Assessing Challenges of Climate Change Adaptation among Supply Chains in Kenya's Energy Firms: A Systematic Literature Review

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ABSTRACT

Climate change poses systemic threats to energy supply chain operations in developing economies, yet the institutional conditions that determine adaptation outcomes remain insufficiently theorized and empirically fragmented. The review aims to examine the challenges of climate change adaptation among supply chain firms in Kenya's energy sector. Guided by the lens of Institutional Theory, the paper employs the PRISMA (2020) model as an analogy to mine 35 verified sources from an initial pool of 180 records across Scopus, Web of Science, Google Scholar, and institutional repositories, and to synthesize them through thematic coding across five domains. Findings reveal that operational vulnerabilities are compounded by an 80% climate finance gap, overlapping regulatory mandates, low organizational climate literacy, and supply chain restructuring that progressively marginalizes smaller actors. Across the five thematic domains, institutional fragmentation emerges as the dominant barrier, producing simultaneous failure across Scott's (2014) regulative, normative, and cognitive pillars and undermining the isomorphic pressures identified institutional theory that would otherwise drive coordinated adaptation. The review contributes a Kenya-specific, theoretically grounded framework linking institutional coherence to supply chain resilience. It identifies institutional reform as the prior condition for durable, inclusive climate adaptation in Kenya's energy sector.

Keywords: Institutional Theory; Climate Change Adaptation; Supply Chain Resilience; Kenya Energy Sector; Regulatory Fragmentation; Institutional Isomorphism.

INTRODUCTION

Climate change has emerged as a structural disruptor of global supply chains, reshaping procurement networks, logistics systems, and energy infrastructure in ways that conventional risk management frameworks were not designed to address. The Intergovernmental Panel on Climate Change (2022) confirms that the frequency and severity of climate-related hazards are increasing across all regions, with Sub-Saharan Africa facing compounded exposure due to poverty, governance fragmentation, and chronic infrastructure deficits. For supply chain firms in energy-dependent economies, these hazards are no longer future risks but present operational realities. Flood damage imposes measurable negative pressure on logistics performance indicators, temperature fluctuations degrade infrastructure quality, and climate shocks at supplier locations make customers 6 to 11% more likely to terminate existing supplier relationships entirely, triggering a systematic redesign of procurement networks toward lower-exposure geographies (Narayan, 2025; Pankratz & Schiller, 2022).

Kenya presents one of the most instructive cases for studying these dynamics. The country generates approximately 90% of its electricity from renewable sources, with geothermal contributing around 45% of installed capacity, hydropower 30%, and wind 16% — an energy matrix that is simultaneously a development achievement and a structural vulnerability (Apergi et al., 2024; Rotich et al., 2024). Hydropower, the backbone of base-load generation, is acutely sensitive to hydrological variability driven by climate change. At the same time, the country's fragmented transmission infrastructure, underdeveloped rural logistics networks, and over 70% of the land area arid or semi-arid compound the exposure of supply chain actors at every node, from

generation to last-mile distribution. Despite a substantive national policy architecture, including the Climate Change Act (2016), the National Climate Change Action Plan 2023 to 2027 (Government of Kenya, 2023), and the National Energy Policy 2025 to 2034 (State Department of Energy, 2025), a structured gap persists between policy ambition and firm-level adaptation performance across Kenya's energy supply chains.

The scholarly literature has not yet synthesized these intersecting challenges within a single theoretically coherent framework. Studies have examined Kenyan energy policy in isolation (Nyapom & Padi, 2025; Othoche, 2024) or supply chain resilience without institutional grounding (Freeman, 2023; Malek et al., 2022), while no systematic review has brought both dimensions together through a framework capable of explaining why adaptation fails structurally rather than merely operationally. Institutional Theory, as established by DiMaggio and Powell (1983) and elaborated by Scott (2014), explains how fragmentation across regulatory, normative, and cognitive pressures produces the uneven, reactive adaptation patterns observable in Kenya's energy sector. Rana and Allen (2024) confirm that institutional incoherence in national business systems directly constrains firms' capacity to embed climate resilience into supply chain governance, while Mair et al. (2012) demonstrate that in institutionally void environments, deliberate intermediary action is required to build inclusive and adaptive market structures.

This review addresses the identified gap by synthesizing evidence on climate change adaptation challenges in Kenya's energy supply chains through an Institutional Theory lens. The objective is to assess the dominant structural and institutional barriers to climate resilience across supply chain firms in Kenya's energy sector, and to develop a theoretically grounded, Kenya-specific framework that bridges international adaptation models with local institutional realities to inform both academic understanding and policy design.

Kenya's Energy Supply Chains

Kenya's energy sector operates through a structured but fragmented supply chain, comprising six principal state-mandated entities. The Kenya Electricity Generating Company (KenGen) holds approximately 65% of national electricity generation, operating hydropower, geothermal, wind, and thermal plants (Othoche, 2024). The Kenya Power and Lighting Company (KPLC) manages electricity distribution and retail across a network comprising 46,051 kilometers of transmission lines. At the same time, the Kenya Electricity Transmission Company (KETRACO) operates the national high-voltage grid (Rotich et al., 2024). The Rural Electrification and Renewable Energy Corporation (REREC) oversees off-grid renewable energy deployment, the Geothermal Development Company (GDC) manages steam field development and facilitates private sector entry into geothermal production, and the Energy and Petroleum Regulatory Authority (EPRA) provides the overarching regulatory framework for the entire sector (State Department of Energy, 2025).

Beyond these anchor institutions, Kenya's energy supply chain includes a diverse ecosystem of private actors. Independent Power Producers currently have 57 active projects under negotiation, covering small hydro, geothermal, wind, and solar with battery storage, which supply power through Power Purchase Agreements with KPLC (KPLC report, 2025). Mini-grid operators, pay-as-you-go solar companies, clean cooking enterprises, biogas suppliers, and petroleum distributors comprise a supply chain spanning formal institutions, informal community-based energy providers, and small- and medium-sized enterprises at the last mile of energy distribution (Rotich et al., 2024; Nyapom & Padi, 2025).

Current adaptation practices reflect real but structurally incomplete progress. Renewable energy accounted for 84.93% of Kenya's generation mix in 2023-2024. KenGen has been appointed to implement the World Bank-supported Battery Energy Storage System program, and KPLC has cut procurement ordering cycles from 6 months to 14 days through supply chain modernization (Othoche, 2024; Kenya Power and Lighting Company, 2025). However, a 9% decline in hydropower generation capacity persists due to rainfall variability, feed-in tariffs, and net metering policies that face chronic implementation failures.

Still, the reintroduction of a 14% tax on solar and wind products has significantly constrained adoption among smaller supply chain actors (Rotich et al., 2024). For SMEs and community-based energy providers, an 80% gap between Africa's documented climate finance needs and actual flows structurally forecloses the very investments their exposure demands (Climate Policy Initiative, 2024; Tamasiga et al., 2023). Adaptation in Kenya's energy

supply chains is therefore real but reactive, meaningful but insufficient. The current review examines and contextualizes this condition through five barrier domains.

Study Objective

The purpose of this review is to assess challenges of climate change adaptation among supply chain firms in Kenya's energy sector and to identify the dominant structural and institutional barriers to resilience based on a systematic review of the extant literature.

THEORETICAL REVIEW

Institutional Theory

Institutional Theory offers the primary analytical lens for this review. DiMaggio and Powell (1983) establish that organizations within shared fields are shaped not only by market competition but by three mechanisms of institutional isomorphism. Coercive isomorphism arises from regulatory requirements and resource dependencies that compel conformity. Mimetic isomorphism emerges when uncertainty drives firms to replicate the behavior of peers perceived as successful. Normative isomorphism reflects the standardizing effect of professionalization, where shared values and expectations produce convergent organizational practices across a field. The critical insight for this study is that where these mechanisms operate coherently, they generate systematic adaptation. Where they are fragmented or contradictory, they produce the uneven, reactive responses that characterize Kenya's energy supply chains.

Scott (2014) strengthens this framework by distinguishing three institutional pillars: the regulative pillar, comprising laws and enforcement mechanisms; the normative pillar, encompassing professional values and shared expectations; and the cognitive pillar, reflecting taken-for-granted beliefs about appropriate organizational behavior. Each pillar has a direct analytical function in this review. The regulative pillar explains why Kenya's progressive policy architecture has produced limited firm-level adaptation. Enforcement is weak, mandates overlap across the Energy and Petroleum Regulatory Authority, county governments, and the National Environment Management Authority, and compliance incentives are insufficient (Nyapom & Padi, 2025; Othoche, 2024).

The normative pillar explains why adaptation among smaller firms and informal distributors remains rare. No shared professional standard for climate-responsive procurement has diffused across the sector, and donor-driven expectations have not yet become internalized organizational norms (Greiner et al., 2023). The cognitive pillar explains the stubbornest dimension of adaptation failure: where climate risk is not yet a taken-for-granted concern within organizational culture, firms do not perceive adaptation as a strategic priority regardless of regulatory signals.

Rana and Allen (2024) extend this analysis into global value chains, demonstrating that the complementarity or incoherence of national institutional systems directly shapes whether firms can reconfigure supply chain governance in response to climate pressures. They argue that dysfunctional institutions do not simply slow adaptation but structurally foreclose the capabilities firms need to adapt. This applies precisely to Kenya, where the absence of coordinated institutional support across regulatory, financial, and knowledge systems leaves energy supply chain firms without the scaffolding required for effective adaptation.

Mair et al. (2012) add a further dimension relevant to Kenya's decentralized energy markets: institutional voids are not passive absences but active sites of conflict among competing institutional logics. In rural and peri-urban energy supply chains, these voids manifest as the exclusion of informal actors from formal governance, the absence of enforceable procurement standards, and the disconnection between national climate ambitions and county-level implementation capacity. Naess et al. (2015), analyzing Kenya's low-carbon energy policy directly, confirm that climate-motivated initiatives do not enter neutral institutional territory but are filtered through entrenched political interests and pre-existing governance conflicts that consistently dilute intended outcomes.

Taken together, these four theoretical contributions structure the entire analytical architecture of this review. The operational, financial, regulatory, and organizational barriers are not treated as isolated deficits. Each maps onto

a specific failure within Scott's (2014) three pillars, as shown in Figure 1. The discussion in Section 5 interprets adaptation pathways through the lens of institutional coherence, legitimacy-seeking behavior, and the conditions under which coercive, mimetic, and normative pressures can be realigned to drive coordinated, durable adaptation across Kenya's energy supply chains.

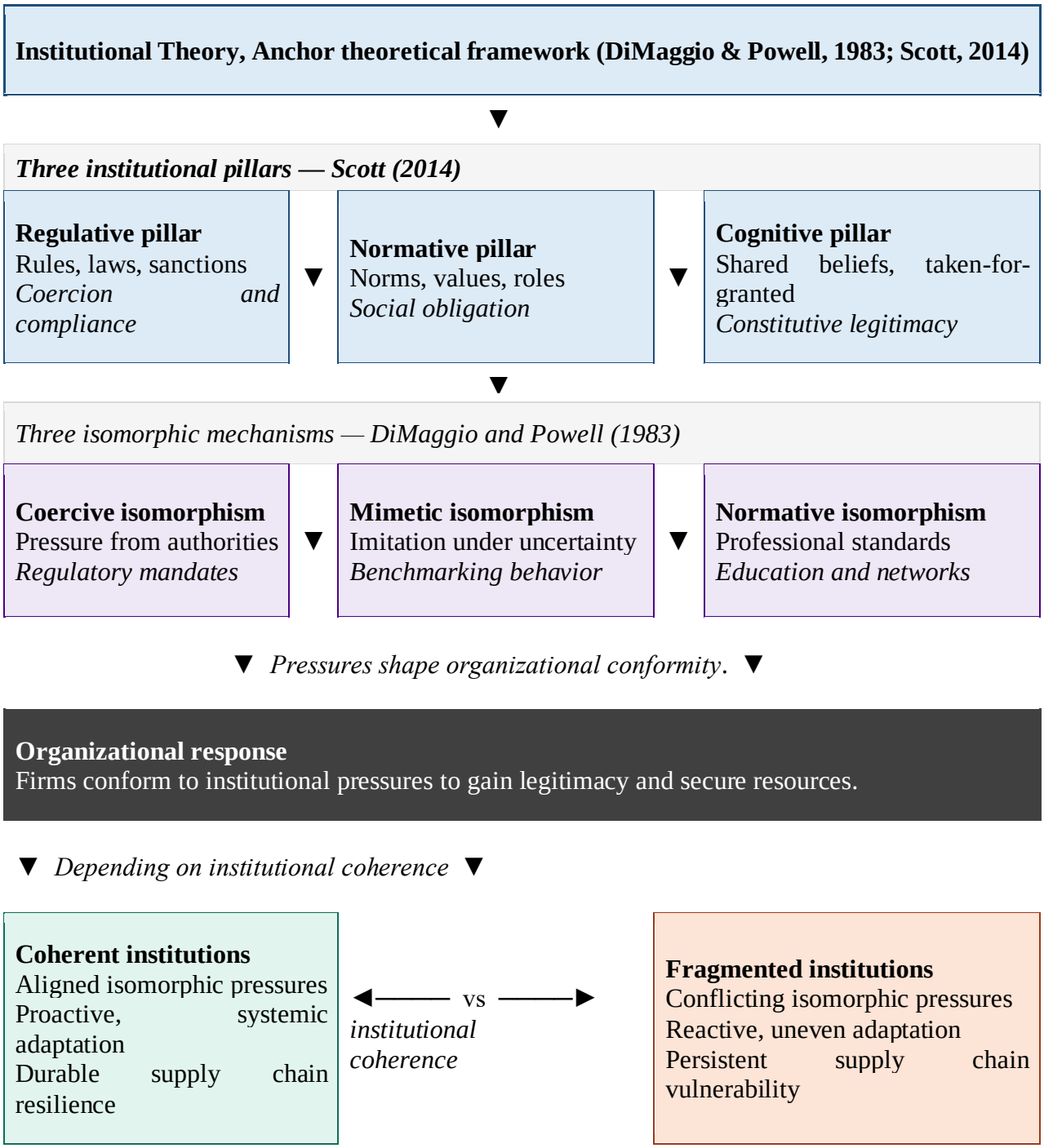

Figure 1: Institutional Theory — anchor theoretical framework. Sources: (DiMaggio and Powell, 1983; Scott, 2014; Rana and Allen, 2024).

RESEARCH METHODOLOGY

The study paper adopts a systematic literature review methodology, consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (2020), to identify, screen, and synthesize published evidence on climate change adaptation challenges in Kenya's energy supply chains. The PRISMA framework (2020) was selected for its capacity to enhance transparency, replicability, and rigor in qualitative evidence synthesis, and for its established application in the energy policy and supply chain management literature (Gudda, 2025; Aming'a et al., 2025). Qualitative synthesis is appropriate in the review given that the

research objective is not to aggregate quantitative outcomes across studies but to identify, compare, and interpret thematic patterns across a heterogeneous body of empirical, theoretical, and policy-oriented literature.

The review design was purposively designed to contextualize global adaptation frameworks within the specific institutional and operational realities of Kenya's energy sector. This required prioritizing sources that connect Theory with practice and speak directly to how energy supply chain firms respond to climate-induced disruptions under conditions of institutional fragmentation and resource constraints. Data extraction and synthesis were structured around the thematic synthesis approach, in which codes are generated inductively from extracted findings and subsequently grouped into descriptive themes and analytical categories that inform the conceptual framework.

The literature search was conducted across three primary academic databases: Scopus, Web of Science, and Google Scholar. Supplementary searches were conducted in grey literature repositories maintained by the Government of Kenya, the International Renewable Energy Agency, the Climate Policy Initiative, and the United Nations Development Program. The search strings that guided the retrieval process are presented in Table 1 below.

Table 1: Search Strings Used in Database and Repository Searches

Search String	Terms Used
String 1	("climate change adaptation" OR "climate resilience") AND ("supply chain" OR "energy supply chain") AND ("Kenya" OR "East Africa" OR "Sub-Saharan Africa") AND ("institutional" OR "governance" OR "regulatory")
String 2	("renewable energy" OR "hydropower" OR "off-grid energy") AND ("supply chain vulnerability" OR "climate risk") AND "Kenya."
String 3	("institutional theory" OR "isomorphism" OR "institutional fragmentation") AND ("climate adaptation" OR "supply chain") AND "developing economies."

Source: (SLR, 2026)

Studies were included or excluded based on the criteria presented in Table 2 below. Two seminal theoretical works published before 2010, including DiMaggio and Powell (1983) and Halldórsson and Kovács (2010), were retained as foundational texts by exception, owing to their direct and irreplaceable contributions to the study's conceptual framework and to the supply chain sustainability literature, respectively.

Table 2: Inclusion Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Published 2010–2025; primary focus 2020–2025	Studies published before 2010 (except for two foundational works retained by exception)
Peer-reviewed journals, institutional reports, or policy documents	Non-peer-reviewed sources without institutional authority
Addresses climate adaptation, supply chain resilience, or energy governance	Purely technical or engineering focus without organizational or governance dimension
Relevant to Sub-Saharan Africa or directly applicable to developing economy contexts	Studies are limited to high-income country contexts with no comparative applicability.
Full text accessible in verified PDF form	Sources inaccessible in full text or unverifiable
Written in English	Non-English language sources

Source: (SLR, 2026)

The initial database and repository search yielded 180 records. After duplicates were removed, 148 unique records were screened at the title and abstract levels. Of these, 86 were excluded as off-topic, focused on non-applicable regions, or inaccessible in full text. The remaining 62 records proceeded to full-text eligibility review. After applying the inclusion and exclusion criteria systematically, a further 27 were excluded owing to a purely

technical or engineering focus without organizational or governance dimensions, or an absence of applicability to developing economy contexts. This produced a final of 35 sources retained for synthesis, comprising 26 peer-reviewed journal articles, 7 institutional or policy reports, and 2 scholarly book chapters. The complete screening process is presented in Figure 2 below.

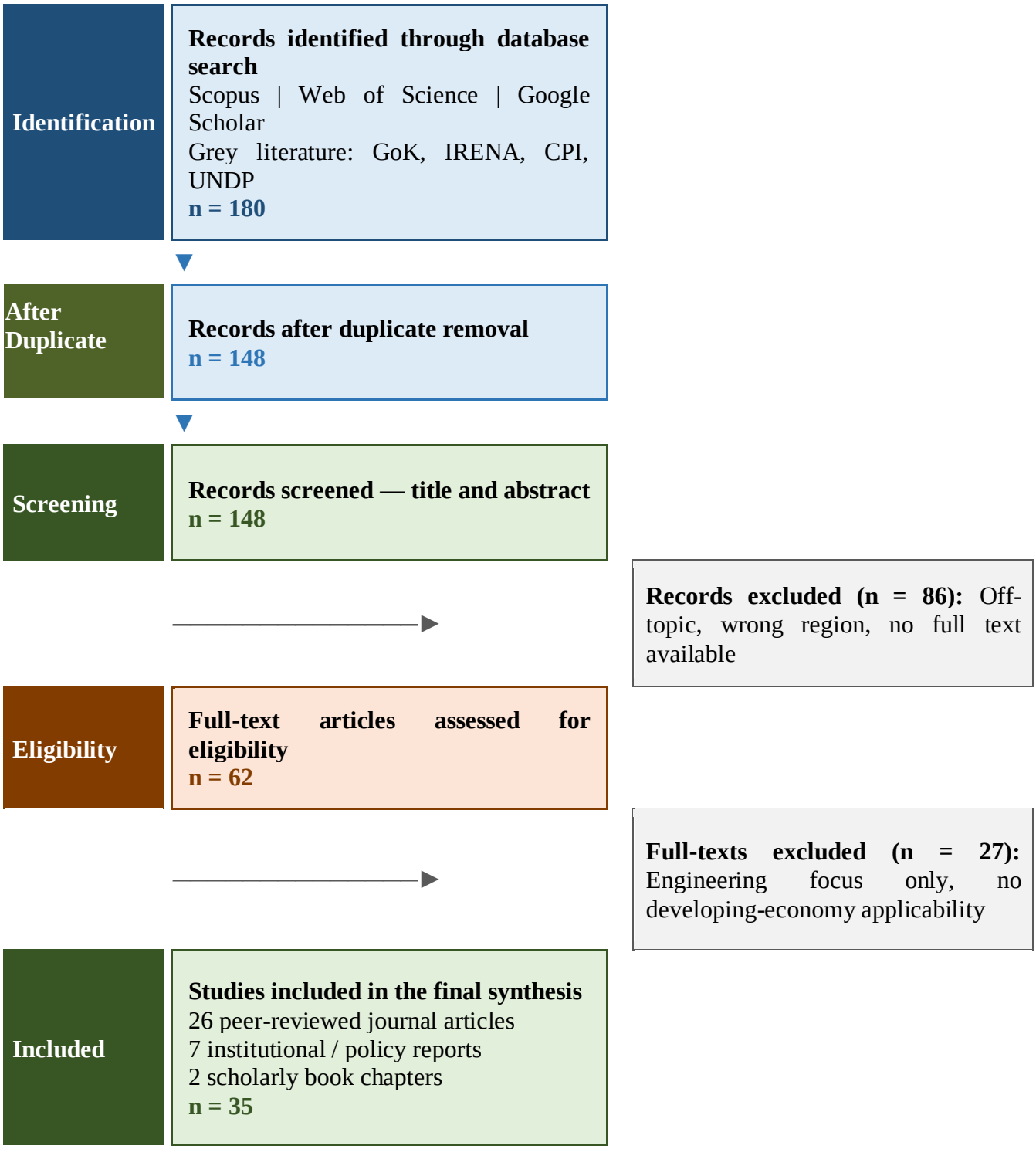

Figure 2: PRISMA Model Flow Diagram Source: (SLR, 2026)

Each retained source was analyzed for its key empirical findings, methodological approach, theoretical positioning, and direct relevance to the four principal barrier categories examined in this review: operational, financial, regulatory, and organizational. Extraction was structured around the analytical framework of Institutional Theory, ensuring that findings were interrogated not only for their descriptive content but for their explanatory relationship to the regulative, normative, and cognitive pillars identified by Scott (2014).

Synthesis was performed thematically rather than source by source, in accordance with the principle of

identifying cross-study patterns rather than cataloging individual contributions (Malek et al., 2022; Freeman, 2023). A literature matrix was constructed mapping each source to its thematic contribution and its resonance with the institutional constructs guiding the review. This matrix is presented in the findings section and serves as the empirical foundation for the thematic analysis and discussion that follow.

FINDINGS

Systematic synthesis of 35 verified sources reveals five interconnected thematic domains through which climate change adaptation challenges manifest in Kenya's energy supply chains. Each theme maps onto the institutional pillars and isomorphic mechanisms established in Section 2. Collectively, they constitute a compounding system of failure rather than a collection of independent problems.

Theme 1: Operational Vulnerabilities and Infrastructure Exposure

Kenya's energy supply chains face severe, quantifiable operational vulnerabilities arising from the intersection of hydrological variability, extreme weather events, and aging physical infrastructure. Hydropower, which accounts for approximately 30% of installed electricity capacity and anchors base-load generation on the grid, is acutely sensitive to declining rainfall and rising temperatures (Apergi et al., 2024; Rotich et al., 2024). Documented evidence from the Kamburu Dam catchment records annual temperature increases of 0.044 degrees Celsius and annual rainfall declines of 0.5897 millimeters, producing a measurable loss of 18,790 megawatt-hours of generation per year — a decadal projection of 187,790 megawatt-hours (David et al., 2024).

Globally, installed hydropower capacity grew by 81% between 2000 and 2022, while generation increased by only 66% over the same period. Divergence was driven by more frequent dry years, greater flow variability, and declining plant efficiency—a pattern that sub-Saharan Africa exemplifies with particular intensity (Othman et al., 2025). These are not isolated technical problems but procurement failures in the making, compressing generation availability, forcing costly thermal substitution, and disrupting every supply chain node dependent on stable electricity output.

The disruption extends beyond generation into logistics, procurement timelines, and last-mile delivery. Across multiple country contexts, flood-related economic damage correlates negatively with logistics performance indicators, including infrastructure quality scores and logistics competence indices (Narayan, 2025; Pankratz & Schiller, 2022). In Kenya's western and arid counties, including Turkana, Busia, and Garissa, unpaved roads, limited cold chain capacity, and informal freight systems compound the impact of extreme weather on input procurement and service delivery (Lutta et al., 2023; Cherono & Recha, 2024).

The frequency and severity of drought in these regions have increased markedly, with events now occurring every 1 to 2 years, compared to approximately once per decade in the 1980s (Lutta et al., 2023). Across East Africa more broadly, most supply chain actors will face considerable increases in heat stress, drought frequency, and extreme rainfall by 2050, requiring geographically differentiated and timely adaptation measures (Malek et al., 2022). Energy efficiency has been systematically neglected as a performance dimension in logistics and supply chain governance, leaving firms without the operational benchmarks needed to manage climate exposure proactively (Halldórsson & Kovács, 2010; Freeman, 2023).

Theme 2: Financial Barriers and Structural Exclusion

Access to climate finance constitutes one of the most structurally entrenched barriers to adaptation, operating simultaneously at the continental, national, and firm levels. Despite a 48% rise in total climate finance flows to Africa from USD 29.5 billion in 2019 to 2020 to USD 43.7 billion in 2021 to 2022, an 80% funding gap persists between documented adaptation needs and actual flows, with annual adaptation finance of USD 14 billion falling far short of reported requirements of USD 70 billion (Climate Policy Initiative, 2024). African nations that contribute less than 4% of global carbon emissions remain systematically marginalized from the global climate finance architecture due to limited institutional capacity, complex bureaucratic access requirements, weak inter-agency coordination, and the absence of specialist climate finance units within national governments (Tamasiga et al., 2023).

In Kenya specifically, persistent reliance on external funding, inadequate domestic financing mechanisms, and insufficient fiscal incentives constrain not only renewable energy transition but also the development of self-sustaining finance ecosystems capable of reaching smaller supply chain actors (Nyapom & Padi, 2025). The consequences are most acutely felt by small and medium-sized enterprises and community-based energy organizations that dominate last-mile energy distribution. Empirical evidence from Kenyan supply chains consistently shows that awareness of climate-smart practices is not the binding constraint — the financial and institutional scaffolding to implement those practices is (Aming'a et al., 2025; Aming'a et al., 2024).

Green procurement combined with environmental design demonstrably improves sustainability outcomes, and reverse logistics positively affects supply chain resilience. However, adoption remains minimal precisely because the capital required lies beyond the reach of most actors (Aming'a et al., 2024; Mbeche & Juma, 2025). Digital procurement tools that improve climate resilience and supply chain transparency face identical constraints: adoption is uneven due to infrastructure gaps, digital literacy deficits, and fragmented institutional support across Kenya's energy and agriculture sectors (Gudda, 2025). What the evidence establishes is not that firms are unwilling to adapt, but that the financial and institutional preconditions for adaptation have not been created.

Theme 3: Regulatory Fragmentation and Institutional Incoherence

Kenya's regulatory environment for climate adaptation is characterized by progressive policy ambition and fragmented implementation. This combination weakens all three of Scott's (2014) institutional pillars and prevents the coercive, mimetic, and normative pressures identified by DiMaggio and Powell (1983) from operating coherently. Despite the Climate Change Act (2016), the National Climate Change Action Plan 2023 to 2027 (Government of Kenya, 2023), and the National Energy Policy 2025 to 2034 (State Department of Energy, 2025), energy transition in Kenya remains constrained by persistent gaps between stated Nationally Determined Contributions under the Paris Agreement and actual institutional transformation (Othoche, 2024). The proliferation of regulatory bodies, spanning the Energy and Petroleum Regulatory Authority, county energy departments, the National Environment Management Authority, and multiple ministries, generates overlapping mandates, duplicated compliance requirements, and elevated transaction costs that suppress private sector investment in adaptive infrastructure (Nyapom & Padi, 2025; Apergi et al., 2024).

A political economy analysis of Kenya's climate governance demonstrates that climate-driven policy initiatives consistently encounter entrenched actor interests, pre-existing power asymmetries, and governance conflicts that dilute intended outcomes in practice (Naess et al., 2015). Global drivers of climate policy yield very different outcomes when refracted through national institutional processes shaped by dominant coalitions and historical patterns of resource governance. Such an insight explains why Kenya's formally sophisticated climate policy framework has not translated into systematic firm-level adaptation (Naess et al., 2015; Greiner et al., 2023).

Scenario modeling of Kenya's energy future confirms that the most critical leverage points for a climate-resilient energy system are not technological but institutional: improving grid governance, reforming electricity market structures, and strengthening coordination between national and county actors (Apergi et al., 2024). Firms operating in institutionally incoherent environments face structurally higher barriers to climate-responsive supply chain reorganization. The complementarity between regulatory agencies, capital markets, and professional knowledge systems is absent (Rana & Allen, 2024).

Theme 4: Organizational Barriers and Low Adaptive Capacity

Within firms, adaptation failure is reproduced through short planning horizons, low climate literacy among decision-makers, the absence of climate-specific performance indicators, and a reactive orientation toward risk management that treats climate disruption as exceptional rather than structural (Apergi et al., 2024; Gudda, 2025; Nyapom & Padi, 2025). Empirical evidence from the diffusion of green supply chain management consistently identifies three adopter types: early adopters, followers, and laggards. It is characterized by short-term cost orientation and the absence of regulatory pressure, systematically underperforming on environmental, operational, and economic metrics (Zhu et al., 2011). The majority of Kenya's energy supply chain firms occupy the laggard position, not through deliberate strategic choice but through the absence of the institutional conditions that would enable and incentivize change. Transitioning to sustainable supply chain management requires a

fundamental reorientation of organizational purpose and performance measurement, and this transformation remains nascent across the sector (Genovese et al., 2015).

The evidence further establishes that overcoming organizational inertia cannot be achieved solely through firm-level effort. Climate-smart supply chain practices demonstrably improve resilience when embedded in organizational governance, including procurement for environmental design, circular production systems, and reverse logistics. However, embedding requires external enabling conditions, such as regulatory clarity, financial incentives, and professional norms, that adapt a taken-for-granted expectation rather than a voluntary initiative (Safdar et al., 2024; Aming'a et al., 2025). System dynamics modeling of energy transition scenarios finds that only 20% of pathways remain within required carbon budgets, with high political capital and early institutional commitment as necessary preconditions for success (Freeman, 2021). In Kenya's energy supply chains, the absence of these preconditions means that even firms with genuine adaptive intent lack the scaffolding to translate that intent into durable structural change (Lutta et al., 2023; Mair et al., 2012).

Theme 5: Supply Chain Restructuring Under Climate Pressure

The cumulative force of physical disruptions, financial exclusion, regulatory fragmentation, and organizational inertia is producing visible restructuring of supply chain relationships. Restructuring that concentrates adaptive capacity among larger, better-resourced actors while progressively marginalizing those in high-exposure, low-capacity geographies. When climate shocks at supplier locations exceed prior expectations, firms become 6 to 11% more likely to terminate existing supplier relationships and subsequently reconfigure procurement networks toward lower-exposure suppliers through experience-based learning (Pankratz & Schiller, 2022). For Kenya's rural and peri-urban energy providers, already the most financially constrained and institutionally underserved, this dynamic compounds existing vulnerability. They are most exposed to climate shocks and most likely to be abandoned by procurement networks precisely when those shocks materialize (Lutta et al., 2023; Cherono & Recha, 2024; Malek et al., 2022).

In institutionally void environments, market restructuring systematically excludes the most vulnerable actors unless deliberate intermediary action redefines market architecture and legitimates new actors within formal governance structures (Mair et al., 2012). The evidence from Kenya's energy governance confirms that without such deliberate intervention, climate-motivated initiatives produce differentiated outcomes that favor established actors and entrench existing inequalities (Naess et al., 2015; Greiner et al., 2023). Africa holds substantial renewable energy potential, and the policy frameworks for its mobilization exist in formal terms, but translating that potential into resilient and inclusive supply chain capacity requires investment mobilization, infrastructure development, and the regulatory coherence that current institutional arrangements have not yet delivered (IRENA, 2022; Government of Kenya, 2023). Where the right institutional conditions are created through regulatory clarity, financial incentives, and normative alignment, sustainable and circular supply chain models demonstrably deliver measurable environmental, operational, and economic improvements (Genovese et al., 2015; Zhu et al., 2011). The gap between that demonstrated possibility and Kenya's current supply chain reality is ultimately an institutional one.

Synthesis and Dominant Barrier Identification

Across the five themes examined, a consistent convergence point emerges: institutional fragmentation is the root condition that amplifies every other barrier documented in this review. Physical climate shocks, financial exclusion, and organizational inertia are each real and independently documented, yet across every theme, the evidence shows these barriers persist not because solutions are technically unavailable. However, because the institutional architecture required to enable, coordinate, and enforce adaptation is fragmented, contradictory, and unevenly applied (Nyapom & Padi, 2025; Naess et al., 2015; Rana & Allen, 2024).

Mapped onto Scott's (2014) three institutional pillars, the findings reveal simultaneous failure across all three dimensions. The regulative pillar is weakened by overlapping mandates, weak enforcement, and the absence of binding adaptation targets (Othoche, 2024; Apergi et al., 2024). The normative pillar is undermined by the absence of shared professional standards for climate-responsive procurement, leaving adaptation driven by donor conditionality rather than internalized organizational values (Greiner et al., 2023; Mbeche & Juma, 2025). The

cognitive pillar remains fractured: climate risk is not yet a taken-for-granted strategic priority within most energy supply chain firms, meaning that even where pathways exist, firms do not perceive or respond to them (Gudda, 2025; Aming'a et al., 2025).

Through the lens of DiMaggio and Powell (1983), coercive isomorphism is present but weakened by enforcement gaps; mimetic isomorphism is constrained by the absence of visible adaptation benchmarks within the sector; and normative isomorphism remains nascent, driven by external expectations rather than professionalized internal standards. This tripartite institutional failure is the dominant barrier. It does not sit alongside financial, operational, and organizational barriers as an equal category; rather, it is the structural condition that prevents those barriers from being resolved. Mair et al. (2012) argue that in institutionally void environments, actors cannot self-organize toward resilience, as deliberate institutional reconstruction is required. Kenya's energy supply chains occupy precisely such a condition, and addressing adaptation failure demands institutional reform as the prior and primary intervention.

Figure 3 presents the five barrier domains identified through thematic synthesis of 35 verified sources. Each domain is color-coded for differentiation and includes the principal barriers documented within it, illustrative evidence, and a frequency count indicating how many sources in the corpus are coded for that theme. Arrows flow downward from Theme 1 through Theme 5, reflecting the analytical sequence from physical-operational disruptions to financial and regulatory constraints, to organizational inertia, and to supply chain restructuring. All five domains converge on institutional fragmentation as the dominant barrier and the root condition that amplifies each domain, preventing the existing adaptation measures from reaching their potential.

Thematic Synthesis Results
Five barrier domains · key barriers · source frequency (n = 35)

▼

T1 Operational	**Hydropower vulnerability · grid fragility · logistics disruption** a) 18,790 MWH/yr hydropower generation loss at Kamburu Dam (David et al., 2024) b) Global hydropower capacity grew 81%, but generation only 66% — climate gap (Othman, 2025)	**n = 30** 86% *of corpus*

▼

T2 Financial	**Climate finance gap · SME exclusion · investment barriers** a) 80% funding gap — USD 14bn flows vs USD 70bn needed for adaptation (CPI, 2024) b) Africa contributes <4% of global emissions, yet is excluded from climate finance (Tamasiga et al., 2023) c) Green procurement improves resilience, but capital remains inaccessible to most firms (Aming'a et al., 2024) d) High transaction costs and the absence of blended finance foreclose SME adaptation investment *Nyapom and Padi (2025) · Mbeche and Juma (2025) · Gudda (2025)*	**n = 23** 66% *of corpus*

▼

T3 Regulatory	**Mandate overlap · policy-implementation gap · stakeholder exclusion** a) Conflicting mandates across EPRA, county governments, and NEMA (Nyapom and Padi, 2025) b) Climate policy diluted by entrenched political interests and power asymmetries (Naess et al., 2015) c) Institutional incoherence raises barriers to climate-responsive SC reorganization (Rana and Allen, 2024) d) Policy implementation gap between NDC commitments and actual firm-level transformation (Othoche, 2024) *Apergi et al. (2024) · Greiner et al. (2023) · Mair et al. (2012)*	**n = 31** 89% *of corpus*
▼		
T4 Organisational	**Low climate literacy · short-termism · reactive planning culture** a) Laggard firms consistently underperform on environmental and economic metrics (Zhu et al., 2011) b) Only 20% of energy transition scenarios stay within required carbon budgets (Freeman, 2021) c) Climate-smart practices improve resilience but require external institutional enablers (Safdar et al., 2024) d) Absent climate KPIs and leadership commitment prevent adaptive transformation *Gudda (2025) · Apergi et al. (2024) · Genovese et al. (2015)*	**n = 30** 86% *of corpus*
▼		
T5 SC Restructuring	**Supplier termination · SME marginalization · institutional voids** 6–11% higher probability of supplier termination after climate shocks (Pankratz and Schiller, 2022) Institutional voids require deliberate intermediary action to build inclusive markets (Mair et al., 2012) Market restructuring deepens inequality without institutional guardrails (Naess et al., 2015) East African supply chains face heatwaves, drought, and extreme rainfall by 2050 (Malek et al., 2022) *IRENA (2022) · Greiner et al. (2023) · Pankratz and Schiller (2022)*	**n = 11** 31% *of corpus*

▼ *All five barrier domains converge.* ▼

Dominant barrier

Institutional fragmentation
Root condition that enables and amplifies all five barrier domains
Rana and Allen (2024) · Scott (2014) · DiMaggio and Powell (1983) · Mair et al. (2012)

Figure 3: Thematic synthesis results — five barrier domains, key barriers, and source frequencies. Systematic literature review on climate change adaptation in Kenya's energy supply chains (n = 35 verified sources). Frequency (n) = number of sources coding for each theme. % = proportion of 35-source corpus.

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Table 3. Thematic Coding and Frequency Distribution of Reviewed Literature

Theme	Sub-code / Barrier	Frequency (Articles)	% of Total	Source
Theme 1 Operational Vulnerabilities	Hydropower and generation vulnerability	**30**	86%	David et al. (2024); Othman et al. (2025); Rotich et al. (2024); Apergi et al. (2024); IPCC (2022); Narayan (2025)
	Extreme weather and logistics disruption	**25**	71%	Pankratz & Schiller (2022); Malek et al. (2022); Lutta et al. (2023); Cherono & Recha (2024); Freeman (2023)
	Infrastructure fragility and grid exposure	**30**	86%	Apergi et al. (2024); Rotich et al. (2024); GoK/NCCAP (2023); NatEP (2025); Halldórsson & Kovács (2010)
Theme 2 Financial Barriers	Climate finance gap	**8**	23%	Climate Policy Initiative (2024); Tamasiga et al. (2023); IPCC (2022); IRENA (2022); Freitas & Mwaniki (2024)
	SME and informal actor exclusion	**23**	66%	Aming'a et al. (2025); Mbeche & Juma (2025); Gudda (2025); Nyapom & Padi (2025); Tamasiga et al. (2023)
	Investment barriers and green procurement	**18**	51%	Aming'a et al. (2024); Genovese et al. (2015); Zhu et al. (2011); Mbeche & Juma (2025); Halldórsson & Kovács (2010)
Theme 3 Regulatory & Institutional Fragmentation	Regulatory fragmentation and mandate overlap	**28**	80%	Nyapom & Padi (2025); Othoche (2024); Naess et al. (2015); Apergi et al. (2024); GoK/NCCAP (2023)
	Policy implementation gap	**31**	89%	GoK/NCCAP (2023); NatEP (2025); Othoche (2024); Naess et al. (2015); IRENA (2022); Rana & Allen (2024)
	Stakeholder exclusion and coordination failure	**30**	86%	Mair et al. (2012); Naess et al. (2015); Greiner et al. (2023); Freeman R.E. (1984); Scott (2014)
Theme 4 Organisational Barriers	Low climate literacy and awareness	**30**	86%	Gudda (2025); Nyapom & Padi (2025); Apergi et al. (2024); Aming'a et al. (2025); Safdar et al. (2024)
	Short-termism and reactive planning	**27**	77%	Apergi et al. (2024); Zhu et al. (2011); Genovese et al. (2015); Freeman M. (2023); Freeman R. (2021)
	Organisational adaptive capacity gaps	**30**	86%	Zhu et al. (2011); Safdar et al. (2024); Barney (1991); Scott (2014); Freeman M. (2023); Aming'a et al. (2024)
Theme 5 Supply Chain Restructuring	Supply chain restructuring under climate pressure	**11**	31%	Pankratz & Schiller (2022); Malek et al. (2022); Mair et al. (2012); Narayan (2025)
	Institutional theory application	**17**	49%	DiMaggio & Powell (1983); Scott (2014); Rana & Allen (2024); Mair et al. (2012); Naess et al. (2015)
	Resilience frameworks and adaptive systems	**5**	14%	Freeman M. (2023); Aming'a et al. (2024); Halldórsson & Kovács (2010); Othman et al. (2025)

Source: (SLR, 2026)

DISCUSSIONS

Institutional Fragmentation: The Root Climate Change Adaptation Issue

The findings of the review, read through the lens of Institutional Theory, reveal that Kenya's energy supply chain adaptation deficit is not primarily a technical or financial problem but an institutional one. DiMaggio and Powell (1983) argue that organizations within a field become similar through coercive, mimetic, and normative pressures, and that the coherence of those pressures determines the depth and durability of organizational change. The findings demonstrate that all three mechanisms in Kenya's energy sector are simultaneously dysfunctional. Coercive pressure exists in the form of climate legislation and policy mandates, but overlapping jurisdictions and absent enforcement weaken it. Mimetic pressure is constrained because no dominant model of climate-adaptive supply chain practice has emerged within the sector for others to emulate. Normative pressure remains externally imposed through donor conditionality rather than emerging from professionalized internal standards. The result is a field in which isomorphic forces pull in multiple directions simultaneously, producing surface-level compliance without genuine adaptive transformation.

Scott's (2014) three-pillar framework adds analytical precision to this diagnosis. The simultaneous failure of the regulative, normative, and cognitive pillars, documented across Theme 3 and corroborated in Themes 2 and 4, explains why adaptation remains uneven even where the will to adapt exists. Firms that lack regulatory clarity about what is expected of them, professional norms that treat climate risk as a taken-for-granted priority, and cognitive frameworks that incorporate climate risk as a strategic concern rather than an operational inconvenience are incapable of generating durable adaptation, regardless of their individual intentions. This theoretical insight reframes the policy problem fundamentally: interventions that address only one pillar, for example, introducing new regulation without strengthening normative alignment or building cognitive awareness, will produce the same fragmented outcomes that current frameworks already generate.

Why Adaptation Fails – Isomorphic Breakdown

The pattern of adaptation failure documented in this review is not random, but follows the logic of institutional incoherence with considerable consistency. Rana and Allen (2024) demonstrate that firms in institutionally dysfunctional environments face structurally higher barriers to climate-responsive reorganization because the complementarity between state bodies, capital markets, and knowledge systems is absent. This is precisely the condition that Kenya's energy supply chains inhabit. The absence of complementarity among the Energy and Petroleum Regulatory Authority, county governments, climate finance mechanisms, and professional training systems means that even firms motivated to adapt encounter an environment that offers no coherent pathway to do so.

This interpretation also explains why adaptation, when it occurs, tends to be reactive and project-driven rather than strategic and systemic. When the institutional environment does not reward forward-looking adaptation through regulatory incentives, access to finance, or normative recognition, firms rationally default to short-term cost minimization and respond to climate shocks only after they materialize. Freeman (2021) demonstrates, through system dynamics modeling, that early institutional commitment to transition dramatically reduces the total mitigation required over time, whereas delayed action compounds costs and narrows available pathways. Applied to Kenya's energy supply chains, this implies that the current pattern of reactive, post-shock adaptation is not only insufficient for building resilience. It is progressively more costly than the proactive institutional investment it defers.

Moderating Factors: What Differentiates Adaptive from Non-adaptive Actors

The findings reveal that adaptation is not uniformly absent across Kenya's energy supply chains. It is unevenly distributed, concentrated among actors with specific characteristics that effectively substitute for the institutional enablers the broader environment fails to provide. Larger firms with donor relationships access climate finance and external normative guidance, partially compensating for domestic institutional voids (Tamasiga et al., 2023; Climate Policy Initiative, 2024). Firms integrated into international value chains encounter the coercive and

normative pressures of global procurement standards, such as ESG disclosure requirements and supplier assessment frameworks, that domestic regulation does not generate (Rana & Allen, 2024; Mbeche & Juma, 2025).

By contrast, SMEs and informal actors operating exclusively within domestic institutional contexts receive none of these substitute pressures. Mair et al. (2012) establish that in institutionally void environments, market actors cannot self-organize toward inclusive and resilient market structures. A deliberate intermediary action is required to redefine participation conditions. The moderating variable, therefore, is not firm capability or awareness, but access to the external institutional scaffolding that compensates for domestic fragmentation. This finding carries a direct policy implication: interventions designed to close the adaptation gap must target the institutional conditions that exclude smaller actors, not the firms themselves.

Contradictions and Tensions in the Findings

One genuine tension running through the findings is the paradox of progressive policy and poor implementation. Kenya possesses one of the most developed climate governance frameworks in sub-Saharan Africa, yet firm-level adaptation remains shallow and reactive. Institutional Theory resolves this paradox rather than ignoring it. Naess et al. (2015) demonstrate that climate-motivated policy initiatives consistently encounter pre-existing political and institutional contexts that refract global drivers through local power asymmetries, diluting intended outcomes. The policy frameworks exist at the regulatory pillar level, but lack normative alignment and a cognitive shift. Regulatory ambition produces compliance theatre rather than adaptive transformation.

A second tension concerns the supply chain restructuring documented in Theme 5. The evidence shows that climate pressure is producing network reconfiguration toward lower-exposure suppliers, which might appear to represent market-driven adaptation. This restructuring compounds vulnerability for the most exposed actors rather than distributing adaptive capacity more broadly. Greiner et al.'s (2023) analysis of Kenya's geothermal sector illustrates how even well-intentioned infrastructure development can produce exclusion and dispossession when institutional planning frameworks are inadequate. The implication is that market-driven restructuring without institutional guardrails will entrench inequality rather than advance resilience. This finding contradicts any assumption that climate pressure alone will drive efficient adaptation outcomes.

Theoretical and Practical Contributions

This review makes two contributions to Institutional Theory as applied to supply chain management. First, it demonstrates that the three isomorphic mechanisms and three institutional pillars identified by DiMaggio and Powell (1983) and Scott (2014) do not merely describe organizational conformity within stable fields. They also explain the anatomy of adaptation failure in fields undergoing climate-induced disruption. When all three mechanisms fail simultaneously, the result is not simply slow adaptation but a structurally reproduced incapacity for adaptation that individual firm effort cannot overcome. This finding extends Institutional Theory into the climate adaptation domain and provides a diagnostic framework applicable across developing economy contexts beyond Kenya.

Second, the review demonstrates that the boundary conditions of Institutional Theory matter as much as its core constructs. Rana and Allen's (2024) business systems perspective proves more analytically productive in this context than standard isomorphism accounts, because it foregrounds the relational and systemic nature of institutional failure rather than treating each pillar in isolation. Future theoretical development should more explicitly integrate these perspectives, particularly in contexts where informal-economy actors and institutional voids coexist alongside formal governance frameworks.

In practice, the findings and their theoretical interpretation converge on a single priority: institutional reform must precede, or at least accompany, investment in physical climate adaptation infrastructure. Strengthening grid quality, expanding access to climate finance, and building organizational climate literacy are necessary, yet without the regulatory coherence, normative alignment, and cognitive reorientation that Scott's (2014) framework identifies as foundational, these investments will yield fragmented and unequal outcomes. Kenya's energy transition commitments under the National Energy Policy 2025 to 2034 and the National Climate Change Action Plan 2023 to 2027 provide the policy architecture. What the evidence demands is the institutional substance to give that architecture operational force.

Table 3: Database of Reviewed Literature (With n = 35)

#	Author(s)	Year	Title	Theme
1	Aming'a, M., Annan, J., & Marwanga, R.	2025	Manufacturers' adoption of circularity science in supply chains and its perceived viability to promote sustainable performance	T2, T4
2	Aming'a, M., Marwanga, R., & Annan, J.	2024	Is it practical to uphold both resilience and sustainability of supply chains using closed-loop supply chain models?	T2, T4
3	Apergi, M., Eicke, L., Goldthau, A., Kurniawan, J., Schuch, E., & Weko, S.	2024	Pathways to a sustainable electricity sector in Kenya: Challenges and transformational factors	T1, T3
4	Barney, J.	1991	Firm resources and sustained competitive advantage	T5
5	Cherono, A., & Recha, C. W.	2024	Vulnerability to climate change from the Kenyan perspective	T1, T3
6	Climate Policy Initiative	2024	Landscape of climate finance in Africa 2024	T2
7	David, N. K., Mwendwa, P. K., & Mutiso, M.	2024	Determination of effects of climate change on hydropower generation at Kamburu Dam, Kenya	T1
8	DiMaggio, P. J., & Powell, W. W.	1983	The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields	T5
9	Freeman, M.	2023	The interplay between supply chain resilience and climate change	T4, T5
10	Freeman, R. E.	1984	Strategic management: A stakeholder approach	T3, T5
11	Freitas, A. S., & Mwaniki, G.	2024	Climate finance in Africa: An overview of climate finance flows, challenges and opportunities	T2, T3
12	Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L.	2015	Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications	T4, T5
13	Government of Kenya	2023	National Climate Change Action Plan (Kenya) 2023-2027	T3
14	Greiner, C., Klagge, B., & Owino, E. A.	2023	The political ecology of geothermal development: Green sacrifice zones or energy landscapes of value?	T3
15	Gudda, K. O.	2025	Enhancing climate resilience in Kenya's maize supply chains through digital procurement: A systematic review	T2, T4
16	Halldórsson, Á., & Kovács, G.	2010	The sustainable agenda and energy efficiency: Logistics solutions and supply chains in times of climate change	T1, T4
17	IPCC	2022	Climate Change 2022: Impacts, Adaptation and Vulnerability (AR6 WGII)	T1, T2, T3
18	IRENA	2022	Renewable energy market analysis: Africa and its regions	T1, T2, T3
19	Kenya Power and Lighting Company	2025	Integrated annual report and financial statements	T1, T3
20	Lutta, A., Mungo, C., Kehbila, A., Sunguti, E., & Osano, P.	2023	Climate change impacts, adaptation options and opportunities for investment in agro-pastoral value chains in arid and semi-arid regions of Kenya	T1, T2

21	Mair, J., Martí, I., & Ventresca, M. J.	2012	Building inclusive markets in rural Bangladesh: How intermediaries work institutional voids	T3, T5
22	Malek, Ž., Loeffen, M., Feurer, M., & Verburg, P. H.	2022	Regional disparities in impacts of climate extremes require targeted adaptation of Fairtrade supply chains	T1, T5
23	Mbeche, R. A., & Juma, D.	2025	Green procurement practices and supply chain performance of hotels in Maasai Mara Game Reserve, Kenya	T2, T4
24	Naess, L. O., Newell, P., Newsham, A., Phillips, J., Quan, J., & Tanner, T.	2015	Climate policy meets national development contexts: Insights from Kenya and Mozambique	T3
25	Narayan, N.	2025	The impact of climate change on supply chain management	T1
26	Nyapom, K., & Padi, D.	2025	Barriers and policy pathways for renewable energy adoption in developing nations: The case of Kenya	T2, T3
27	Othman, M. E. F., Sidek, L. M., Basri, H., El-Shafie, A., Chua, L. H., & Ahmed, A. N.	2025	Review on climate change impacts on hydropower potentials: Mitigation and adaptation strategies	T1
28	Othoche, B.	2024	An assessment of the strategies for energy transition in Kenya as a climate change mitigation strategy	T3
29	Pankratz, N. M., & Schiller, C. M.	2022	Climate change and adaptation in global supply-chain networks	T1, T5
30	Rana, M. B., & Allen, M. M. C.	2024	How institutions influence firms' climate change strategies: Extending IB and GVC perspectives with business systems	T3, T5
31	Rotich, I. K., Chepkirui, H., & Musyimi, P. K.	2024	Renewable energy status and uptake in Kenya	T1, T3
32	Safdar, M., Shahid, M. A., Yang, C., Rasul, F., Tahir, M., Raza, A., & Sabir, R. M.	2024	Climate smart agriculture and resilience	T4
33	Scott, W. R.	2014	Institutions and organizations: Ideas, interests, and identities (4th ed.)	T3, T5
34	Tamasiga, P., Molala, M., Bakwena, M., Nkoutchou, H., & Onyeaka, H.	2023	Is Africa left behind in the global climate finance architecture? A comprehensive review	T2
35	State Department of Energy	2025	National Energy Policy 2025-2034	T3

Source: Author's systematic review, 2026

Model Framework: Adaptation Challenges

Figure 4 presents the conceptual framework developed from the systematic synthesis of 35 verified sources. The flow reads left to right across four analytical stages. The institutional context (input) on the left shows Kenya's institutional environment through Scott's (2014) three pillars and DiMaggio and Powell's (1983) isomorphic mechanisms, with the failure condition of each pillar identified. The five barrier domains follow as mediating conditions — operational, financial, regulatory, organizational, and supply chain restructuring (Themes 1 to 5). All five converge on the dominant barrier node: institutional fragmentation, shown in the central column. The adaptation outcomes on the right (Theme 5) distinguish the current fragmented state from the target coherent state achievable through institutional reform.

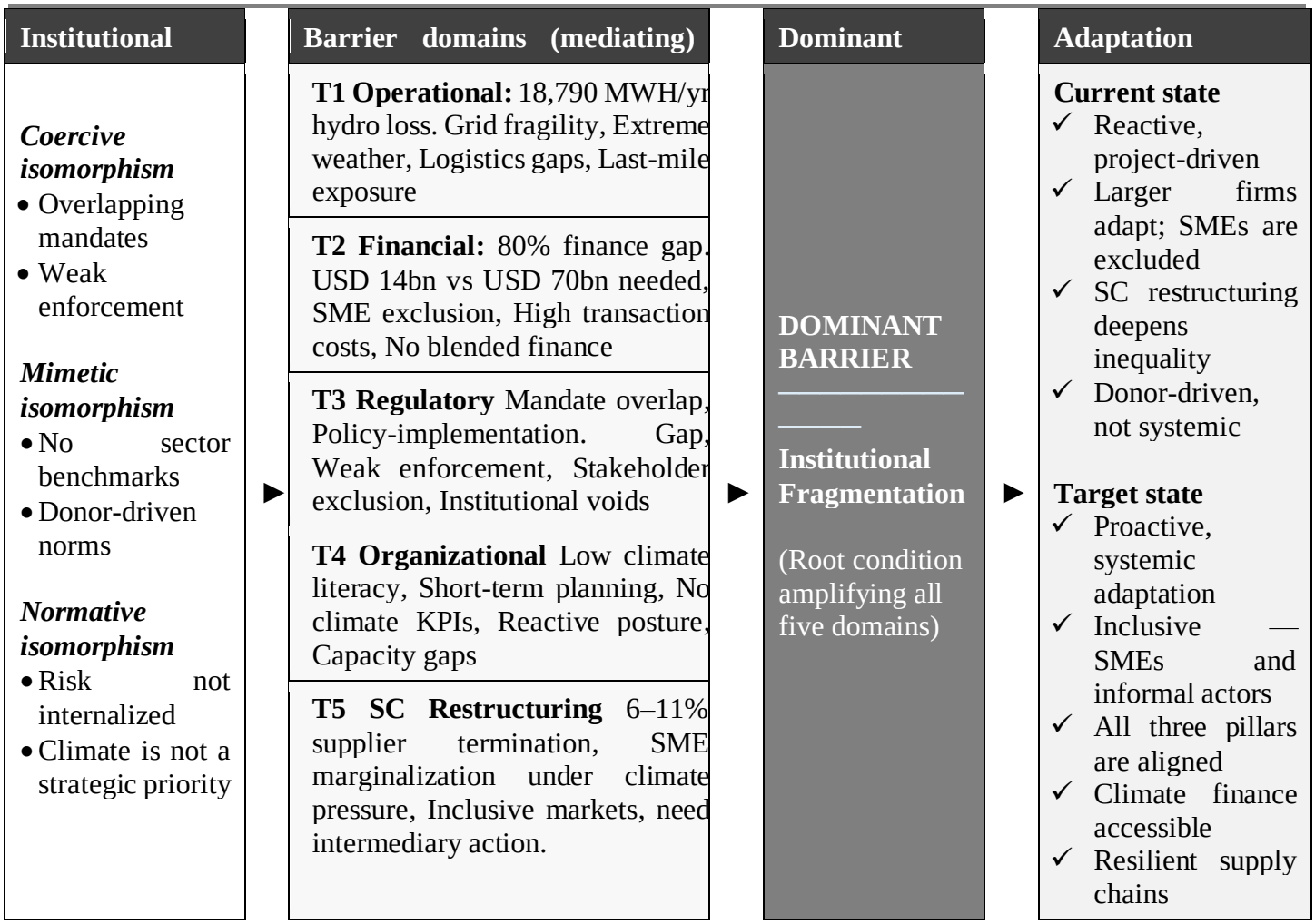

Figure 4: Framework of the challenges of climate change adaptation in Kenya's Supply Chain firms

Policy Implications and Briefs

The findings of this review carry direct, actionable implications for policymakers, energy sector regulators, and development finance institutions operating within Kenya's energy supply chain. The first is institutional coherence before infrastructure investment. Strengthening grid capacity, expanding renewable energy access, and building climate-resilient logistics infrastructure will yield fragmented and unequal outcomes unless the regulatory architecture that coordinates these investments is first rationalized. The Energy and Petroleum Regulatory Authority, county energy departments, the National Environment Management Authority, and the Ministry of Environment, Climate Change, and Forestry should operate under a unified climate adaptation mandate with binding inter-agency coordination protocols.

The second is to reform the architecture for climate finance access for smaller actors. The current climate finance system channels resources predominantly to large, donor-connected institutions. Kenya's National Climate Change Action Plan 2023 to 2027 and the National Energy Policy 2025 to 2034 should establish dedicated SME and community energy provider windows within domestic climate finance mechanisms, with simplified eligibility criteria, capacity-building support for proposal development, and performance-linked disbursement tied to adaptation outcomes rather than compliance documentation.

Third, embed climate risk in procurement standards. KPLC, KenGen, KETRACO, and REREC should integrate climate risk criteria into supplier assessment, contract management, and Power Purchase Agreement design. Procurement standards that reward climate-adaptive capacity will create the normative isomorphic pressure that currently drives adaptation only among firms exposed to international value chains.

Fourthly, strengthen county-level climate governance. The implementation gap between national policy and county-level energy supply chain practice is the most consistently documented failure mode across this review.

County governments should be resourced and mandated to develop locally tailored climate adaptation plans for energy supply chains, with dedicated budget lines, trained climate officers, and reporting requirements linked to national NDC commitments.

Finally, invest in climate literacy across the supply chain. Low climate literacy among supply chain managers and decision-makers is not a marginal problem, but a structural one that reproduces organizational inertia regardless of external regulatory pressure. Industry associations, universities, and the Kenya Private Sector Alliance should co-design and mainstream climate risk training programs specifically targeted at supply chain governance roles across the energy sector.

CONCLUSION

Climate change adaptation in Kenya's energy supply chains is not primarily a technical problem but an institutional one. The systematic review of 35 verified sources demonstrates that physical climate shocks, financial exclusion, regulatory fragmentation, low organizational capacity, and supply chain restructuring under climate pressure are not independent failures but interconnected symptoms of a single root condition: the simultaneous breakdown of Kenya's regulative, normative, and cognitive institutional pillars.

The evidence is unambiguous. Hydropower generation at Kamburu Dam is declining by 18,790 megawatt-hours annually. Africa faces an 80% gap in climate finance. Firms are 6 to 11% more likely to terminate suppliers after climate shocks, progressively marginalizing the most exposed actors. Yet across all five thematic domains, the binding constraint is not the absence of solutions, it is the absence of the institutional coherence required to implement them.

This review contributes a theoretically grounded, Kenya-specific synthesis that bridges global adaptation frameworks with local institutional realities. Future research should develop measurable indicators of institutional coherence for energy supply chains, examine the role of county governments as mediating institutions, and investigate how informal supply chain actors build adaptive capacity outside formal governance structures. Institutional reform must precede investment if adaptation is to be durable, inclusive, and systemic.

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