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Urban Energy Resilience in Southeast Asian Megacities: Integrating the 4A Framework and Multi-Level Governance Gaps in Jakarta, Manila, and Bangkok

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Abstract

Urban energy resilience has become a critical challenge for Southeast Asian megacities amid rapid urbanization, climate induced hazards, and increasing dependence on centralized energy systems. While existing studies predominantly emphasize technical reliability, the governance dimension of urban energy resilience remains insufficiently theorized. This study proposes a conceptual framework that integrates the four dimensions of energy security, Availability, Accessibility, Affordability, and Acceptability (4A) with the OECD's Seven Multilevel Governance Gaps to examine how institutional structures shape urban energy resilience. This qualitative systematic literature review applies the framework to a comparative analysis of Jakarta, Manila, and Bangkok. The findings reveal contrasting resilience profiles across the three cities. Manila demonstrates low adaptive capacity due to fragmented governance and high reliance on imported energy. Jakarta exhibits dependent resilience, characterized by a stable supply but limited local autonomy under centralized energy governance. Bangkok demonstrates relatively strong resilience, supported by higher institutional capacity, although constrained by policy inertia and coordination gaps. The study concludes that urban energy resilience is driven primarily by governance performance rather than technical capacity alone. This framework provides a policy oriented analytical tool to strengthen urban energy resilience in developing countries.

Keyword: Urban Energy Resilience, Multilevel Governance, Governance Gaps, Southeast Asian Megacities

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INTRODUCTION

Urban energy resilience has emerged as a critical concern for rapidly urbanizing regions (Sharifi & Yamagata, 2016), particularly in Southeast Asian megacities where rising energy demand, climate-related hazards, and institutional complexity intersect. While urban energy systems in cities such as Jakarta, Manila, and Bangkok have generally maintained a stable electricity supply in recent years, this apparent stability often conceals underlying vulnerabilities stemming from governance structures rather than from technical capacity alone

Existing studies on energy security and resilience have traditionally emphasized technical dimensions, including system robustness, infrastructure reliability, and supply adequacy (Panteli & Mancarella, 2015). Although these aspects remain essential, a growing body of literature suggests that urban energy resilience is increasingly shaped by governance arrangements that determine how risks are anticipated, managed, and mitigated across different levels of authority. In highly centralized or fragmented systems, cities may experience limited capacity to respond adaptively to energy-related disruptions, even when national energy systems appear robust.

In Southeast Asia, megacities operate within complex institutional settings where authority over energy planning, pricing, and infrastructure development is often concentrated at the national level (OECD, 2017) In contrast, the impacts of energy disruptions are felt most acutely at the urban scale. This misalignment raises essential questions about the role of city governments in enhancing urban energy resilience and the extent to which governance structures enable or constrain local adaptive capacity. To address these challenges, this study integrates the 4A framework of energy security availability, accessibility, affordability, and acceptability with a multi-level governance perspective operationalized through the Seven Governance Gaps framework. Rather than treating urban energy resilience as a purely technical outcome, the study conceptualizes it as a governance-driven process shaped by interactions among national institutions, local governments, utilities, and other stakeholders (Claire Charbit, 2011).

Using a qualitative comparative approach, this paper examines Jakarta, Manila, and Bangkok as representative Southeast Asian megacities with distinct governance configurations and energy policy contexts. By analyzing recent energy conditions, prevailing policy frameworks, and governance dynamics in each city, the study seeks to answer the following research questions:

1. How do multi-level governance arrangements shape urban energy resilience in Southeast Asian megacities?

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2. In what ways do governance gaps influence the performance of the 4A dimensions at the urban level?
3. What comparative insights can be drawn to inform more adaptive and resilient urban energy governance?

By addressing these questions, this study contributes to the literature on urban energy resilience by highlighting governance as a central determinant of cities' capacity to absorb disruptions, adapt to structural constraints, and recover from systemic shocks.

LITERATURE REVIEW

Energy Security Indicators (*Availability, Accessibility, Affordability,* and *Acceptability)*

In this study, urban energy resilience is conceptualized as the capacity of urban energy systems to maintain, adapt, and recover their core functions under stress, with energy security operationalized through the 4A dimensions serving as a key analytical component rather than a standalone objective. Recent studies conceptualize energy security through the 4A dimensions, which includes availability, accessibility, affordability, and acceptability (Paravantis & Kontoulis, 2020) This framework is a contemporary development of energy security theory, which assesses supply stability not only from a technical perspective but also from political, social, and environmental perspectives. (Paravantis & Kontoulis, 2020) explain that availability refers to the adequacy of energy supply and the ability of the system to maintain service reliability; accessibility focuses on distribution equity, infrastructure stability, and equitable access for all social groups; affordability assesses the affordability of energy costs in relation to the economic conditions of the community and industry; and acceptability emphasizes the alignment of energy use with sustainability standards and social acceptance.

Recent literature indicates that these four dimensions are not static but reflect the level of energy vulnerability in the face of internal and external disruptions. Studies in the last five years have highlighted that availability is closely related to energy source diversification and supply chain resilience; accessibility is related to governance quality and institutional capacity to provide inclusive energy services; affordability is influenced by price regulations, subsidies, and the impact of global market volatility; while acceptability is increasingly linked to the shift towards renewable energy and sustainability demands.

In urban contexts, particularly in developing countries, the 4A framework is practical for identifying key energy security challenges. (Paravantis & Kontoulis, 2020) emphasize that the readiness of government institutions greatly influences the successful fulfillment of the 4A framework, the quality of energy policies, and the capacity to adapt to climate risks. Therefore,

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the use of 4A in assessing energy security in cities such as Jakarta, Manila, and Bangkok helps map how the aspects of availability, access, cost, and public acceptance influence a city's ability to cope with energy disruptions. Thus, 4A provides a relevant analytical foundation for developing an urban energy security model that integrates governance dynamics and environmental risks.

MultiLevel Governance (MLG) & Seven Governance Gaps Theory

Multi-Level Governance (MLG) conceptualizes public policy as the outcome of interactions among actors operating across multiple levels of government, where authority and decision-making are distributed rather than centralized within a single level (Marks, 2004). n complex sectors such as energy and urban sustainability, policy outcomes are shaped not only by formal planning arrangements but also by the governance arrangements, coordination challenges, and power relations among actors across governance levels. Studies on urban sustainability transitions emphasize the role of collaborative governance and multi-actor coordination in enabling systemic change (Bulkeley et al., 2016; Nevens et al., 2013).MLG is characterized by interdependent vertical and horizontal relationships, in which the distribution of authority, resources, and capacity across governance levels is often uneven. Such imbalances frequently generate coordination challenges, divergent policy priorities, and constraints on implementation capacity.

To operationalize the governance challenges identified in Multi-Level Governance (MLG) settings, the OECD introduced the Seven Governance Gaps framework, comprising funding, administrative, policy, information, capacity, objective, and accountability gaps (OECD, 2017). These gaps explain recurring governance failures that emerge when policy responsibilities are distributed across multiple actors and levels of government. According to the (OECD, 2017), a funding gap arises when fiscal resources are misaligned with assigned responsibilities across levels of government; an administrative gap reflects mismatches between functional responsibilities and the territorial scale of governance; a policy gap refers to inconsistencies or fragmentation among policies across institutions; the information gap stems from asymmetries in data availability and analytical capacity; the capacity gap denotes limitations in technical expertise and human resources; the objective gap relates to divergent political priorities among actors; and the accountability gap occurs when responsibilities and oversight mechanisms are unclear. In this study, the Seven Governance Gaps framework is applied analytically to explain why the fulfillment of the 4A dimensions of energy security at the city level often remains incomplete or suboptimal.

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RESEARCH METHOD

This study adopts a qualitative research approach using a Systematic Literature Review (SLR) design to examine urban energy resilience. The analysis integrates the 4A dimensions of energy security availability, accessibility, affordability, and acceptability with the OECD's Seven Governance Gaps framework. All research data were derived from secondary sources, including peer-reviewed journal articles, international reports, and policy documents related to the cities of Jakarta, Manila, and Bangkok. Literature selection followed a structured process involving inclusion and exclusion criteria, screening, and quality appraisal. A data extraction matrix was employed to code and organize findings according to the 4A dimensions and the identified governance gaps. Data analysis employed thematic analysis, pattern matching, and cross-city comparative analysis, and the credibility of the findings was ensured through source triangulation and theoretical consistency.

In this study, Multi-Level Governance (MLG) serves as the primary theoretical lens for understanding interactions among energy actors across national and urban levels. The Seven Governance Gaps framework is applied as an operational analytical tool to diagnose specific institutional and coordination failures that influence urban energy resilience outcomes.

RESULT AND DISCUSSION

Urban Energy Resilience Through 4A and Governance Gaps in Manila

Over the past five years, Metro Manila's energy system has faced increasing pressure due to rising electricity demand and a structural dependence on fossil-fuel-based generation at the national level. This dependence increases exposure to global energy price fluctuations and supply risks, resulting in a gradual and uneven transition to more sustainable energy sources (IEA, 2023; Viktor Tachev, 2024). Within the 4A framework, electricity availability and accessibility in Metro Manila are relatively good overall, but distribution disruptions and access inequalities persist for specific community groups. Affordability remains a significant challenge, with electricity prices remaining relatively high despite national policy interventions. Meanwhile, the acceptability of renewable energy shows positive developments, reflected in the increasing willingness of households to support clean energy despite varying ability to pay (Palanca-Tan et al., 2024).

At the city level, resilience planning and long-term development are reflected in the Plan MANILA 2030 framework and the Manila Disaster Risk Reduction and Management Plan 2021–2028, which prioritize climate risk mitigation and infrastructure resilience. However, core energy policy remains regulated by the national government through legal frameworks such as the

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Renewable Energy Act ((REPUBLIC OF THE PHILIPPINES CONGRESS OF THE PHILIPPINES Metro Manila, 2008)) and national electricity market mechanisms.

From a multi level governance perspective, Metro Manila exhibits intense fragmentation of authority between the national government, regulators, private utilities, and local governments. This situation creates persistent policy and coordination gaps, with city governments responsible for urban risk management yet lacking full authority to influence strategic energy planning. As a result, Manila's urban energy resilience is highly dependent on the coherence of national policies and the effectiveness of cross-level coordination.

Urban Energy Resilience Through 4A and Governance Gaps in Bangkok

Over the past five years, Bangkok has experienced a significant increase in energy demand, driven primarily by the transportation, industrial, and urban services sectors. Thailand's national energy supply structure remains dominated by natural gas, while the contribution of renewable energy is gradually increasing, but is not yet sufficient to reduce dependence on fossil fuels (IEA, 2024). This trend places Bangkok in a relatively stable position in the short term, but it faces medium term resilience challenges. Within the 4A framework, the availability of Bangkok's electricity supply is relatively reliable, supported by the national grid and reserve capacity. Affordability is generally maintained, although certain groups are experiencing pressure from energy costs. On the acceptability dimension, low emission transportation and energy efficiency policies is increasing, consistent with the city's sustainability agenda.

At the city level, the Bangkok Metropolitan Administration has adopted the on the acceptability dimension, low-emission transportation and energy efficiency policies have been increasingly emphasized in Bangkok’s urban sustainability agenda (Bangkok Action Plan on Global Warming Mitigation - C40 Cities, 2019) and related action plans, which emphasize emissions reduction, energy efficiency, and sustainable transportation. However, electricity generation planning and network development remain governed by national frameworks, such as Thailand’s Power Development Plan (climatepolicydatabase, 2024), which sets the long-term strategy of the national energy system.

Viewed through the lens of multi level governance, Bangkok exhibits more coordinated governance arrangements than Manila, but remains hierarchical. The centralization of strategic energy authority at the national level limits the city's capacity to independently determine its energy transition path, making Bangkok's urban energy security highly dependent on the alignment between city policies and national energy planning. This condition highlights the importance of vertical policy integration in reducing governance gaps.

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Urban Energy Resilience Through 4A and Governance Gaps in Jakarta

In Jakarta, urban energy security is shaped by a combination of a stable electricity supply, a highly centralized energy governance structure, and the city government's limited authority to manage energy risks independently. Over the past five years, Jakarta has not experienced any large-scale electricity supply disruptions; however, this stability has been supported mainly by the Java-Bali interconnection system and national energy policies, rather than by adaptive capacity at the city level. This condition reflects the character of dependent resilience, in which the performance of the urban energy system depends on the scale and redundancy of the national system. In contrast, the flexibility of local policies is relatively limited.

In terms of availability and accessibility, Jakarta enjoys a high level of electrification and a relatively reliable electricity supply. However, its strong dependence on a centralized network increases the city's exposure to systemic disruption risks, including those triggered by extreme hydrometeorological events, surges in electricity demand, and load pressures in metropolitan areas. The literature on system resilience indicates that dependence on centralized networks can mask latent vulnerabilities that become apparent only when large-scale disruptions occur (Panteli & Mancarella, 2015)

In terms of affordability, electricity prices in Jakarta have remained relatively stable over the past five years, supported by national-level subsidy mechanisms and tariff controls. This policy has contributed significantly to urban social and economic stability, particularly during the post-pandemic recovery period. However, from a long-term energy security perspective, reliance on nationally determined subsidy and tariff mechanisms can constrain the ability of subnational governments to pursue more context-specific policy instruments, including energy-efficiency incentives and the development of decentralized energy solutions (Cherp & Jewell, 2014) to design more context specific energy policies, including energy-efficiency incentives and the development of decentralized energy solutions.

In terms of acceptability, public awareness of clean energy issues, building energy efficiency, and low emission transportation in Jakarta has increased over the past five years. This indicates the social potential to support urban energy transition. However, the implementation of clean energy initiatives at the city level remains limited and fragmented, as urban renewable energy development is highly dependent on regulatory frameworks, licensing, and coordination across levels of government (Sovacool et al., 2019).

The DKI Jakarta Provincial Government's efforts to formally address these challenges are reflected in the Regional Low Carbon Development Plan (RPRKD), established by DKI Jakarta Governor Regulation No. 90 of 2021 (DKI Jakarta (Provinsi), 2021), which remains in effect. This

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document emphasizes increasing energy efficiency, reducing emissions from the energy and transportation sectors, and integrating climate risk mitigation into regional development planning. However, the implementation of this policy remains constrained by local governments' limited authority to determine the energy mix, power plant development, and electricity network management.

These limitations are inseparable from the national energy policy framework that is still in effect. The National Energy Policy, as stipulated in Presidential Regulation No. 79 of 2014, places strategic energy planning and control of the electricity system under the authority of the central government. In addition, opportunities for renewable energy development in urban areas are strengthened by Presidential Regulation No. 112 of 2022(*Presidential Regulation No. 112 of 2022 on Accelerated Development of Renewable Energy for Electricity Supply - Climate Change Laws of the World*, 2022) on the Acceleration of Renewable Energy Development, which creates space for the development of clean energy plants, including in urban areas. However, in practice, the implementation of this policy in Jakarta still relies heavily on cross-level coordination, particularly for licensing, network integration, and tariff mechanisms.

Overall, the discussion of Jakarta indicates that the primary challenge to urban energy security is not the absence of policies or insufficient supply, but rather the gap between regional policy commitments and available implementation authority. From a Multi-Level Governance perspective, Jakarta faces a combination of policy, administrative, and capacity gaps, in which energy risks and their impacts are local. In contrast, policy control and resources remain centralized at the national level. These findings confirm that, over the last five years, Jakarta's energy security has reflected the stability of the national system rather than the city's own adaptive capacity.

CONCLUSION

This study demonstrates that urban energy resilience in Jakarta, Manila, and Bangkok is not primarily determined by the adequacy of energy supply or technical system reliability, but by the structure and performance of multi-level governance arrangements that shape cities' adaptive capacity. While all three cities have maintained a relatively stable electricity supply over the past five years, the underlying drivers of resilience differ significantly, reflecting distinct governance configurations rather than technical conditions alone.

The comparative analysis shows that Jakarta exhibits a form of dependent resilience, where urban energy stability relies heavily on centralized national policies and interregional infrastructure. At the same time, the city government has limited authority to influence energy

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planning and diversification. In contrast, Metro Manila faces persistent coordination and policy gaps arising from fragmented authority among national regulators, private utilities, and local governments, which constrain the city's ability to address affordability and long-term transition challenges systematically. Bangkok represents an intermediate case, where municipal climate and sustainability planning is relatively advanced. Yet, strategic control over energy generation and grid development remains centralized at the national level, limiting the city's autonomy in shaping its energy transition pathway.

Across the three cases, the 4A dimensions of energy security availability, accessibility, affordability, and acceptability are deeply intertwined with governance quality. Availability and accessibility are secured mainly through national systems, while affordability is strongly influenced by centralized pricing and subsidy mechanisms. However, acceptability and long-term resilience depend on local institutional capacity, public engagement, and city governments' ability to translate national energy objectives into context-specific urban strategies. Where such translation capacity is weak, governance gaps persist despite the presence of formal policies.

By integrating the 4A framework with a multi-level governance perspective operationalized through the Seven Governance Gaps, this study reframes urban energy resilience as a governance driven outcome rather than a purely technical function. The findings underscore that strengthening urban energy resilience in Southeast Asian megacities requires not only investment in infrastructure but also improved vertical policy integration, more precise allocation of authority across governance levels, and enhanced capacity for cities to manage energy-related risks. These insights contribute to the growing literature on urban energy resilience by highlighting governance as a central determinant of cities' ability to anticipate, absorb, and recover from energy disruptions. As a limitation, this study is based on a systematic literature review and has not quantitatively tested the conceptual framework. Therefore, further research is recommended to apply this framework to empirical studies based on primary data or cross city quantitative analyses to enhance external validity and broaden the generalizability of findings.

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