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Mini Fuel Stations as Alternative Last-Mile Fuel Distribution in Non-SPBU Areas: A Qualitative SWOT–TOWS Analysis

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ABSTRACT

Fuel access in archipelagic regions is not only a logistical issue but also a governance problem involving spatial equity, regulatory compliance, safety assurance, and supply-chain resilience. This study examines mini fuel stations as last-mile distribution infrastructure in non-SPBU areas of the Kepulauan Riau, Indonesia. A qualitative design was employed using in-depth interviews, field observation, and document review. Informants were purposively drawn from mini-station owners, service users, and village officials, and the evidence was triangulated across sources and methods. Thematic coding identified six interrelated dimensions: accessibility, support for local economic activity, legal status, operational safety, quantity and quality assurance, and dependence on upstream supply. These themes were subsequently organized through SWOT analysis and converted into TOWS strategies. The findings indicate that mini fuel stations reduce spatial barriers and sustain everyday mobility and productive activities, but their public value is constrained by uneven registration, variable safety practices, weak transaction traceability, and supply vulnerability. The article proposes a graduated governance model that combines operator formalization, risk-based inspection, authorized procurement, digital transaction records, and co-governance among BPH Migas, local governments, suppliers, operators, and user groups. The study contributes by reframing mini fuel stations from an informal retail phenomenon into a last-mile energy-governance problem in an archipelagic setting.

Keyword: Fuel Distribution, Mini Fuel Station, Regulatory Governance, SWOT

INTRODUCTION

Equitable access to modern energy services remains difficult in dispersed island territories because distance, small market size, weather exposure, and fragmented infrastructure raise the cost of conventional distribution. Energy-access research shows that availability alone is insufficient: affordability, reliability, spatial reach, social recognition, and procedural fairness determine whether an energy service produces inclusive development outcomes

(Bhattacharyya, 2012; Jenkins et al., 2016; Nussbaumer et al., 2012; Riva et al., 2018; Sovacool et al., 2016). These considerations are especially relevant in Indonesia, where remote-island energy systems face persistent institutional, technical, financial, and logistical constraints (Simatupang et al., 2021a, 2021b).

The Kepulauan Riau provide a particularly salient setting. Settlements and economic activities are distributed across islands, while formal fuel outlets are concentrated in more accessible locations. The source manuscript reports that some communities travel approximately 10–25 km to reach an SPBU and continue to rely on mini fuel stations even where an SPBU exists because the formal outlet is inefficient for routine needs. Such spatial inequality can be interpreted through energy-justice scholarship, which emphasizes distributional, recognition, and procedural dimensions of access (Bouzarovski & Simcock, 2017; Heffron & McCauley, 2017; Walker & Day, 2012).

Mini fuel stations often referred to locally as Pom Mini or Pertamini—have emerged as a decentralized retail response. Their principal advantage is proximity: they place fuel within everyday travel corridors and support motorcycles, small-scale transport, fishing, farming, and trading. Similar to other decentralized energy solutions, however, technological presence does not automatically produce sustainable service. Long-term performance depends on institutional fit, local participation, accountability, and alignment with community practices (Mandelli et al., 2016; Palit & Chaurey, 2011; Urmee & Md, 2016; Yadoo & Cruickshank, 2012).

The policy issue is complicated by the distinction between informal mini retailers and legally recognized sub-distributors. Indonesia's sub-distributor framework was initially regulated through BPH Migas Regulation No. 6 of 2015 and was subsequently updated by BPH Migas Regulation No. 1 of 2024. The framework acknowledges that areas without formal distributors require alternative arrangements, while also imposing verification, technical, safety, and accountability requirements. The relevant analytical question is therefore not whether decentralized retail should exist, but how proximity can be reconciled with public safety, product assurance, price fairness, and transparent supply allocation.

The distribution problem also has a supply chain dimension. Island retail depends on upstream allocation, transport continuity, storage capacity, and the operational condition of formal outlets. Supply chain resilience literature explains that continuity under disruption depends on redundancy, visibility, collaboration, flexibility, and coordinated response capacity (Ambulkar et al., 2015; Christopher & Peck, 2004; Kamalahmadi & Parast, 2016; Pettit et al., 2010; Ponomarov & Holcomb, 2009; Tukamuhabwa et al., 2015). For mini fuel stations, limited storage and dependence on the nearest SPBU create a structural vulnerability: local access can improve while supply reliability remains fragile.

Regulatory scholarship similarly cautions against a simple formal–informal dichotomy. Effective regulation in fragmented service systems often requires combinations of state rules, self-regulation, local oversight, and network coordination (Baldwin & Black, 2008; Black, 2001; Gilad, 2010; Gunningham & Sinclair, 1999). Collaborative-governance approaches are relevant because national regulators, local governments, fuel suppliers, operators, and user groups hold different resources and responsibilities (Ansell & Gash, 2008; Emerson et al., 2012; Provan & Kenis, 2008; Sørensen & Torfing, 2009).

The original manuscript identifies accessibility, legality, safety, measurement, product quality, and supply limitations, but its analytical sections remain largely descriptive and its SWOT discussion repeats textbook definitions rather than linking evidence to strategy. This revision addresses that weakness by integrating energy justice, supply-chain resilience, responsive regulation, and collaborative governance into a single analytical framework. It also applies the TOWS logic, which converts SWOT factors into actionable SO, WO, ST, and WT strategies (Helms & Nixon, 2010; Hill & Westbrook, 1997; Pickton & Wright, 1998; Weihrich, 1982). The study's novelty lies in treating mini fuel stations not merely as small businesses, but as hybrid last-mile infrastructure positioned between informal retail and regulated public-service delivery. To clarify the analytical contribution of the revised article, Table 1 compares the dominant tendencies in earlier mini fuel-station studies with the framework developed in this research.

Table 1. Research gap and contribution

Dimension	Prior tendency	Contribution of this study
Problem framing	Mini fuel stations treated mainly as informal retail or legality issues.	Reframes them as last-mile energy infrastructure in an archipelagic governance system.
Theory	Single use of SWOT or descriptive legal analysis.	Integrates energy justice, supply-chain resilience, responsive regulation, and collaborative governance.
Analysis	Lists strengths, weaknesses, opportunities, and threats.	Links empirical themes to SWOT factors and derives TOWS strategies.
Policy output	General recommendations for government and suppliers.	Proposes a staged governance model with responsibilities, controls, and indicators.

Source: Authors' analysis, 2026.

The comparison confirms that the principal contribution lies in reframing mini fuel stations as last-mile infrastructure and connecting the diagnosis to a staged governance model rather than ending with a descriptive SWOT inventory. The institutional relationships surrounding last-mile fuel access are presented in Figure 1. The visual places regulators, formal suppliers, local government, mini fuel-station operators, and island users within one interconnected governance ecosystem.

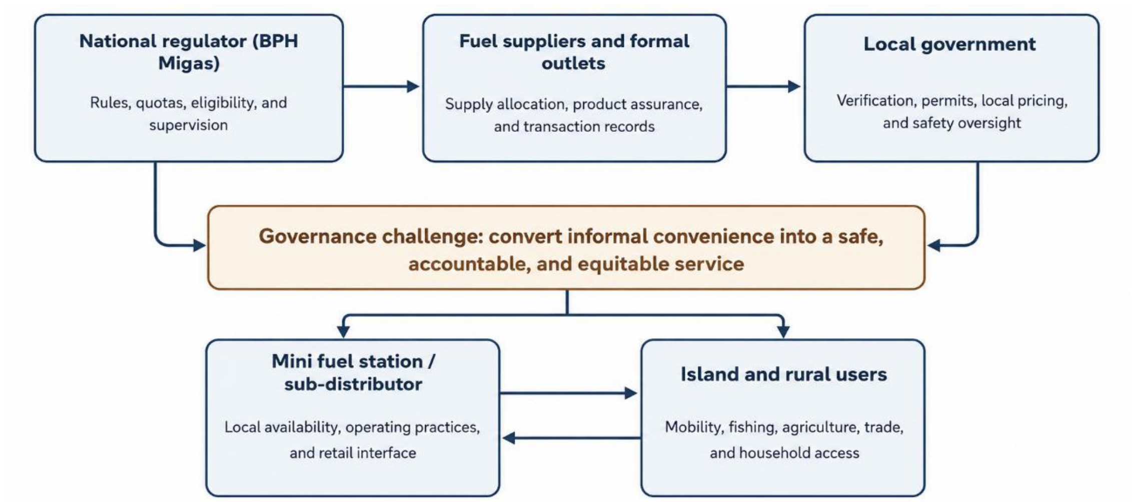

Figure 1. Last-mile fuel distribution governance ecosystem
Source: Authors, 2026.

The figure shows that proximity alone cannot guarantee reliable service. Authorization, supply allocation, local oversight, operator accountability, and user feedback must function as a connected system so that expanded access does not generate new legal or safety risks.

RESEARCH METHOD

The study employed a qualitative descriptive–analytical design. The source manuscript reports three evidence streams: in-depth interviews, field observations, and document review. Participants were selected purposively from three stakeholder categories mini fuel-station owners, service users, and village officials because these groups represent operational, user, and local-governance perspectives. The source material does not report the number of participants, interview dates, or saturation procedure; this omission is retained as an explicit reporting limitation rather than being replaced with unsupported information.

Data analysis was reconstructed into four transparent stages. First, the empirical material was organized into meaning units concerning access, economic use, legality, safety, measurement and quality, and supply. Second, thematic coding was applied following the logic of Braun and Clarke (2006) and Nowell et al. (2017). Third, evidence was compared across interviews, observation, and documents to improve credibility through triangulation (Carter et al., 2014; Fusch et al., 2018). Fourth, the themes were mapped into SWOT categories and translated into TOWS strategies. This approach avoids using SWOT as a purely classificatory checklist and instead connects diagnosis to policy action (Benzaghta et al., 2021; Helms & Nixon, 2010).

Trustworthiness was strengthened through source and method triangulation, an evidence-to-theme matrix, and an audit trail that links each strategic recommendation to a reported empirical issue. Credibility, dependability, confirmability, and transferability were interpreted in accordance with established qualitative-quality criteria (Gioia et al., 2013; Shenton, 2004; Tracy, 2010). Because the source manuscript did not provide verbatim interview quotations or a complete fieldwork log, the revised analysis uses cautious language and does not claim prevalence or statistical generalizability.

This sequence clarifies that the strategic recommendations were derived from the empirical themes rather than appended after the analysis. Each stage provides an explicit bridge from raw evidence to governance options and therefore strengthens the transparency of the research process. The function of each evidence source is detailed in Table 2. Interviews, observations, and documents were assigned distinct analytical purposes so that the study could compare stakeholder experience, physical operating conditions, and formal regulatory expectations.

Table 2. Data sources and analytical functions

Evidence source	Primary analytical function	Contribution to triangulation
Interviews with mini-station owners	Operational practices, supply dependence, perceived constraints.	Explains internal capabilities and weaknesses.
Interviews with service users	Accessibility, convenience, trust, and service expectations.	Validates the public-value dimension of local fuel access.

Evidence source	Primary analytical function	Contribution to triangulation
Interviews with village officials	Local conditions, governance concerns, and institutional feasibility.	Adds a public-authority perspective.
Field observation	Location, facility condition, service setting, and visible practices.	Checks whether reported practices are observable.
Document review	Regulatory framework, policy context, and prior studies.	Provides legal and conceptual benchmarks.

Source: Authors' analysis, 2026.

The distribution of functions reduces dependence on a single source and supports methodological triangulation. It also helps distinguish reported perceptions from directly observed practices and documentary requirements. Table 3 presents the coding framework used to move from first-order evidence to second-order themes and aggregate analytical dimensions. This structure makes the connection between empirical material and the final governance interpretation explicit.

Table 3. Analytical coding framework

First-order evidence	Second-order theme	Aggregate dimension
Closer location; reduced travel burden; flexible opening hours	Spatial convenience	Accessibility and service reach
Support for mobility, fishing, farming, and trade	Productive-use support	Local economic function
Unregistered operators; unclear status	Institutional ambiguity	Legality and accountability
Variable tanks and facilities; fire concerns	Preventive-control gaps	Operational safety
Potential discrepancies in volume and fuel condition	Assurance deficit	Quantity and quality protection
Purchasing from nearest SPBU; stock shortages	Upstream dependence	Supply-chain vulnerability

Source: Authors analysis, 2026.

The framework shows that access, public value, and regulatory risk emerged from recurring evidence rather than from generic SWOT categories. The coding structure therefore provides the analytical foundation for the later strategic matrices.

RESULTS AND DISCUSSION

1. Mini fuel stations as last-mile access infrastructure

The central empirical finding is that mini fuel stations reduce the spatial friction of fuel access. Their locations near settlements, village roads, and market areas allow users to avoid long trips to formal outlets. The public value is therefore not limited to retail convenience; it includes time savings, lower travel costs, and continuity of productive activities. This result aligns with energy-access research showing that development effects arise through interactions among infrastructure, mobility, income-generating activity, and household capability rather than through supply alone (Riva et al., 2018).

In an archipelagic context, proximity can function as a form of distributive justice. Formal infrastructure may be technically available at the provincial or district level but remain practically inaccessible to residents separated by distance, transport costs, or irregular connectivity. The mini-station model partially corrects this spatial mismatch, although it does so through a service form whose legal and technical quality varies. The finding supports the argument that energy justice must examine who receives access, where services are located, and whether affected communities are recognized in policy design (Bouzarovski & Simcock, 2017; Jenkins et al., 2016; Walker & Day, 2012). The physical context of mini fuel-station operation is illustrated in Figure 2. The photographs show how fuel retail is embedded in roadside settlements and how dispenser-based units provide a recognizable point of access for nearby users.

Figure 2. Field documentation of mini fuel-station contexts
Source: Authors' elaboration based on the source manuscript, 2026.

The documentation reinforces the importance of location and everyday accessibility, while also drawing attention to the need for adequate spacing, storage, equipment, and preventive safety arrangements. Visual evidence therefore complements the interview and documentary findings. The relationship between reported evidence and the resulting interpretation is summarized in Table 4. The matrix identifies the evidence base, the analytical meaning attached to it, and the governance implication derived from each finding.

Table 4. Evidence-to-finding matrix

Reported evidence	Interpretation	Governance implication
Mini stations are situated close to villages, markets, and main roads.	They reduce the geographic cost of access.	Service planning should use spatial-gap mapping.
Users continue to buy locally despite the existence of a distant SPBU.	Nominal coverage does not equal effective accessibility.	Access indicators should include travel time and distance.
Fuel supports motorcycles, fishing, agriculture, and trade.	Last-mile fuel has productive and livelihood functions.	Regulation should avoid abrupt closure without replacement access.

Reported evidence	Interpretation	Governance implication
Local residents operate many units.	The service creates micro-enterprise opportunities.	Formalization should be affordable and capability-building oriented.

Source: Authors' analysis, 2026.

The table demonstrates that the same service feature can generate both value and risk. Local proximity supports mobility and economic activity, yet weak registration, safety controls, and supply traceability can undermine that contribution.

2. Public value and local economic dependence

The source material links local fuel availability to transport, fisheries, agriculture, and small trade. This indicates that mini fuel stations occupy an infrastructural position in local economies: temporary supply disruption can affect mobility and productive activity beyond the retail transaction itself. Decentralized energy studies similarly show that local services generate wider benefits only when operational arrangements are socially embedded and institutionally supported (Palit & Chaurey, 2011; Urmee & Md, 2016; Yadoo & Cruickshank, 2012).

This embeddedness also creates a policy dilemma. A purely enforcement-oriented response may remove unsafe or unauthorized units but simultaneously deepen access inequality if no alternative service is available. Responsive regulation suggests using graduated interventions information, assistance, verification, corrective orders, and sanctions proportionate to risk and compliance behavior (Baldwin & Black, 2008). Such sequencing is more appropriate than treating all units as equivalent because operators differ in facility condition, willingness to formalize, and service importance. Figure 3 consolidates the empirical findings into six interrelated themes.

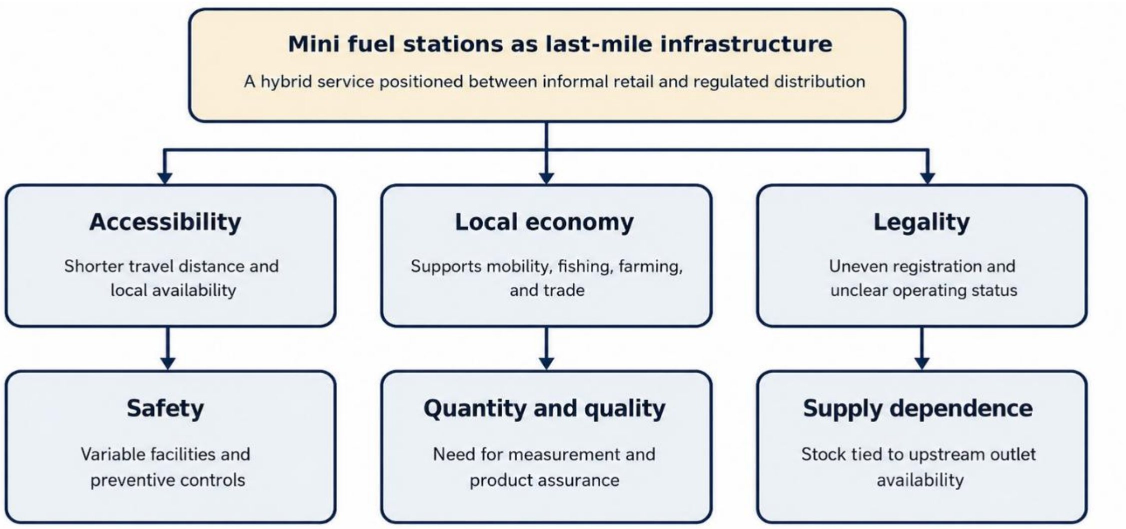

Figure 3. Thematic structure of the empirical findings
Source: Authors, 2026.

Accessibility and local economic support represent the principal public benefits, whereas legality, safety, quantity and quality assurance, and supply dependence define the principal governance constraints. The thematic structure indicates that the benefits and risks cannot be evaluated separately. A policy that preserves access but neglects safety or traceability remains incomplete, while strict enforcement without replacement access may disrupt mobility and local livelihoods.

3. Legality, safety, quantity, and quality assurance

Legality emerged as a central constraint. The source manuscript distinguishes between the social function of mini fuel stations and the fact that many units are not registered as formal sub-distributors. This institutional ambiguity weakens accountability: responsibilities for procurement, storage, measurement, price, and complaint handling become difficult to assign. Regulatory pluralism is therefore unavoidable, but it must be structured through a clear division of roles among the national regulator, local government, suppliers, and operators (Black, 2001; Gunningham & Sinclair, 1999).

Safety is equally important. The source reports variation in storage facilities and concern regarding leakage and fire. The revised article does not provide technical operating instructions; instead, it treats safety as a governance obligation requiring minimum standards, risk-based inspection, training, incident reporting, and corrective enforcement. A risk-based model would prioritize densely populated locations, visibly inadequate facilities, repeated complaints, and operators unwilling to comply.

Quantity and quality assurance concern consumer trust. Without calibrated measurement, documented procurement, and complaint mechanisms, users cannot easily verify whether the quantity delivered and product condition correspond to what they purchase. Digital transaction records and periodic measurement checks can improve traceability, but technology should complement rather than replace institutional accountability. Meta-regulation is useful here because operators can be required to maintain their own records within a publicly supervised framework (Gilad, 2010).

Table 5 converts the principal operational concerns into a governance risk-and-control matrix. Each risk domain is paired with a feasible control mechanism and the actor most directly responsible for implementation.

Table 5. Governance risk and control matrix

Risk domain	Observed or reported problem	Proposed control	Responsible actors
Legal status	Uneven registration and uncertain authorization.	Operator registry, eligibility verification, defined service area.	BPH Migas; district/city government
Safety	Variable facility quality and preventive practices.	Minimum standards, training, risk-based inspection, incident reporting.	Local government; fire/safety agencies; suppliers
Quantity	Potential mismatch between displayed and delivered volume.	Periodic measurement verification and complaint channel.	Metrology office; local government
Product assurance	Unclear procurement and handling chain.	Authorized procurement and transaction documentation.	Supplier; formal outlet; operator

Risk domain	Observed or reported problem	Proposed control	Responsible actors
Price fairness	Potential mark-up without transparent basis.	Local price rules and displayed price information.	Local government; operator
Supply continuity	Dependence on nearest SPBU and limited stock.	Allocation planning, collective procurement, contingency protocols.	BPH Migas; suppliers; operator network

Source: Authors' analysis, 2026.

The allocation of responsibility is deliberately distributed because no single institution controls the complete service chain. Effective risk reduction requires coordination among regulators, local government, safety agencies, suppliers, metrology functions, and operators.

4. Supply-chain vulnerability in island distribution

Mini fuel stations improve the final distribution node but do not remove upstream vulnerability. Operators generally procure fuel from the nearest formal outlet; when that outlet experiences shortage, local stocks decline rapidly. Limited storage and small purchasing volumes further reduce buffering capacity. Supply-chain resilience research explains that visibility, collaboration, flexible sourcing, and contingency planning are necessary to maintain service under disruption (Hosseini et al., 2019; Ivanov & Dolgui, 2020; Scholten et al., 2014; Scholten & Schilder, 2015).

For the Kepulauan Riau, resilience should be designed at network level rather than operator level. A verified operator network could aggregate demand, communicate shortages, coordinate delivery schedules, and provide regulators with near-real-time information about local availability. Such collaboration would not eliminate geographic risk, but it would improve anticipation and coordinated response. The governance arrangement should remain polycentric: national rules establish minimum protections, while local actors adapt implementation to island conditions (Ostrom, 2010). The institutional position of alternative fuel-access channels is compared in Table 6. The comparison considers access reach, regulatory status, investment scale, and the principal governance issue associated with each channel.

Table 6. Comparative institutional position of fuel-access channels

Channel	Access reach	Regulatory status	Investment and scale	Main governance issue
SPBU	High capacity but spatially concentrated.	Fully formal.	High investment and large scale.	Geographic coverage in dispersed islands.
Pertashop	Designed for areas without SPBU; formal retail.	Formal under supplier requirements.	Moderate investment and standardized model.	Commercial feasibility in small markets.

Channel	Access reach	Regulatory status	Investment and scale	Main governance issue
Registered sub-distributor	Targets communities without a formal distributor.	Formal under BPH Migas and local verification.	Smaller scale; collective-user orientation.	Effective implementation and oversight.
Informal mini fuel station	Very high proximity and flexibility.	Uncertain or non-compliant status.	Low-to-moderate investment; micro scale.	Safety, traceability, measurement, and legality.

Source: Authors' analysis, 2026.

The comparison highlights the distinctive trade-off of informal mini fuel stations: they provide the highest proximity and flexibility but also carry the greatest uncertainty in legality, measurement, safety, and traceability. This trade-off supports a graduated formalization approach.

5. SWOT diagnosis and TOWS strategies

The SWOT analysis was reconstructed from the empirical themes rather than from generic definitions. Strengths concern proximity, flexibility, low entry barriers, and local trust. Weaknesses concern storage limits, uneven safety compliance, measurement assurance, and upstream dependence. Opportunities arise from the legal sub-distributor pathway, digital records, collective procurement, and local-government partnership. Threats include regulatory closure, supply and price volatility, safety incidents, and long-term transport transition. This evidence-based application responds to longstanding criticism that SWOT becomes superficial when factors are not prioritized or connected to action (Hill & Westbrook, 1997; Pickton & Wright, 1998).

The prioritized internal and external factors are visualized in Figure 4. The matrix distinguishes the service advantages generated by proximity and flexibility from weaknesses related to scale, compliance, measurement assurance, and upstream dependence.

Figure 4. SWOT diagnosis of mini fuel stations
Source: Authors, 2026.

The configuration suggests that the strongest policy opportunity is not simple business expansion, but the conversion of locally trusted services into a verified and traceable distribution network. The threats also justify phased supervision rather than a uniform enforcement response. Table 7 condenses the empirical diagnosis into the priority factors that should guide policy design. The strategic meaning column explains how each SWOT category should influence the direction of intervention.

Table 7. Evidence-based SWOT matrix

Category	Priority factors	Strategic meaning
Strengths	Proximity; flexible hours; local familiarity; micro-enterprise base.	Preserve accessibility and local embeddedness.
Weaknesses	Small scale; safety variation; weak traceability; supply dependence.	Build capability and accountability.
Opportunities	Formalization; digital records; collective procurement; co-governance.	Convert informal service into a verified network.
Threats	Closure risk; supply volatility; incidents; mobility transition.	Use graduated regulation and adaptive planning.

Source: Authors' analysis, 2026.

The matrix emphasizes preservation of accessibility, correction of institutional weaknesses, conversion of informal service into a verified network, and adaptive planning for closure, volatility, incidents, and mobility transition. Figure 5 translates the SWOT diagnosis into four TOWS strategy pathways. Each quadrant connects a specific combination of internal conditions and external pressures with an operational policy response.

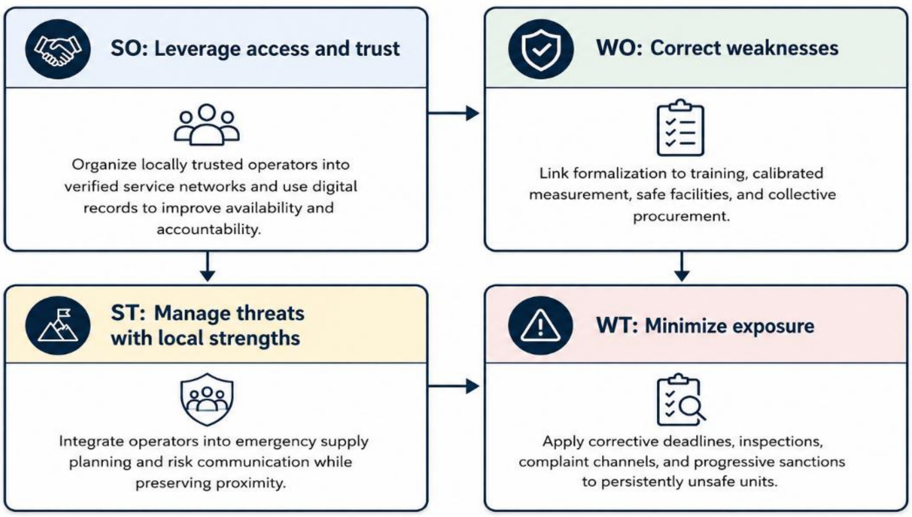

Figure 5. TOWS strategy architecture
Source: Authors, 2026.

The strategy architecture demonstrates that access preservation and risk reduction should proceed simultaneously. Formalization, training, collective procurement, emergency planning, and progressive corrective action become complementary components of one governance package. The operational content of the TOWS strategies is set out in Table 8. The table links each strategy type to a concrete action package and an expected governance result.

Table 8. TOWS strategic options

Strategy	Action package	Expected result
SO	Organize locally trusted operators into verified service networks; map service gaps; use digital availability records.	Expanded access with improved visibility.
WO	Tie formalization to training, measurement verification, safe facilities, and collective procurement.	Weaknesses corrected through institutional support.
ST	Integrate operators into emergency supply planning and risk communication while preserving local reach.	Greater resilience without losing proximity.
WT	Apply corrective deadlines and progressively sanction units that remain unsafe or untraceable; provide replacement access before closure.	Reduced risk and protected community access.

Source: Authors' analysis, 2026.

This translation is essential because SWOT categories do not by themselves constitute policy. The table converts diagnosis into implementable measures involving network organization, training, measurement verification, emergency planning, and progressive sanctions.

6. Proposed governance model and implementation roadmap

The analysis supports a five-pillar governance model: formalize operators, assure safety, secure supply, trace transactions, and co-govern the network. Formalization should begin with mapping and verification rather than immediate exclusion. Safety assurance should be risk-based. Supply security should require authorized procurement and contingency planning. Transaction traceability should combine records, measurement checks, and complaints. Co-governance should provide regular coordination among BPH Migas, local governments, suppliers, operators, and user groups.

This design reflects collaborative-governance principles: stakeholders need a shared problem definition, credible rules, joint capacity, and mechanisms for learning and adaptation (Ansell & Gash, 2008; Emerson et al., 2012). Network effectiveness also depends on a clearly designated coordinating authority and manageable accountability arrangements (Provan & Kenis, 2008). Policy mixes should be coherent: licensing without supply access, inspection without training, or digital records without enforcement would produce fragmented implementation (Howlett & Rayner, 2007).

The proposed governance model is summarized as five sequential and mutually reinforcing pillars. The model begins with operator formalization and continues through safety assurance, supply security, transaction traceability, and collaborative governance. The order of the pillars is important because registration without supply access, inspection without training, or digital reporting without institutional follow-up would produce fragmented implementation. The model therefore treats governance capacity as an integrated system. Table 9 assigns lead responsibilities and performance indicators to the five governance pillars. The indicators were selected to monitor both implementation activity and changes in service quality and accountability.

Table 9. Policy responsibilities and performance indicators

Pillar	Lead responsibility	Core indicators
Formalize	BPH Migas and local government	Share of mapped operators; share verified; service gaps remaining.
Assure safety	Local government and relevant safety agencies	Training completion; inspection coverage; corrective actions; incident rate.
Secure supply	BPH Migas, suppliers, and formal outlets	Authorized procurement share; shortage duration; contingency activation.
Trace transactions	Operators, metrology office, local government	Measurement checks; transaction-record completeness; complaints resolved.
Co-govern	Inter-agency coordination forum	Meeting regularity; data sharing; joint problem resolution; user participation.

Source: Authors' analysis, 2026.

The proposed indicators create a practical basis for periodic evaluation. They enable decision makers to assess operator coverage, training and inspection performance, supply continuity, transaction completeness, complaint resolution, and inter-agency coordination. Figure 6 arranges the policy recommendations into a staged implementation pathway. The roadmap separates immediate mapping and interim controls from medium-term capacity building, integrated supervision, and long-term consolidation.

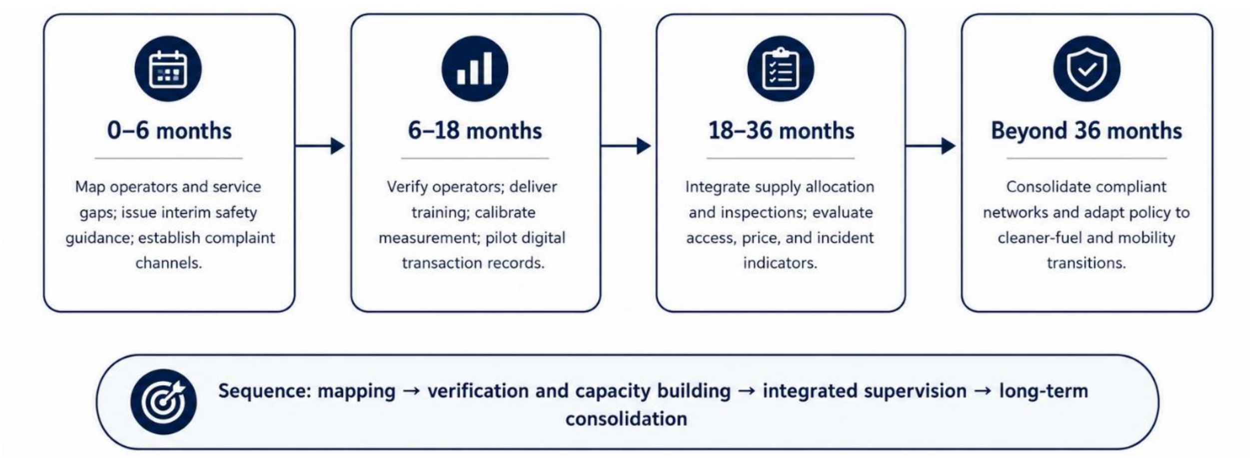

Figure 6. Staged implementation roadmap
Source: Authors, 2026.

The staged approach allows regulators and local governments to reduce urgent risks while preserving community access. It also creates clear evaluation points before the policy advances to broader network consolidation and adaptation to future mobility transitions. The study is constrained by the reporting quality of the source manuscript. The number and characteristics of participants, fieldwork dates, interview protocol, verbatim quotations, and detailed locations are not available. Consequently, the findings should be interpreted as an analytically strengthened qualitative case rather than a statistically representative assessment of all mini fuel stations in the Kepulauan Riau.

Future research should document participant profiles, compare multiple islands and districts, measure travel-time and price differences, assess user trust, evaluate safety compliance, and map actual supply flows. A mixed-method design could combine interviews with spatial accessibility analysis, transaction records, measurement audits, and incident data. Longitudinal research is also needed to examine whether formalization improves access and safety without creating unaffordable compliance costs. Before journal submission, the empirical reporting gaps identified in the source manuscript should be addressed as summarized in Table 10. The table distinguishes the current reporting status from the specific improvement required for methodological completeness.

Table 10. Reporting items requiring completion before journal submission

Item	Status in source material	Required improvement
Participant number and profile	Not reported.	Provide sample size, stakeholder distribution, and selection rationale.
Fieldwork period and locations	Not reported in sufficient detail.	Provide dates and specific study sites.
Interview protocol and quotations	Not included.	Add core questions and representative anonymized quotations.
Ethics and consent	Not reported.	State ethical review or institutional procedure and informed consent.
Analytical audit trail	Partially reconstructable.	Retain coding matrix and document the decision process.
Empirical indicators	Mostly descriptive.	Add travel distance/time, price, supply interruption, and compliance data where available.

Source: Authors’ analysis, 2026.

Completing these items would strengthen transparency, reproducibility, and ethical reporting without changing the study’s qualitative orientation. In particular, participant profiles, fieldwork details, interview evidence, consent procedures, and empirical indicators require explicit documentation.

CONCLUSION

Mini fuel stations in the Kepulauan Riau perform a meaningful last-mile function by reducing spatial barriers to fuel access and supporting mobility and productive activities. Their relevance persists even where an SPBU exists because formal coverage may remain practically distant. The empirical contribution is therefore best understood through an energy-justice lens: proximity expands access, but equitable service also requires recognition of island conditions and participation in regulatory design. The same decentralized model creates legal, safety, measurement, product-assurance, and supply risks. These risks are not adequately addressed by either unrestricted informality or uniform closure. The SWOT–TOWS analysis indicates that the most viable strategy is graduated formalization: preserve local accessibility while linking continued operation to verified status, minimum safety controls, authorized procurement, measurement assurance, digital traceability, and risk-based supervision. The proposed governance model combines national standards with local implementation and collaborative oversight. Its central policy implication is that mini fuel stations should be governed as part of an archipelagic service network rather than treated only as isolated micro-enterprises. Such a shift can reconcile equitable access with public protection and supply-chain resilience.

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