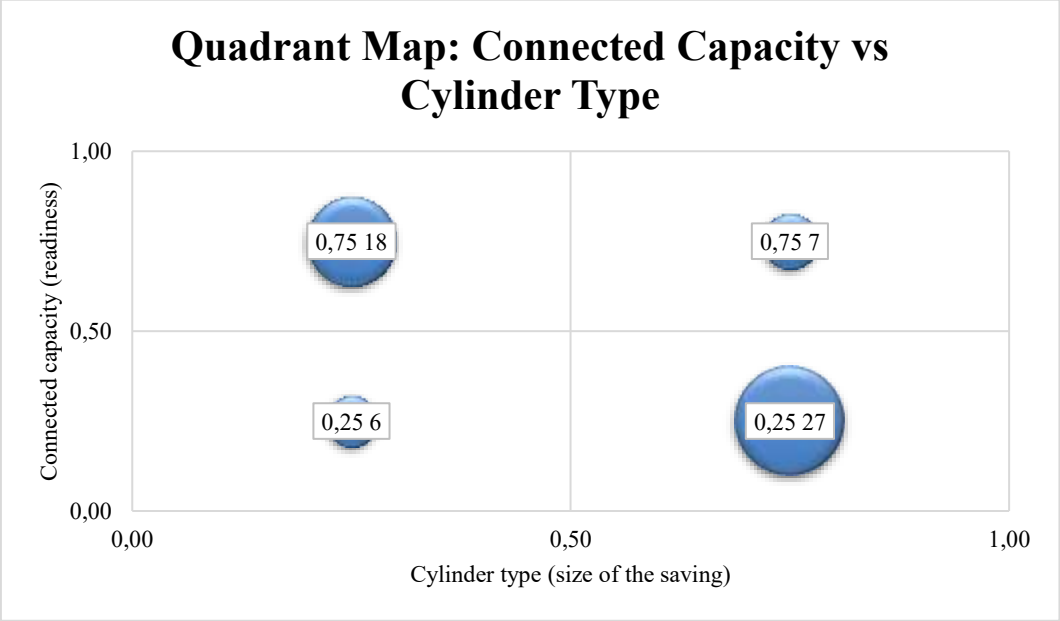


Figure 1. Competitive Position Quadrants and Respondent Segment Distribution

Drawing on the segmentation, targeting, and positioning developed in Sections IV.5.2 to IV.5.4, the marketing mix in Section IV.5.5, and the two quadrant analyses above, the marketing strategy for increasing adoption of electric water heaters among coffee shops in Banda Aceh is set out in the following five points.

1. Make Perceived Usefulness the intermediate target of all marketing activity. It is the only belief with a significant effect on Attitude Towards Using (β = 0.809), and attitude is the only significant determinant of Behavioral Intention (β = 0.785), giving Perceived Usefulness a total effect of 0.635 on intention. Because neither Cost Affordability nor Perceived Safety has a direct path to attitude or intention, their entire influence must pass through perceived usefulness.
2. Build the benefit message around security of energy supply rather than around cost savings. The highest-scoring usefulness items are PU6 on gas scarcity, at 4.333, and PU5 on reduced dependence, at 4.183, while the item on brewing consistency scores lowest at 2.847.
3. Answer electrical safety doubts with technical evidence. Perceived Safety occupies Quadrant II with performance right on the dividing line, and its weakness is concentrated in item KM2 at 3.500. An electrical safety certificate, an automatic circuit breaker, and a joint earthing check at installation address that doubt directly.
4. Treat price as a structural barrier rather than a promotional message. Cost Affordability occupies Quadrant III, so efforts to change price perceptions yield little, while the competitive position quadrant shows that the upfront investment is the main determinant of payback. An installment scheme set below current monthly gas spending removes that barrier without requiring any change in perception.
5. Set the targeting order according to the competitive position quadrants, applied within the positive-intention group first: the three Quadrant I respondents with positive intention first, then Quadrant III using the security of supply argument, and then the positive-intention

respondents in Quadrants II and IV once the capacity-upgrade scheme is available. Quadrant IV respondents without positive intention are deferred until device prices fall or co-financing becomes available.

CONCLUSION

The first research question examined the financial feasibility of electric water heaters compared with liquefied petroleum gas (LPG) in terms of operating costs, energy efficiency, and supply stability. Installation trials at two coffee shops demonstrated that electricity had a lower cost per kilowatt-hour (kWh) of useful energy, at IDR 1,315, compared with IDR 3,470 for nonsubsidized 12-kg LPG cylinders and IDR 1,735 for subsidized 3-kg LPG cylinders, after accounting for stove efficiency of 45% and electric water heater efficiency of 92%. All investment scenarios were financially feasible, with net present values (NPVs) ranging from IDR 5,121,159 to IDR 24,823,489, internal rates of return (IRRs) ranging from 42.0% to 232.7% against a discount rate of 12%, profitability indices (Pis) ranging from 1.83 to 8.41, and payback periods ranging from 5.14 to 23.64 months, all within the equipment's five-year economic life. However, financial feasibility varied across scenarios. Cost savings reached 62.1% compared with nonsubsidized LPG cylinders but only 24.2% compared with subsidized cylinders. Furthermore, coffee shops requiring electrical capacity upgrades faced approximately twice the initial investment cost. Thus, LPG subsidies narrowed the cost differential that would otherwise provide a stronger financial incentive to switch to electric water heaters.

The second research question examined coffee shop operators' perceptions of the usefulness and ease of use of electric water heaters. Both constructs were classified within the neutral category, with mean scores of 3.668 for perceived usefulness (PU) and 4.168 for perceived ease of use (PEOU), whereas behavioral intention (BI) remained below the neutral point, with a mean score of 3.076. The structural model revealed that perceived usefulness was the only belief construct that significantly influenced attitude toward using, with a path coefficient of 0.809. Attitude, in turn, was the only significant predictor of behavioral intention, with a path coefficient of 0.785. Perceived ease of use had no statistically significant effect on attitude ($\beta = 0.016$, $p = 0.825$), despite having the highest mean score among the six constructs. This finding suggested that perceived ease of use did not necessarily translate into a favorable attitude toward adoption. Within the perceived usefulness construct, items related to supply security received the highest scores, whereas the item concerning brewing consistency received the lowest score. Perceived safety was the strongest predictor of perceived usefulness ($\beta = 0.700$), although its lowest-scoring item concerned the risks of short circuits and electric shock, with a mean score of 3.500.

The third research question focused on developing a marketing strategy to increase electric water heater adoption. Market segmentation was based on prospective buyers' behavioral intentions. Coffee shops were classified into four groups according to their composite behavioral intention scores: disagree, undecided, somewhat agree, and agree. The somewhat agree and agree categories comprised 10 respondents, representing 13.9% of the sample, and were classified as the positive-intention group. Within this group, segmentation by LPG cylinder type and installed electrical capacity identified three coffee shops that used

nonsubsidized LPG cylinders and had an existing electrical capacity of at least 2,200 volt-amperes (VA). These establishments combined positive adoption intentions with the shortest estimated payback periods of 5–10 months and the lowest initial investment requirements, making them the priority targets for the initial implementation phase. Respondents with positive adoption intentions were concentrated in Ulee Kareng, accounting for six of the ten respondents, followed by Meuraxa and Kuta Raja, with two respondents each. The three coffee shops identified for the initial implementation phase were located in Meuraxa and Kuta Raja (Table IV.36).

The proposed positioning strategy prioritized electrical safety and supply security, followed by operating cost savings, without emphasizing improvements in brewing quality, consistent with the relative importance of factors identified in the structural model. The corresponding marketing mix included electric water heaters equipped with visible electrical safety features, installment payment plans with monthly payments below existing LPG expenditures, electrical capacity assessments before purchase, and product demonstrations at coffee shops where the devices had already been installed. Marketing communications were tailored to each behavioral intention segment. Given that 97.2% of respondents had never observed an electric water heater in operation, limited direct product exposure was identified as a major barrier to adoption, highlighting the importance of demonstrations over conventional promotional activities. The RENCONG program, implemented under PLN's Electrifying Lifestyle initiative (PLN UID Aceh, 2026; PT PLN (Persero), 2019), was proposed as a platform for delivering these interventions. Although all investment scenarios were financially feasible, behavioral intention remained below the neutral point, indicating that economic feasibility alone was insufficient to ensure adoption. Accordingly, the proposed strategy prioritized coffee shop operators who had already demonstrated positive adoption intentions, while targeted communication and demonstration activities were recommended to strengthen adoption readiness among undecided and somewhat agreeable respondents.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of the research, preparation, or publication of this article.

AUTHOR CONTRIBUTION

All authors contributed to the preparation of this article. Ardi Muslim and Mustika Sufiati Purwanegara, was responsible for the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation. The other authors contributed to the review, editing, and final approval of the manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The authors declare that no generative artificial intelligence was used in the preparation of this article.

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