



A Multi-Methodological Framework for Electric Vehicle Policy in Emerging Economies: Integrating Soft Systems Methodology, Innovation Diffusion Theory, Principal-Agent Theory, and Strategic Choice Approach through a Systematic Literature Review

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Abstract

Electric vehicle (EV) adoption in emerging economies is shaped by interacting technical, economic, institutional, and behavioral factors. In Indonesia, despite substantial fiscal and non-fiscal incentives, EV adoption remains below 1% of vehicle sales, reflecting persistent misalignment among government targets, industry capabilities, and consumer acceptance. Existing studies tend to analyze these challenges in isolation and rarely integrate behavioral and institutional dimensions within a single coherent framework suited to such "wicked" policy problems. This study is conceptual and methodological in nature. Through a systematic literature review (SLR) of 81 articles, supported by a System of Systems Methodologies (SOSM) analysis and refined by a pilot workshop with Indonesian experts, it develops an integrated problem-structuring framework. The review indicates that Problem Structuring Methods, particularly Soft Systems Methodology (SSM), remain underutilized in emerging-economy transport policy. On this basis, the study proposes a six-stage integration protocol that positions SSM as the methodological backbone, complemented by Innovation Diffusion Theory (IDT), Principal-Agent Theory (PAT), and Strategic Choice Approach (SCA), spanning problem exploration, innovation analysis, incentive mapping, conceptual modeling, uncertainty management, and implementation strategy. The framework offers a structured way to combine interpretive, behavioral, institutional, and strategic perspectives while maintaining theoretical coherence. Its applicability is illustrated through an exploratory application to Indonesia's EV charging-infrastructure policy, with broader empirical validation identified as a priority for future research.

Keywords: *Soft Systems Methodology, Multi-Methodology Integration, Electric Vehicle Policy, Wicked Problems, Emerging Economies, Systematic Literature Review*

INTRODUCTION

The global transition toward low carbon transportation has placed electric vehicles (EVs) at the center of efforts to achieve net zero emissions, with projections indicating up to a 90% reduction in transport related CO₂ emissions by 2050 (IEA, 2021) and life cycle evidence confirming that EVs emit substantially less CO₂ than internal combustion vehicles (Kawamoto et al., 2019). Global EV uptake has accelerated rapidly, reaching nearly 20% of new car sales by 2023 (IEA, 2024). Indonesia has aligned itself with this transition through ambitious national targets of 400,000 electric cars and 2.1 million electric motorcycles by 2030 (Ministry of Energy and Mineral Resources, 2021), supported by a range of fiscal and non fiscal incentives. Actual progress, however, remains far below these targets, with only about 12,000 cars and 62,000 two wheelers adopted by 2023, representing less than one percent of vehicle sales (Antara, 2023; Hakam & Jumayla, 2024). This persistent gap between policy ambition and adoption reality reflects more than technical or economic constraints. It is shaped by high upfront costs, limited charging

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infrastructure, low consumer trust, fragmented regulations, and misalignment among government, industry, and consumer interests (Gicha et al., 2024; Chhikara et al., 2021; Li et al., 2025). Taken together, these interconnected and contested conditions characterize Indonesia's EV transition as a wicked problem rather than a straightforward optimization task (Hakam & Jumayla, 2024; Damanik et al., 2025).

Research on EV adoption in Indonesia has examined this challenge from several distinct angles. Economic studies emphasize cost barriers and total cost of ownership (Wibowo & Septiari, 2023; Pirmana et al., 2023), infrastructure studies focus on the spatial optimization of charging stations (Setiawan et al., 2020), behavioral studies analyze consumer attitudes and perceptions (Lazuardy et al., 2024), and institutional studies highlight regulatory inconsistency and coordination failures (Sasongko et al., 2024; Lonan & Ardi, 2020). While each stream offers valuable insight, most rely on reductionist and single method approaches that isolate one dimension of the problem. Conventional adoption theories such as Innovation Diffusion Theory (Rogers, 2014), together with expanded behavioral models such as TPB and UTAUT, explain individual adoption factors but remain grounded in rational decision making assumptions and rarely account for Indonesia's institutional and socio spatial complexity (Abbasi et al., 2021; Lazuardy et al., 2024).

Building on this body of work, the systematic literature review conducted in this study (Section 4) confirms that behavioral and institutional barriers are seldom integrated within a single coherent framework, and that Problem Structuring Methods, particularly Soft Systems Methodology, remain underutilized in emerging economy transport policy (Flores et al., 2024; Franco & Montibeller, 2010). The research gap, therefore, does not lie in a shortage of individual studies but in the absence of a systematic methodological framework that connects their behavioral, institutional, and strategic dimensions in a way that reflects the wicked nature of the problem. This fragmentation leaves policymakers without an analytical structure capable of capturing how these dimensions interact.

To address this gap, the objective of this study is to develop an integrated, stage specific multi methodological framework for analyzing EV policy in emerging economies, using Indonesia as the primary context. The framework positions Soft Systems Methodology (Checkland & Poulter, 2007) as the methodological backbone and combines it with Innovation Diffusion Theory, Principal-Agent Theory, and Strategic Choice Approach so that behavioral, institutional, and strategic dimensions can be analyzed within a single coherent structure. The framework is developed through a systematic literature review and refined through a pilot workshop with Indonesian experts.

Guided by this objective, the study addresses four research questions:

1. How has Soft Systems Methodology been applied in public policy contexts, particularly in transportation and energy transitions?
2. What are the methodological strengths and limitations of Soft Systems Methodology in addressing wicked problems in these domains?
3. How can Soft Systems Methodology be effectively integrated with complementary methodologies (IDT, PAT, and SCA) to analyze complex policy challenges such as EV adoption?
4. What are the key implementation considerations for applying multi methodological approaches in emerging economy contexts such as Indonesia?

In answering these questions, the study offers two contributions. Methodologically, it proposes a six stage integration protocol that combines interpretive, behavioral, institutional, and strategic perspectives while preserving theoretical coherence, advancing the way Problem Structuring Methods can be systematically integrated. Practically, it provides a context sensitive

analytical basis for policymakers navigating EV transitions in emerging economies. As a conceptual and methodological contribution, the framework is illustrated through a preliminary application to Indonesia's EV charging infrastructure policy, with broader empirical validation identified as a priority for future research.

LITERATURE REVIEW

Indonesia's EV transition illustrates the methodological challenges of policy analysis in emerging economies. As noted, adoption remains below one percent of vehicle sales despite substantial fiscal incentives (Antara, 2023; Hakam & Jumayla, 2024). This gap stems from institutional fragmentation, reflected in conflicting priorities among ministries, limited PLN charging infrastructure of 1,582 stations across 1,131 areas, and regulatory uncertainty for foreign OEMs, together with socio cultural resistance such as range anxiety, hybrid bias, and the dominance of two wheelers (Sasongko et al., 2024; Tritto, 2025; Setiawan et al., 2020; Lazuardy et al., 2024; Wibowo & Septiari, 2023).

This emphasis reflects a longer shift in Operational Research, which began with the mathematical optimization developed during World War II for quantifiable problems with clear objectives, then moved toward interpretive and participatory methodologies as critics judged technique driven analysis to be excessively reductionist (Ackoff, 1979; Rosenhead, 1996). That shift introduced the distinction between tame problems, which yield to technical solutions, and wicked problems, which are marked by stakeholder disagreement, interconnected causality, and irreversible consequences (Rittel & Webber, 1973), and it established the foundation for PSMs, including SSM, which prioritize dialogue and iterative exploration over the search for a single optimum (Checkland, 1981; Rosenhead, 1996). Table 1 summarizes this evolution and the rationale for an SSM based multi methodology in Indonesia's EV transition.

Table 1. Evolution from Hard to Soft Operational Research: A Paradigmatic Comparison

Aspect	Hard Operational Research	Soft Operational Research
Origin & Period	Developed from the 1930s to 1970s, rooted in military optimization such as RAF radar systems, focusing on scientific decision support (Mingers & White, 2010)	Emerged from the 1970s as a response to Hard OR limitations in addressing real world, complex strategic problems
Approach & Focus	Quantitative and model driven, emphasizing mathematical optimization, algorithms, and prediction for decision making	Interpretive and participatory, focusing on structuring complex situations through dialogue, learning, and stakeholder engagement
Problem View	Assumes problems are well defined, structured, and solvable through analytical techniques, typically dealing with tame problems	Recognizes problems as messy, ambiguous, and interconnected, often classified as wicked problems requiring exploration rather than solution
Methods & Concepts	Uses deterministic models, optimization techniques, and efficiency driven analysis grounded in mathematical logic	Uses Problem Structuring Methods, incorporating concepts such as messes, wicked problems, and systemic thinking (Ackoff, 1979; Rittel & Webber, 1973)

Aspect	Hard Operational Research	Soft Operational Research
Characteristics & Legacy	Mechanistic, reductionist, and focused on finding a single optimal solution, forming the foundation of analytical decision science but often criticized for limited real-world relevance	Adaptive, inclusive, and context sensitive, emphasizing socio political complexity and leading to the development of PSMs for complex policy and organizational problems

Problem Structuring Methods, Theories, and Their Integration

PSMs are designed for decision contexts marked by complexity, uncertainty, and multiple stakeholder perspectives, and rather than seeking definitive solutions they rely on iterative learning, value pluralism, and participatory modeling (Mingers & Rosenhead, 2011). A distinction often blurred in the literature, and one this study makes explicit, is that the four approaches integrated here are not of the same kind. SSM and the Strategic Choice Approach (SCA) are problem structuring methodologies, that is, procedures for organizing inquiry and decision making under complexity, whereas Innovation Diffusion Theory (IDT) and Principal-Agent Theory (PAT) are substantive theories that explain how adoption spreads and how incentives become misaligned. Treating the two as interchangeable obscures their distinct functions and the conditions under which they can be combined. Table 2 sets out each approach by type, role, core assumptions, contribution, and key limitations.

Table 2. Comparison of the Integrated Approaches by Type, Role, Assumptions, Contribution, and Limitations

Approach (Type, Source)	Role in the Framework	Core Assumptions	Contribution	Key Limitations
SSM, Methodology (Checkland & Poulter, 2007)	Methodological backbone that structures problem exploration and integrates stakeholder worldviews across all stages	Social reality is interpreted and socially constructed; no single optimal solution exists; understanding improves through debate and accommodation (interpretivist)	Provides rich pictures, root definitions, CATWOE, and conceptual models that surface implicit assumptions and accommodate plural worldviews	Qualitative and facilitation dependent; limited predictive and prescriptive power when used on its own
SCA, Methodology (Friend & Hickling, 2012)	Structures strategic decision making and converts analysis into feasible, sequenced policy options	Decisions are made under uncertainty across interconnected decision areas; planning is incremental and negotiated	Distinguishes types of uncertainty and offers tools for shaping, designing, comparing, and committing to decisions	Depends on active stakeholder participation; does not explain adoption behavior or causal mechanisms
IDT, Theory	Explanatory lens	Innovations	Specifies	Centered on

Approach (Type, Source)	Role in the Framework	Core Assumptions	Contribution	Key Limitations
(Rogers, 2014)	for adoption behavior; informs the stages concerned with why and how EVs are adopted	diffuse through a social system over time, driven by innovation attributes and adopter categories	innovation attributes (relative advantage, compatibility, complexity, trialability, observability) and adopter categories	individual diffusion; underweights institutional power and assumes relatively rational adopters
PAT, Theory (Jensen & Meckling, 2019)	Explanatory lens for institutional and incentive misalignment between principals and agents	Actors are self interested under conditions of information asymmetry, divergent goals, and imperfect monitoring	Supplies concepts of moral hazard, adverse selection, and incentive alignment to diagnose policy implementation gaps	Assumes narrow self interest; underweights worldviews, culture, and interpretive meaning

Because these approaches rest on different assumptions, with SSM and SCA grounded in an interpretivist and participatory stance and IDT and PAT in more functionalist and rationalist premises, their integration requires explicit justification rather than simple juxtaposition. Following the logic of multimethodology (Mingers & Brocklesby, 1997; Mingers, 2006), the framework manages this in three ways: SSM serves as the overarching methodology that frames the inquiry and supplies the interpretive structure for the others; IDT and PAT are used not as competing paradigms but as bounded lenses inserted only at the stages where their assumptions hold, IDT where adoption behavior is examined and PAT where incentive structures are diagnosed; and this stage specific deployment keeps each theory within its zone of validity so that assumption conflicts are contained. The System of Systems Methodologies provides the meta level rationale for matching each approach to its context (Jackson & Keys, 1984), developed further in the findings. Despite their suitability for wicked problems, PSMs remain underutilized in fragmented policy contexts, particularly in emerging economies where technocratic optimization still dominates (Head & Alford, 2015). Applying this lens, Table 3 disaggregates Indonesia's EV transition across four dimensions, showing for each the specific challenges, the stakeholders involved, and the wicked problem characteristics that conventional analysis tends to overlook.

Table 3. Multi-Dimensional Analysis of Indonesia's EV Adoption as a Wicked Problem

Dimension	Specific Challenges	Stakeholders Involved	Wicked Problem Characteristics
Infrastructure	Only 1,582 charging stations (SPKLU) across 1,131 areas; urban-rural gap; limited grid capacity; lack of standardization	PLN; private charging providers; local governments; urban planners	Needs vary by location; no stopping rule for "adequate" infrastructure; solutions generate new problems
Economic &	High upfront costs; limited	Ministry of Finance;	No true or false

Dimension	Specific Challenges	Stakeholders Involved	Wicked Problem Characteristics
Financial	financing; inconsistent subsidies; investment-return uncertainty	financial institutions; consumers; investors	solutions, only better or worse; impacts irreversible; each intervention has consequences
Policy & Regulatory	Conflicting incentives (import-duty exemptions vs. local-content rules); fragmented regulations; unclear long-term direction; JETP challenges	President and cabinet; Ministry of Industry; Ministry of Energy; local governments; international partners	No finite set of solutions; policies create unintended consequences; multiple explanations for failure
Social & Cultural	Low public awareness and acceptance; range anxiety; resistance to behavior change; urban-rural disparity	End-users (urban and rural); civil society; media; educational institutions	Stakeholders hold different values; no stopping rule for social change; consumer behavior is unpredictable

Soft Systems Methodology and Stage-Specific Integration

Among PSMs, SSM is especially relevant for the ill structured problems that characterize EV policy (Checkland, 1981; Checkland & Poulter, 2007). Grounded in interpretivist epistemology, it does not seek an optimal solution but facilitates structured learning among stakeholders with differing worldviews through rich pictures, root definitions, CATWOE analysis, and conceptual models, surfacing implicit assumptions and accommodating contextual diversity. Because a single method rarely captures the technical, behavioral, and institutional dimensions of complex transitions, SSM benefits from integration with complementary approaches, for which Mingers' multimethodology framework (Figure 1) provides the conceptual basis by showing how tools from different methodologies combine across the stages of an intervention (Mingers & Brocklesby, 1997). This need is especially clear in emerging economies, where conventional analysis assumes clear objectives, stable preferences, and linear causality that rarely hold, and where PSM application remains limited, particularly in transportation policy with its complex infrastructure, multi level governance, and behavioral change (Head, 2019; Flores et al., 2024; Georgiou, 2013; Franco & Montibeller, 2010). Indonesia's EV ecosystem displays exactly these features, which makes SSM a suitable central framework when complemented by IDT, PAT, and SCA (Checkland & Poulter, 2007; Sasongko et al., 2024).

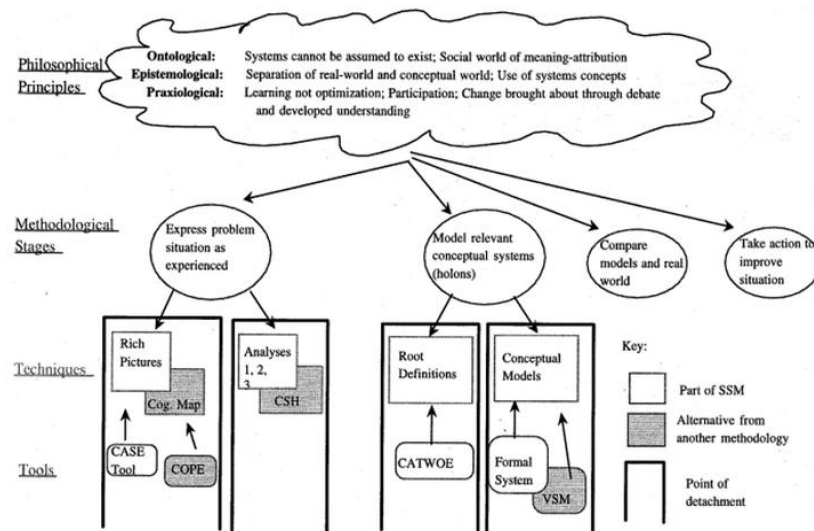


Figure 1. Mingers' Multimethodology Framework

Building on these foundations, Figure 2 presents a six stage integration protocol that combines SSM with the complementary theories and methods in a structured but iterative process (Mingers & Brocklesby, 1997). It begins with SSM for problem exploration and stakeholder mapping, then introduces IDT to assess adoption barriers and PAT to analyze incentive structures and information asymmetries, synthesizes these into conceptual models that capture both behavioral and institutional dimensions, and applies SCA to manage uncertainty and evaluate feasible alternatives. The final stage produces integrated implementation strategies that maintain systemic coherence while addressing governance fragmentation and coordination challenges in Indonesia's EV ecosystem (Setiawan et al., 2020; Tritto, 2025).

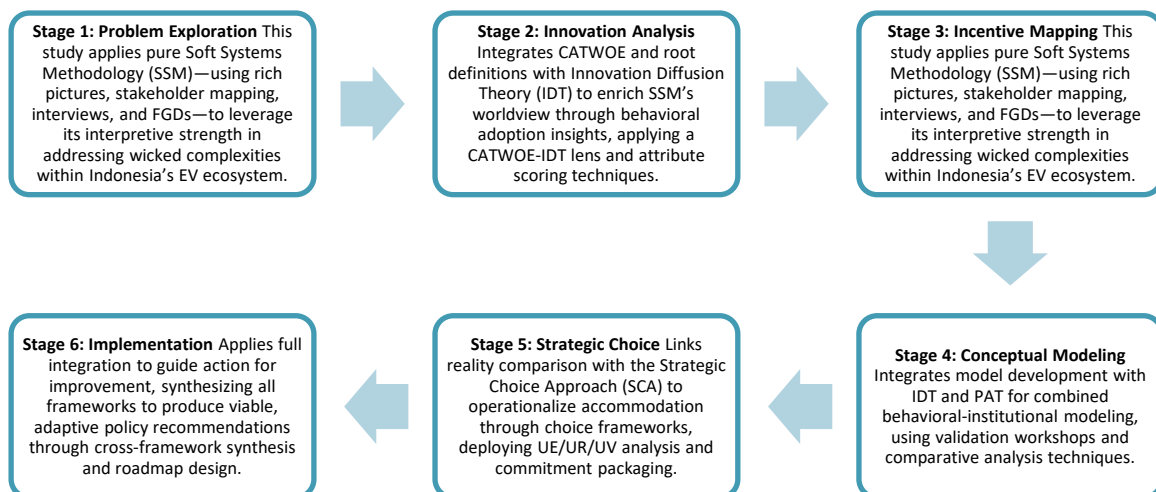


Figure 2. Six-Stage Multi-Methodology Integration Framework for EV Policy Analysis.

METHODOLOGY

This study employs a Systematic Literature Review (SLR), complemented by an expert validation workshop, to investigate the application and suitability of Soft Systems Methodology (SSM) in complex public policy challenges, with particular attention to transportation and energy

transitions. The review follows a transparent and replicable protocol based on established guidelines (Tranfield et al., 2003; Snyder, 2019), and is guided by four research questions: (1) how SSM has been applied in public policy, particularly in transportation and energy transitions; (2) what its methodological strengths and limitations are in addressing wicked problems; (3) how it can be integrated with complementary approaches (IDT, PAT, and SCA) to analyze challenges such as EV adoption; and (4) what the key implementation considerations are for applying multi methodological approaches in emerging economies such as Indonesia.

Scopus served as the primary database because it offers broad, peer reviewed, interdisciplinary coverage and consistent metadata for advanced filtering (Mongeon & Paul-Hus, 2016). A single primary database was chosen to keep metadata and filtering consistent, and because relying on one database limits recall, backward and forward snowballing of the included articles was added as a corrective (Tranfield et al., 2003). The search was conducted on 16 June 2025 across the title, abstract, and keyword fields (TITLE-ABS-KEY) using the string (Electric Vehicles OR Electric Mobility OR Low-Carbon Transportation) AND (Emerging Economies OR Developing Countries) AND (Adoption OR Transition OR Policy), which returned 170 records. Duplicate removal and title and abstract screening then excluded 42 records, leaving 128 for eligibility assessment, after which full text assessment excluded a further 47 and produced a final corpus of 81 articles published between 2007 and 2025. Inclusion was limited to English language articles in final publication stage within the Business, Management and Accounting subject area that addressed technology adoption or policy in emerging economies, while purely technical studies without policy relevance, non final publications, and records outside that subject area were excluded, and each retained article was additionally checked for peer reviewed status, methodological clarity, and relevance to the research questions. Extraction was carried out in NVivo using a structured coding scheme organized around problem dimensions, methodologies, and policy implications, with the individual article as the coding unit. Two researchers first calibrated the scheme on a shared subset of articles and then coded all 81 articles independently, reaching a Cohen's kappa of 0.86, which indicates almost perfect agreement, with the few remaining discrepancies resolved through discussion (Landis & Koch, 1977). The complete selection process is summarized in Figure 3.

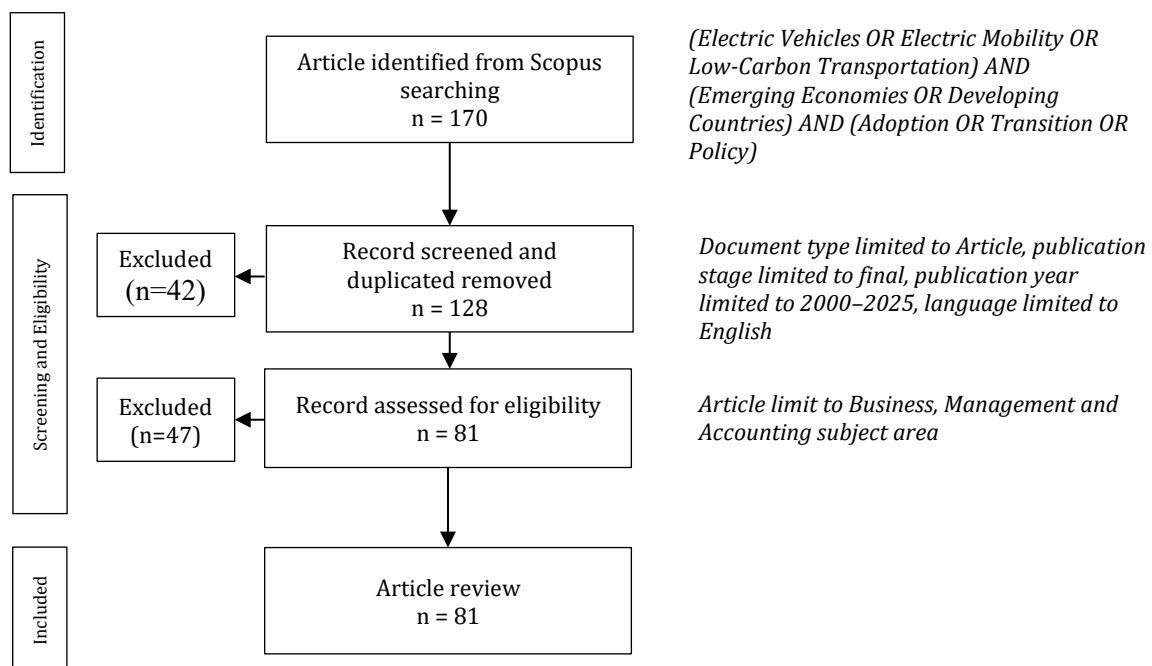


Figure 3. PRISMA Flow Diagram for Systematic Literature Review Process

Building on the framework derived from this review, a pilot validation workshop with nine Indonesian experts was conducted using SSM principles to strengthen contextual validity. The experts were selected purposively on the basis of direct expertise in Indonesia's EV ecosystem and representation across the relevant stakeholder domains, including government, industry, energy, and academia. Working through SSM and CATWOE prompts, participants assessed the framework's stages, the realism of the identified barriers, and its fit with coordination dynamics, mobility patterns, and informal governance in Indonesia, and the discussion was recorded with consent and analyzed thematically so that the resulting themes confirmed and refined the framework rather than generating new empirical findings.

FINDINGS AND DISCUSSION

This section addresses the four research questions, drawing on the systematic review of 81 articles and an illustrative application of the framework. To keep the basis of each claim transparent, findings drawn from the literature review are distinguished throughout from the authors' analytical interpretation and from the issues raised during the validation workshop.

Systematic Literature Review Findings

The systematic review of 81 articles indicates three recurring patterns in EV policy research for emerging economies, summarized in Table 4 across study focus, methodological approach, and identified gaps.

Table 4. Summary of Systematic Literature Review Findings

Study Focus	Representative Studies	Key Findings	Methodological Approach	Identified Gaps
Economic & Technical Barriers	Wibowo & Septiari (2023); Anugrah et al. (2025); Pirmana et al. (2023)	Upfront cost, limited financing, and infrastructure gaps as primary barriers; notable TCO premium over ICEVs	Quantitative: TCO, input-output, cost-benefit	Assumes rational consumers; overlooks institutional and behavioral factors
Infrastructure Planning	Setiawan et al. (2020); Anugrah et al. (2025); Hakam & Jumayla (2024)	Charging heavily concentrated in Java-Bali; urban-rural inequity	MCDM: AHP, fuzzy logic, GIS	Technocratic focus neglects worldviews, coordination, implementation
Consumer Behavior	Lazuardy et al. (2024); Syamnur et al. (2019); Sitinjak et al. (2025)	Range anxiety, reliability concerns, and brand loyalty drive resistance; public opinion	Surveys, SEM, sentiment analysis, TPB/UTAUT	Individual focus disconnected from institutional and multi-stakeholder factors

Study Focus	Representative Studies	Key Findings	Methodological Approach	Identified Gaps
		fragmented		
Policy & Regulation	Sasongko et al. (2024); Tritto (2025); Setiawan et al. (2020)	Regulatory inconsistency, BEV-HEV ambiguity, central-local misalignment	Qualitative: document analysis, interviews, system dynamics	Descriptive not prescriptive; lacks wicked-problem frameworks
Institutional Dynamics	Pandyaswargo et al. (2021); Lonan & Ardi (2020); Habiburrahman et al. (2025)	SOE coordination failures, technology-transfer barriers, recycling gaps	Mixed: case studies, system dynamics, network analysis	Institutional analysis peripheral; weak link to behavioral or strategic theory
Multi-Methodology Applications	Flores et al. (2024); Georgiou (2013); Franco & Montibeller (2010)	PSMs and SSM underutilized; transport policy gets limited PSM attention	Methodological reviews, meta-analyses	No protocol integrating SSM, IDT, PAT, and SCA for complex transitions

Across these studies, the review indicates that Indonesia's EV challenge is typically addressed in separate analytical silos, with economic work centered on cost barriers, infrastructure work on spatial optimization, behavioral work on consumer attitudes, policy work on regulatory inconsistency, and institutional work on coordination failures. What the reviewed literature does not offer is a single framework that integrates these dimensions in a way suited to wicked problems. In the authors' reading, this fragmentation helps account for the persistent distance between the policy ambition of 400,000 EVs by 2030 and current adoption below one percent, and it motivates the stage specific integration protocol set out earlier.

SOSM Framework Mapping for EV Transition

Applying the SOSM framework, this study assesses the complexity of Indonesia's EV transition as predominantly complex rather than simple or complicated. Although some technical elements such as battery systems and grid engineering have complicated characteristics, these are outweighed by socio political dynamics, emergent market behavior, and adaptive stakeholder responses that limit linear planning, as detailed in Table 5.

Table 5. System Complexity Assessment of Indonesia's Electric Vehicle Transition

Complexity Level	General Characteristics	Evidence from Indonesia's EV Transition	Assessment
Simple	- Clearly defined problems - Linear cause-effect relationships - Limited number of variables - Predictable outcomes	- No clear evidence - Multiple interconnected variables - Unpredictable market responses	Not Applicable

Complexity Level	General Characteristics	Evidence from Indonesia's EV Transition	Assessment
Complicated	- Many components but analyzable - Requires expert knowledge - Technically complex - Allows for linear problem-solving	- Some technical components (e.g., battery chemistry, grid engineering) - Dominated by socio-political factors - Expert disagreement on solutions	Partially Applicable
Complex	- Emergent behavior - Non-linear interactions - Adaptive systems - High uncertainty and ambiguity	- Emergent market dynamics - Non-linear effects of policy - Adaptive stakeholder responses - Uncertain technological paths	Highly Applicable

On the participant dimension, the literature characterizes stakeholder relationships as predominantly pluralist, with emerging unitary consensus around climate and economic goals and manageable coercive elements arising from power asymmetries (Ansell & Gash, 2018; Li et al., 2025; Geels et al., 2017). Table 6 summarizes this assessment..

Table 6. Stakeholder Dynamics Assessment Framework

Participant Type	Core Characteristics	Indonesia EV Context
Unitary	Shared goals, high consensus, cooperative relationships (Ansell & Gash, 2018)	Growing alignment on climate goals, carbon reduction, and economic opportunities, indicating emerging consensus (Li et al., 2025)
Pluralist	Multiple viewpoints, reconcilable interests, negotiation and open participation (Geels et al., 2017; Turnheim et al., 2015)	Diverse stakeholders with complementary roles, including government trade-offs, industry value chains, varied consumer needs, and active collaboration through partnerships and policy dialogue (Sovacool et al., 2019; Bergek et al., 2008)
Coercive	Power asymmetry, conflicting interests, unequal influence (Fischer & Newig, 2016)	Imbalances between large firms and SMEs, as well as regional disparities, addressed through regulation, support programs, and structured cooperation (Head, 2019; Kivimaa & Kern, 2016)

These two dimensions are read against the System of Systems Methodologies, a meta framework that matches problem solving approaches to the complexity of a system and the nature of its stakeholder relationships rather than prescribing a fixed solution (Jackson & Keys, 1984; Jackson, 1990). Figure 4 presents this grid, which maps systems methodologies against levels of complexity and the unitary, pluralist, or coercive character of stakeholder relationships.

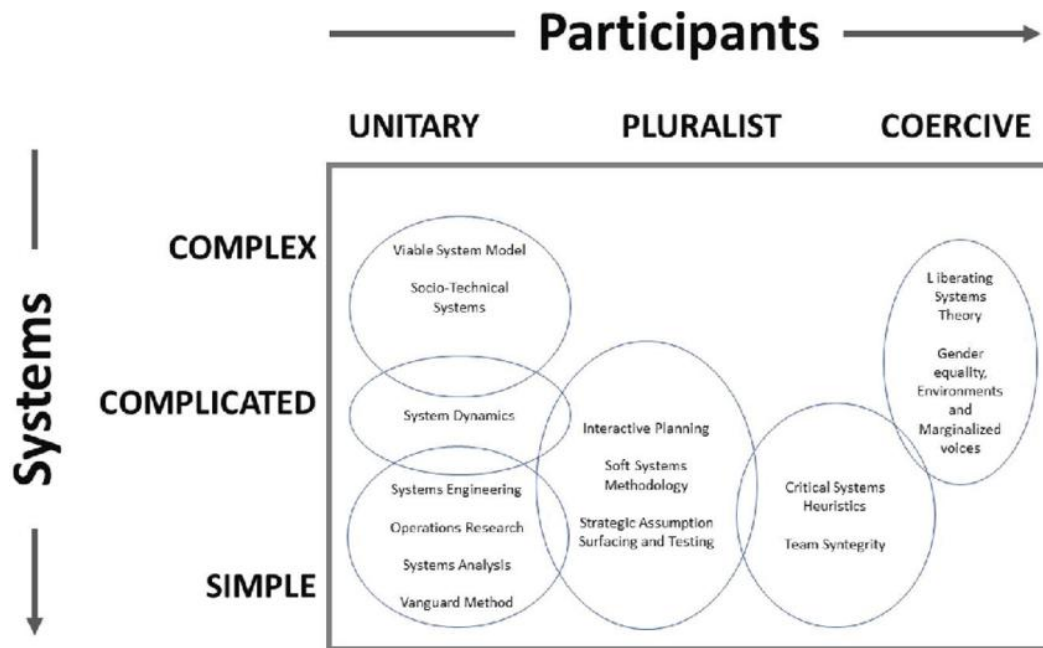


Figure 4. System of System Methodology, A Conceptual Framework (Jackson, 1990)

Positioned on this grid, Indonesia's EV transition falls primarily in the Complex Pluralist quadrant, with secondary relevance to the Complex Coercive domain. The Complex Unitary perspective fits poorly given the fragmented policy environment, while Complicated Pluralist approaches remain too reductionist to capture the socio political complexity of the transition. The Complex Pluralist position offers the strongest fit because it accommodates system complexity and diverse interests through participatory and interpretive methodologies, which provides the rationale for using SSM as the methodological backbone, complemented where power asymmetries arise by approaches suited to the Complex Coercive domain. Table 7 sets out this positioning across the four candidate quadrants.

Table 7. SOSM Framework Positioning for Indonesia's Electric Vehicle Transition

Framework Position	System Type	Participant Type	Applicable Methodologies	Relevance to Indonesia's EV Transition
Complex-Unitary	Complex	Unitary	Viable System Model Socio-Technical Systems	Low Relevance Lacks sufficient stakeholder alignment
Complex-Pluralist	Complex	Pluralist	Interactive Planning Soft Systems Methodology (SSM) Strategic Assumption Surfacing and Testing (SAST)	Highly Relevant Represents the primary fit for Indonesia's EV context
Complex-Coercive	Complex	Coercive	Liberating Systems Theory Critical Systems	Moderately Relevant Reflects the presence of power imbalances

Framework Position	System Type	Participant Type	Applicable Methodologies	Relevance to Indonesia's EV Transition
Complicated-Pluralist	Complicated	Pluralist	Heuristics	Limited Relevance Too reductionist to fully capture system complexity
			Team Syntegrity	
			Systems Engineering	
			System Dynamics	
			Operational Research	

This positioning explains why a single interpretive methodology is necessary but not sufficient, and why SSM is paired with IDT, PAT, and SCA in the stages that follow.

Limitations of Conventional Approaches

Even with fiscal and non fiscal incentives, EV adoption in Indonesia remains below one percent of car sales, which points to systemic issues beyond the availability of incentives (Hakam & Jumayla, 2024; Sitinjak et al., 2025). The reviewed literature describes a transition marked by stakeholder fragmentation, the absence of a shared vision, and high uncertainty over infrastructure and industrial direction, all of which are characteristic of wicked problems (Sasongko et al., 2024; Tritto, 2025). Table 8 contrasts the assumptions of conventional tame problem solving with the wicked problem reality of Indonesia's EV transition.

Table 8. Characteristics of Indonesia's EV Policy as a Wicked Problem Adapted from Rosenhead (1996, p. 515)

Tame Problem Characteristics	Wicked Problem Reality in Indonesia's EV Transition
Trade-off of single objective for optimization	Multiple, competing goals (economic growth, emissions reduction, local content, social equity), often in conflict and difficult to optimize simultaneously (Setiawan et al., 2020).
Data greed, distortion	Unreliable or incomplete data, especially in infrastructure usage, consumer sentiment, and lifecycle emissions (Wibowo & Septiari, 2023; Anugrah et al., 2025).
Assumption of consensus, scientization of politics	Fragmented actor interests (central vs. local govt, SOEs vs. startups, ICEV lobby vs. BEV proponents); policies often made top-down with poor transparency (Sasongko et al., 2024).
People as passive object	Citizens and industry actors respond actively, resisting or adapting policy (e.g., hybrid preference, battery swapping, price avoidance) (Sitinjak et al., 2025; Choi et al., 2022).
Hierarchy, abstract objectives	Local interpretations vary widely: some focus on battery industry, others on urban mobility or private adoption—no clear universal priority (Tritto, 2025; Pandyaswargo et al., 2021).
Future certainty, so "predict and prepare"	High uncertainty in technology readiness, charging infra rollout, and behavioral change; requiring iterative learning and adaptive response (Setiawan et al., 2020; Lonan & Ardi, 2020).

The contrasts in Table 8 show how closely Indonesia's EV challenges fit the classic features of wicked problems, in which no single actor holds a complete view and conventional tools struggle with value laden conflict (Rittel & Webber, 1973; Rosenhead, 1996). This is reflected in the way EV

policy research in Indonesia has relied on technocratic tools such as Total Cost of Ownership, the Analytic Hierarchy Process, and input output modeling, which estimate costs and efficiencies well but capture behavioral, institutional, and political dynamics less effectively (Wibowo & Septiari, 2023; Setiawan et al., 2020). Because these tools assume rational behavior, they tend to overlook public skepticism, policy misalignment, and fragmented governance (Anugrah et al., 2025; Sasongko et al., 2024). Problem Structuring Methods offer a more suitable lens, and among them SSM is well placed to integrate multiple perspectives and generate context sensitive understanding (Checkland & Poulter, 2007; Georgiou, 2013). Table 9 sets out how SSM complements each conventional method.

Table 9. Comparison of Existing EV Policy Methods and the Added Value of SSM

Conventional Methodology	Main Focus	Limitations in EV Policy Context	How SSM Addresses the Gap
Total Cost of Ownership (TCO)	Economic viability over lifecycle	Assumes rational consumers; overlooks distrust in reliability and charging access	Surfaces perceptions, values, and systemic barriers via rich pictures and root definitions
Analytic Hierarchy Process (AHP)	Multi-criteria prioritization	Oversimplifies actor interests; weak interpretive depth	Accommodates competing worldviews via CATWOE and conceptual modeling
Input-Output Modeling	Economic and supply-chain impact	Misses social and political drivers; assumes linear causality	Reframes institutional tensions through participatory exploration
System Dynamics (SD)	Feedback-based policy modeling	Strong on structure, weak on stakeholder narratives	Hybridizes with SSM to ground maps in stakeholder discourse
Sentiment Analysis / Surveys	Public-opinion trends	Surface-level; cannot unpack worldviews	Enables dialogic, narrative-based inquiry into perceptions

As Table 9 indicates, conventional methods contribute valuable but partial insights, while SSM adds the integrative and participatory depth needed for Indonesia's wicked EV policy challenges. The next section illustrates how these strengths translate into an applied framework

Framework Operationalization in Indonesian Context

To illustrate how the framework operates, this study applies it to Indonesia's EV charging infrastructure policy. This application is illustrative rather than a full empirical test, and it draws on the patterns identified in the systematic review together with the issues raised during the validation workshop. Applied in this way, the early stages surface competing stakeholder priorities, with government actors oriented toward technical deployment, private operators toward commercial viability, and consumers toward accessibility and convenience. Subsequent stages bring out adoption barriers such as limited infrastructure, incompatible standards, and low visibility, alongside incentive misalignments between public and private actors that participants linked to underused charging stations. This misalignment was captured in the observation that current policy provided "no user incentives, only for manufacturing and importers", while the dependence on imported equipment was summarized in the remark that "all charging equipment is imported" (Lazuardy et al., 2024; Sasongko et al., 2024).

A further set of barriers concerned institutional dependence and geographic inequity. One recurring observation, that "password communication held by brand owners" can block locally developed components even when they are technically viable, illustrates the information asymmetry that Principal-Agent Theory is intended to surface, while the comment that "several regions especially outside Java still cannot develop electric vehicles" reflects the uneven reach of infrastructure beyond Java and Bali. Integrating these behavioral and institutional insights then allows alternative policy scenarios to be set out, including government led, market driven, and hybrid options, while structured uncertainty analysis separates immediate actions from deferred commitments (Friend & Hickling, 2012). Because this application is exploratory, its results are best read as indicative of the framework's analytical reach rather than as validated policy conclusions.

Discussion

The findings respond to the four research questions by showing that Soft Systems Methodology has been applied in public policy mainly as a problem structuring device, that its interpretive strength is matched by a limited prescriptive capacity when used alone, and that this limitation can be addressed by integrating it with complementary approaches at defined stages. The central contribution of this study lies in the third point. Whereas the reviewed literature treats economic, infrastructural, behavioral, and institutional dimensions in separate silos, the proposed framework connects them within one structure by assigning IDT, PAT, and SCA to the stages where each is analytically valid, with SSM and CATWOE acting as linking devices that preserve coherence across the stages (Figure 5).

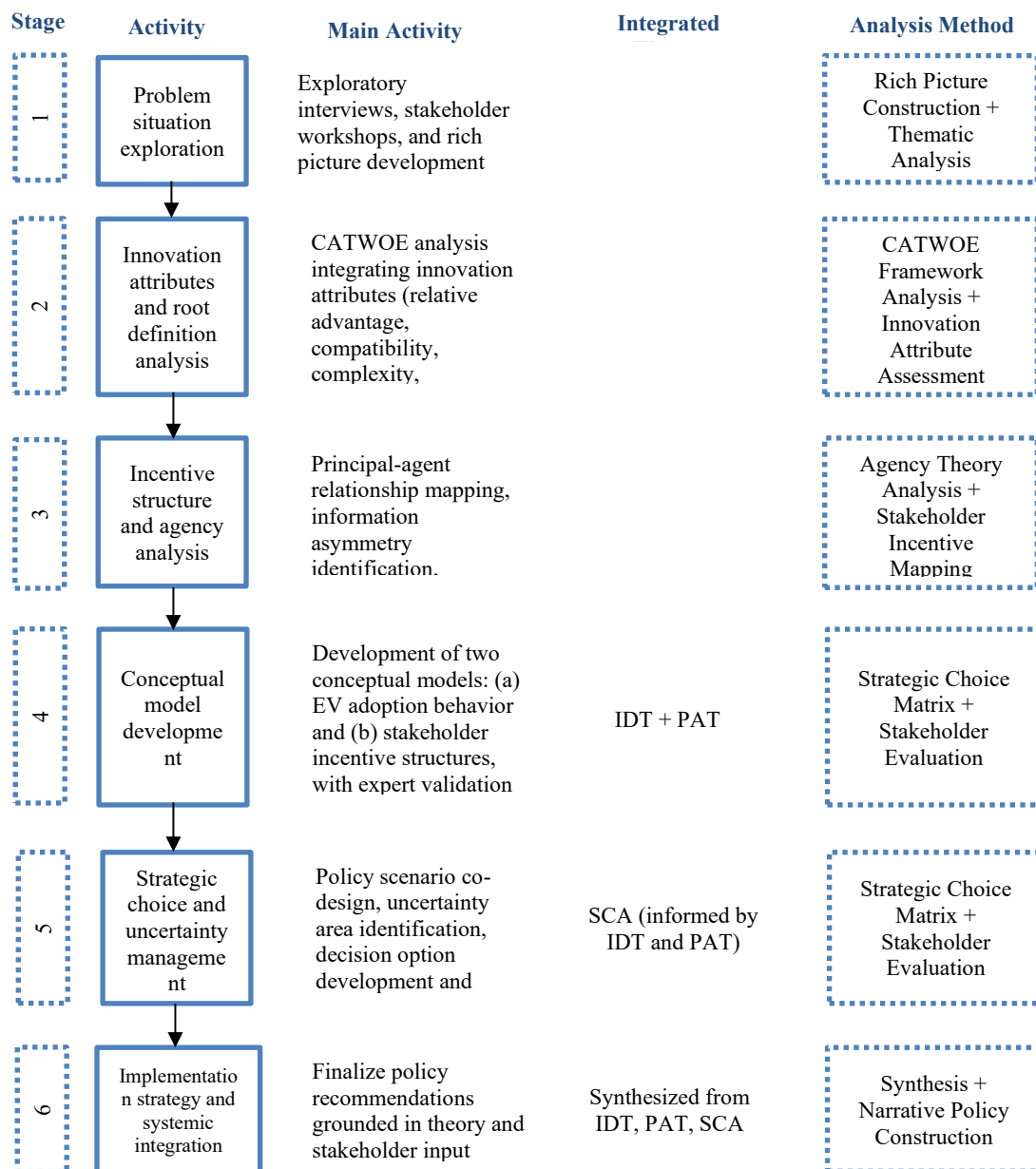


Figure 5. Multi-Methodology Integration Framework: SSM as Methodological Backbone with IDT, PAT, and SCA Integration Points

The illustrative application points to three observations that connect these methodological choices back to Indonesia's context. First, the competing priorities of government, private operators, and consumers indicate that innovation attributes are better read within institutional realities than in isolation, which extends diffusion based accounts that focus on individual adopters (Rogers, 2014). Second, the principal agent misalignments surfaced in the application correspond to gaps between policy expectations and outcomes, particularly in infrastructure utilization and incentive effectiveness, and offer one explanation for why investments may underperform that cost based models tend to leave out (Laffont & Martimort, 2002; Wibowo & Septiari, 2023). Third, structured uncertainty analysis helps separate immediate actionable decisions from longer term strategic choices, which supports adaptability in a fast changing policy environment (Friend &

Hickling, 2012). Because these observations come from an illustrative rather than a fully validated application, they are best read as evidence of the framework's analytical reach, and their empirical confirmation is left to future work.

CONCLUSION

This study addresses a methodological gap in EV policy research for emerging economies by proposing a stage specific multi methodological framework that integrates Soft Systems Methodology with complementary approaches, using Indonesia as the primary context. The four research questions can be answered briefly. On the first, the review indicates that SSM has been applied in public policy mainly as a problem structuring tool that supports stakeholder engagement, contextual understanding, and iterative learning, including in transportation and energy transitions. On the second, its strengths lie in handling ambiguity and accommodating multiple perspectives, while its limitations are its qualitative nature, reliance on facilitation, and limited prescriptive power when used alone. On the third, the study shows that SSM can be integrated with IDT, PAT, and SCA through stage specific alignment, so that behavioral, institutional, and strategic dimensions are addressed without losing coherence. On the fourth, the key implementation considerations identified are stakeholder diversity, institutional fragmentation, and the need for adaptive and iterative policy processes.

These answers carry two kinds of implication. Theoretically, the study contributes a structured way to combine interpretive, behavioral, institutional, and strategic perspectives within a single coherent protocol, advancing how Problem Structuring Methods can be integrated rather than applied in isolation. Practically, the six stage framework offers policymakers a flexible basis for analyzing and designing EV policy in settings marked by fragmentation and competing interests. These contributions should be read with appropriate caution. The framework is proposed rather than fully tested, it has so far received only preliminary validation through a systematic literature review and an illustrative application refined in an expert workshop, and further empirical testing is needed before its utility can be established. While it is developed for Indonesia and may inform comparable emerging economies, its transferability to other institutional and socio economic settings remains to be examined.

LIMITATION AND FURTHER RESEARCH

This study has several limitations. First, the framework is developed primarily through a systematic literature review and an illustrative application, so its empirical validation across different contexts is still limited. Second, the review relied on Scopus as the single primary database and included only English language, peer reviewed articles, which means relevant work in other databases, in other languages, or in grey literature such as government and industry reports may have been missed. Third, the contextual validation rested on a small pilot workshop, whose limited number of participants constrains the strength of the validation. Fourth, the multi methodology approach is itself demanding, since combining four approaches requires considerable expertise and facilitation capacity for practical use. Finally, the study focuses on the Indonesian context, which limits the generalizability of its findings to countries with different institutional and socio economic conditions.

Building on these limitations, future research can pursue several directions. The most immediate is empirical validation of the proposed framework through case studies, pilot implementations, or longitudinal analysis in different policy settings, supported by validation with a larger and more diverse group of stakeholders. Comparative studies across countries would help assess how well the framework adapts to varying institutional environments, while broader literature coverage that includes additional databases, non English studies, and grey literature

would strengthen its evidence base. Future work could also integrate quantitative methods such as system dynamics or simulation to complement the framework's qualitative insights, and could examine how digital and data driven tools might support the operationalization of multi methodology frameworks in complex policy contexts.

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