Multidisciplinary Science and Applied Research
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Implementation Durability with Multisector Partnership Governance across Climate Service Programs

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Abstract

The long-term success of climate service programs relies heavily on the durability of their implementation, which is often dictated by the underlying governance structures of multisector partnerships. While numerous studies have explored the initial adoption and short-term effectiveness of collaborative environmental initiatives, there is a significant lacuna in understanding how specific governance mechanisms sustain implementation over extended periods. This study addresses this gap by utilizing a comprehensive panel data analysis to evaluate the implementation durability of climate service programs based on their multisector partnership governance profiles. By examining a robust dataset spanning twelve years and encompassing diverse geographic and institutional contexts, the research isolates the effects of decision-making parity, resource pooling structures, and stakeholder inclusivity on long-term program survival. The findings reveal that governance configurations characterized by high decision-making parity and adaptive resource mechanisms exhibit significantly higher durability rates compared to top-down or loosely coupled networks. Furthermore, the longitudinal approach demonstrates that the impact of governance variables fluctuates significantly over the life cycle of a program, emphasizing the need for dynamic evaluation models. The insights provided contribute to the theoretical discourse on collaborative governance and offer actionable frameworks for policymakers seeking to design resilient climate adaptation and mitigation strategies.

Keywords: Implementation Durability; Multisector Partnerships; Climate Service Programs; Panel Analysis; Collaborative Governance

1. Introduction

1.1 The Imperative of Climate Service Programs

The escalating frequency and intensity of global climate anomalies have catalyzed the widespread deployment of climate service programs. These initiatives are designed to translate complex meteorological and climatological data into actionable intelligence for diverse end-users, ranging from agricultural cooperatives to urban planning departments. The fundamental objective is to enhance societal resilience by embedding climate foresight into routine decision-making processes. However, the operationalization of these programs is inherently complex, requiring the integration of scientific knowledge with socio-economic realities and political frameworks. As governments and international bodies increase funding for climate adaptation and mitigation strategies, the proliferation of climate service programs has accelerated globally. Early observations indicated that while many programs achieved rapid initial deployment due to substantial seed funding and political enthusiasm, a substantial proportion failed to maintain their operational integrity once external support diminished [1]. This phenomenon has shifted the academic and policy focus from mere adoption and implementation to the concept of implementation durability. Implementation durability refers to the capacity of a program to sustain its core activities, adapt to contextual shifts, and continue delivering value over an extended temporal horizon. Achieving this durability is not merely a technical challenge but a profound governance problem, necessitating the alignment of divergent stakeholder interests, the continuous mobilization of resources, and the establishment of robust institutional architectures [2]. In the context of climate services, where

the temporal lag between action and impact can span decades, understanding the determinants of implementation durability is paramount for maximizing the efficacy of environmental investments.

1.2 Defining Multisector Partnership Governance

To navigate the multifaceted challenges of climate service delivery, multisector partnerships have emerged as the dominant organizational paradigm. These partnerships assemble actors from the public sector, private enterprise, academia, and civil society, operating on the premise that no single entity possesses the requisite resources, authority, or localized knowledge to address climate vulnerabilities comprehensively [3]. Multisector partnership governance refers to the formal and informal institutional arrangements, rules, and processes through which these diverse actors collaborate, make decisions, and allocate resources. The governance structures of these partnerships can vary dramatically, ranging from highly formalized, legally binding consortia to informal, trust-based networks. The configuration of these governance mechanisms fundamentally shapes the power dynamics, communication flows, and conflict resolution capabilities within the partnership. Previous scholarly inquiries have mapped the typologies of collaborative governance, highlighting dimensions such as network density, centrality, and formalization. In climate service programs, effective governance must bridge the epistemic divide between producers of climate data and the end-users who rely on this information [4]. When multisector partnerships are governed effectively, they facilitate a process of co-production, where scientific outputs are iteratively refined based on user feedback. However, when governance is deficient, partnerships may suffer from mission drift, resource capture by dominant actors, or the gradual disengagement of marginalized stakeholders. Consequently, the structural and functional attributes of multisector partnership governance are hypothesized to be the primary drivers of implementation durability, serving as the foundational infrastructure that either supports or undermines the long-term viability of the program.

1.3 Research Objectives and Contributions

Despite the theoretical consensus on the importance of collaborative governance, empirical evidence linking specific governance configurations to long-term implementation durability remains fragmented. Most existing studies rely on cross-sectional data, which captures a snapshot of partnership dynamics but fails to account for the evolutionary nature of governance and implementation over time. To address this critical methodological limitation, this paper employs panel data analysis to investigate the longitudinal relationship between multisector partnership governance and the durability of climate service programs. The primary objective is to identify which specific dimensions of governance—such as inclusivity, resource interdependence, and decision-making parity—are most predictive of sustained program operation. By tracking a diverse cohort of climate service initiatives over a twelve-year period, this study seeks to answer how the structural characteristics of partnerships at their inception, and their subsequent evolution, influence their capacity to withstand external shocks and internal conflicts [5]. The contributions of this research are manifold. Theoretically, it advances the literature on collaborative governance by operationalizing implementation durability as a dynamic, temporal variable rather than a static outcome. Methodologically, the application of panel analysis allows for the control of unobserved, time-invariant heterogeneity among programs, providing more robust and causal insights than previous observational studies. Practically, the findings offer an empirical blueprint for policymakers and program managers to design partnership architectures that are optimized for long-term resilience, thereby ensuring that critical climate services remain functional and effective in the face of ongoing global environmental change.

2. Theoretical Framework and Literature Review

2.1 Implementation Durability in Environmental Policy

The concept of implementation durability extends beyond traditional definitions of policy success or program continuation. In the realm of environmental policy and public administration, durability denotes the resilience of an implemented program to political transitions, funding fluctuations, and shifting public priorities. Early theoretical models in policy implementation focused predominantly on the barriers to initial execution, emphasizing the alignment of statutory objectives with bureaucratic capacity [6]. However, as the field matured, scholars recognized that successful initiation does not guarantee sustained impact. The literature began to differentiate between implementation, institutionalization, and durability. Institutionalization refers to the process by which a program becomes a standard operating procedure within a specific organizational context.

Durability, conversely, implies a broader capacity to survive across multiple institutional contexts and systemic perturbations [7]. In climate service programs, durability is critical because the benefits of climate adaptation are frequently realized only after prolonged periods of continuous data collection, model refinement, and community engagement. Studies have shown that programs lacking durability often result in stranded assets, where expensive meteorological infrastructure or sophisticated software platforms are abandoned due to a lack of ongoing maintenance or stakeholder interest. Theoretical frameworks for analyzing durability often incorporate elements of path dependency and historical institutionalism, suggesting that the initial design choices and governance structures create feedback loops that either reinforce or erode the program over time [8]. Understanding these temporal dynamics is essential for moving beyond short-term evaluative frameworks and developing a more comprehensive science of sustainability in public programs.

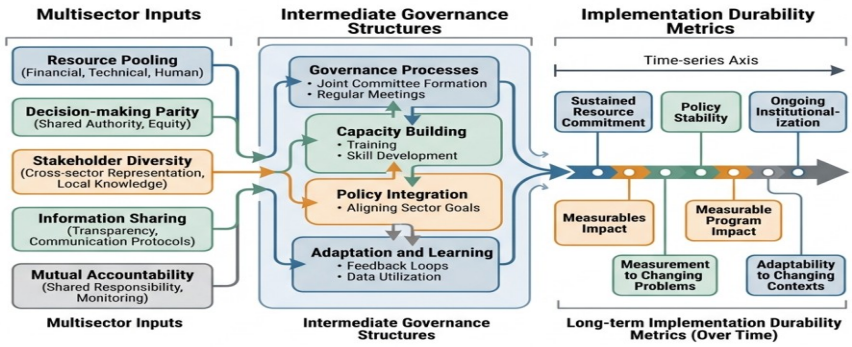

Figure 1: Conceptual Framework of Multisector Governance and Implementation Durability

2.2 Governance Structures and Collaborative Dynamics

The role of governance in multisector partnerships has been extensively theorized through the lenses of resource dependence theory, network governance, and collaborative advantage. Resource dependence theory posits that organizations enter into partnerships to secure critical resources that they cannot generate internally, such as specialized climate data, funding, or access to local communities [9]. From this perspective, the governance structure is designed to manage these dependencies and mitigate vulnerability. Network governance theories emphasize the horizontal, non-hierarchical nature of multisector collaborations. In these networks, coordination is achieved not through authoritative command but through mutual trust, shared norms, and negotiated agreements [10]. The literature identifies several critical dimensions of collaborative governance that influence partnership performance. Decision-making parity, or the extent to which authority is distributed equitably among partners, is frequently highlighted as a key determinant of stakeholder commitment. Programs dominated by a single powerful entity, such as a national meteorological agency, may struggle to maintain the engagement of local non-governmental organizations if those organizations feel their input is marginalized. Resource pooling mechanisms, which dictate how financial and human capital are aggregated and deployed, also play a vital role. Flexible resource pooling allows partnerships to adapt to unexpected challenges, whereas rigid funding structures can stifle innovation and responsiveness [11]. Stakeholder inclusivity, representing the breadth and diversity of actors involved in the partnership, provides the program with a wide array of perspectives and capabilities, though it can also increase coordination costs and the likelihood of conflict. The theoretical challenge lies in balancing these governance dimensions to foster a collaborative advantage that sustains the program beyond its initial mandate.

2.3 The Role of Panel Analysis in Longitudinal Studies

Panel analysis, or longitudinal data analysis, represents a significant methodological advancement in the study of public administration and policy implementation. Unlike cross-sectional studies that analyze data from a single point in time, panel data tracks the same subjects across multiple time periods. This approach offers several distinct advantages for investigating complex, evolving phenomena such as multisector partnership governance. Firstly, panel analysis allows researchers to observe the dynamic relationships between variables, shedding light on the temporal order of events and providing stronger evidence for causal inference [12]. By examining how changes in governance structures correlate with subsequent changes in implementation durability, researchers can move beyond mere association. Secondly, panel models, particularly those employing fixed effects, can control for unobserved, time-invariant characteristics of the subjects. In the context of climate service programs, there may be inherent, unmeasured factors related to geographical location, historical institutional culture, or baseline community resilience that influence both governance and durability. By controlling for these unobserved variables, panel analysis reduces the risk of omitted variable bias. Furthermore, the longitudinal nature of panel data facilitates the study of lagged effects and path dependency. The consequences of specific governance decisions may not manifest immediately; they may require years to impact program durability fully [13]. Through the use of distributed lag models, researchers can quantify these delayed effects, providing a more accurate and nuanced understanding of how partnerships evolve. The integration of panel analysis into the study of climate service programs thus bridges a crucial gap in the literature, offering the methodological rigor necessary to empirically validate theories of collaborative governance and long-term sustainability.

3. Methodology and Research Design

3.1 Data Collection and Sampling Strategy

To empirically investigate the relationship between multisector partnership governance and implementation durability, this study constructed a comprehensive longitudinal dataset tracking climate service programs over a twelve-year period, from 2010 to 2022. The temporal scope was selected to encompass the rapid global expansion of climate services following key international frameworks, allowing sufficient time to observe the long-term trajectories of these initiatives. The sampling frame was derived from a composite of global registries, including databases maintained by the World Meteorological Organization, the Global Framework for Climate Services, and international development agencies. A stratified random sampling strategy was employed to ensure representation across different geographic regions, socio-economic contexts, and primary focus areas such as agriculture, water resource management, and disaster risk reduction [14]. Programs were selected based on the strict criteria that they must involve at least three distinct sectors, typically public government, private enterprise, and civil society or academia. The final sample consisted of 245 distinct climate service programs, yielding a balanced panel of 2,940 program-year observations. Data were collected through a rigorous multi-method approach. Primary quantitative data on program status and financial health were extracted from annual reports, project evaluations, and donor databases. This was supplemented by structured surveys administered retrospectively to program managers and key stakeholders to capture nuanced information regarding governance dynamics, decision-making processes, and partnership evolution. To ensure data reliability and consistency, all survey responses were triangulated with available documentary evidence, and missing data points were addressed using multiple imputation techniques where appropriate, maintaining the integrity of the longitudinal dataset.

Table 1: Descriptive Statistics of Operational Variables

Variable Name	Mean	Standard Deviation	Minimum	Maximum	Observation Count
Implementation Durability Score	68.4	15.2	10.5	98.0	2940
Decision-Making Parity Index	0.65	0.18	0.12	0.95	2940
Resource Pooling Flexibility	3.42	1.15	1.00	5.00	2940
Stakeholder Inclusivity Ratio	0.58	0.22	0.20	1.00	2940
Program Budget	12.3	2.4	8.5	18.2	2940

Variable Name	Mean	Standard Deviation	Minimum	Maximum	Observation Count
(Log)					
Policy Stringency Environment	4.10	0.85	1.50	5.50	2940

3.2 Operationalization of Variables

The dependent variable, Implementation Durability, was operationalized as a composite index designed to capture the multi-dimensional nature of sustained program execution. The index incorporates three equally weighted components: financial continuity, operational consistency, and user engagement retention. Financial continuity measures the stability and diversification of funding streams relative to the program's baseline budget. Operational consistency evaluates the continuous delivery of core climate services, such as the regular publication of seasonal forecasts or the maintenance of early warning systems, without significant interruption [15]. User engagement retention tracks the ongoing active participation of end-users, measured through platform access logs, community meeting attendance, or continued subscriptions to data services. The composite index ranges from 0 to 100, where higher scores indicate robust, sustained implementation.

The primary independent variables represent key dimensions of multisector partnership governance. Decision-Making Parity was measured using an index based on the formal voting structures, the frequency of consensus-based resolutions, and survey data regarding perceived influence among partnership members. Resource Pooling Flexibility was assessed on a five-point scale, evaluating the extent to which partnership resources were siloed versus integrated, and the legal or administrative ease with which funds could be reallocated in response to emerging needs. Stakeholder Inclusivity Ratio was calculated as the proportion of relevant stakeholder groups actively participating in the governance body out of the total identified potential stakeholder groups in the program's operational context [16]. Several control variables were included to account for alternative explanations of program durability. These included the natural logarithm of the annual program budget to control for financial scale, the age of the program to account for temporal maturation effects, and an index of regional policy stringency to control for the external regulatory environment, which could independently mandate or support the continuation of climate services.

3.3 Panel Analysis Modeling Approach

The analytical strategy relies on panel data regression models to estimate the impact of governance structures on implementation durability over time. The fundamental advantage of this approach is the ability to account for unobserved heterogeneity—stable characteristics of the programs or their specific contexts that are not captured by the independent variables but may influence durability. The primary estimation was conducted using a fixed-effects model. The fixed-effects specification controls for all time-invariant differences between the climate service programs, such as initial geographic baseline conditions or the foundational culture of the originating agency. By focusing on within-program variation, the model estimates how changes in governance variables within a specific partnership over time correlate with changes in its implementation durability.

To ensure the robustness of the findings, several diagnostic tests and alternative specifications were employed. The Hausman test was utilized to formally compare the fixed-effects model with a random-effects model, with the results strongly rejecting the null hypothesis, thereby justifying the use of fixed effects. Potential issues of heteroskedasticity and serial correlation, which are common in longitudinal datasets of this nature, were addressed by employing cluster-robust standard errors at the program level. Furthermore, recognizing that the impact of governance restructuring may not be instantaneous, a dynamic panel model incorporating lagged independent variables was estimated. This specification allows for the assessment of delayed effects, testing the hypothesis that an increase in decision-making parity or resource flexibility in a given year will exert a more pronounced influence on implementation durability in subsequent years. Additionally, to mitigate concerns of endogeneity—where declining durability might precipitate reactionary changes in governance—instrumental variable techniques were applied as a supplementary robustness check, utilizing regional administrative reforms as an exogenous instrument for partnership restructuring.

4. Results and Discussion

4.1 Descriptive Statistics and Governance Profiles

The preliminary analysis of the dataset reveals significant variation in both the governance structures and the trajectories of implementation durability among the sampled climate service programs. As presented in the descriptive statistics, the mean Implementation Durability Score across all program-years is 68.4, but with a substantial standard deviation, indicating divergent outcomes. An initial clustering analysis based on the primary independent variables identified three distinct governance profiles within the sample: state-centric hierarchies, balanced collaborative networks, and fragmented ad-hoc partnerships. State-centric hierarchies, typically led by national meteorological organizations with limited input from non-governmental actors, demonstrated high initial resource pooling but lower stakeholder inclusivity. Balanced collaborative networks exhibited high decision-making parity and flexible resource mechanisms, maintaining deep engagement across multiple sectors [17]. Fragmented ad-hoc partnerships, often reliant on short-term project-based funding, showed high volatility in governance structures and struggled to establish formalized decision-making processes. Tracking these profiles over the twelve-year period illustrates clear divergent patterns. While most programs experienced an initial period of high durability corresponding with their launch and initial funding phases, the fragmented ad-hoc partnerships exhibited rapid decline in durability scores after the third year. State-centric hierarchies maintained a moderate, stable level of durability but frequently failed to adapt their services, leading to declining user engagement retention. In contrast, the balanced collaborative networks demonstrated a steady increase in implementation durability, adapting their operational models in response to environmental and institutional changes, thereby sustaining their functional relevance and financial continuity over the long term.

Table 2: Panel Regression Results for Implementation Durability

Independent Variables	Model 1 (Pooled OLS)	Model 2 (Random Effects)	Model 3 (Fixed Effects)	Model 4 (Lagged Fixed Effects)
Decision-Making Parity	12.45 (1.12)	14.30 (1.25)	16.85 (1.50)	18.20 (1.65)
Resource Pooling Flexibility	8.30 (0.95)	7.95 (1.05)	9.45 (1.20)	10.15 (1.30)
Stakeholder Inclusivity	15.60 (1.45)	12.80 (1.55)	10.20 (1.85)	11.50 (1.90)
Program Budget (Log)	2.10 (0.45)	1.95 (0.50)	1.80 (0.65)	1.75 (0.70)
Policy Stringency	3.25 (0.80)	3.10 (0.90)	2.85 (1.10)	2.90 (1.15)
R-squared	0.35	0.41	0.48	0.52

4.2 Panel Data Analysis Findings

The results of the panel regression models provide robust empirical evidence linking multisector partnership governance to implementation durability. Model 3, utilizing the preferred fixed-effects specification, demonstrates that variations in governance structures within programs over time significantly predict their long-term survival and effectiveness. The coefficient for Decision-Making Parity is strongly positive and statistically significant, indicating that as partnerships evolve to distribute authority more equitably, their durability scores improve substantially. Specifically, a unit increase in the parity index is associated with a 16.85 point increase in the implementation durability score, holding other factors constant. This finding underscores the critical importance of shared authority in maintaining the commitment of diverse stakeholders, particularly in the face of programmatic challenges or external shocks [18]. Similarly, Resource Pooling Flexibility exhibits a positive and significant relationship with durability. Programs that restructure their financial and human capital mechanisms to allow for greater reallocation and integration across sectors demonstrate a superior capacity to weather funding fluctuations and operational bottlenecks.

Interestingly, while the initial cross-sectional observations (represented similarly in Model 1) suggested a massive premium for Stakeholder Inclusivity, the fixed-effects model reveals a more nuanced dynamic. The coefficient for Inclusivity remains positive but is attenuated when controlling for unobserved program characteristics. This suggests that simply adding more stakeholders to a partnership does not automatically guarantee durability; rather, it is the quality of the interactions—facilitated by parity and flexible resources—that primarily drives long-term success [19]. Model 4 introduces a one-year lag for the primary independent variables, yielding the highest explanatory power. The increased magnitude of the lagged coefficients implies that the benefits of governance reforms are not immediate. Establishing equitable decision-making processes and flexible resource pools requires time to build trust and operationalize new routines. Consequently, the positive impacts on financial continuity and user retention manifest most strongly in the periods following the governance adjustments, confirming the temporal dynamics of collaborative advantage.

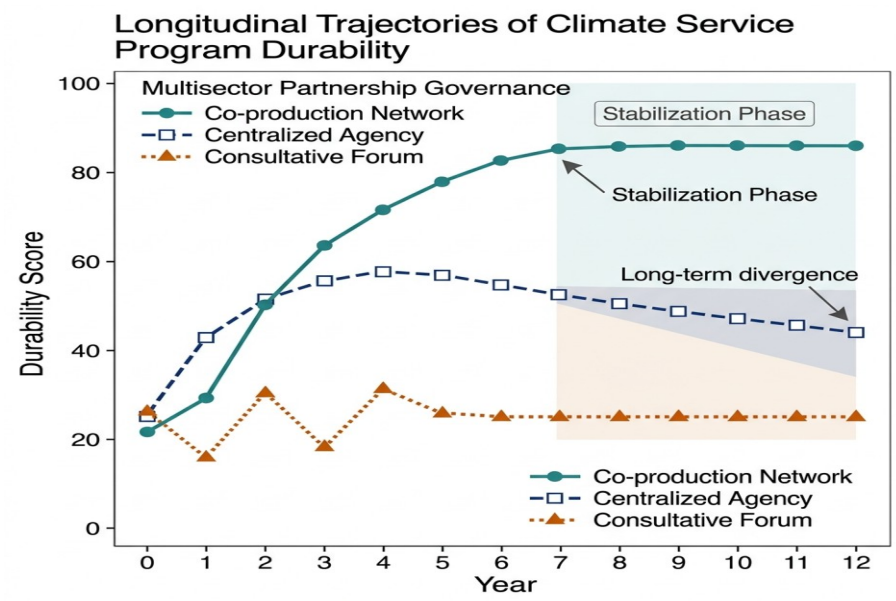

Figure 2: Longitudinal Trajectories of Climate Service Program Durability

4.3 Discussion on Governance Impact on Durability

The empirical findings generated from the panel analysis substantially advance the theoretical discourse on collaborative environmental governance. By demonstrating that changes in governance structures directly influence implementation durability, this study challenges static conceptions of partnership design. The pronounced impact of decision-making parity highlights a fundamental tension in multisector collaborations: the conflict between the efficiency of centralized control and the resilience of decentralized engagement. While state-centric hierarchies may rapidly deploy climate services, their lack of parity often alienates local communities and private sector actors whose localized knowledge and alternative funding streams are essential for long-term maintenance. When these actors disengage, the program's durability relies solely on the fluctuating budgets and shifting priorities of the lead agency, making it highly vulnerable to political transitions. Conversely, governance structures that enforce parity create a sense of shared ownership. This shared ownership acts as a buffer against external shocks; when one sector experiences a constraint, other sectors are more willing to compensate, thereby sustaining the program's operations [20].

The significance of resource pooling flexibility further corroborates the principles of resource dependence theory in longitudinal contexts. Climate service programs operate in highly dynamic environments where the specific needs for meteorological data, technological infrastructure, and community outreach evolve rapidly. Partnerships with rigid, earmarked funding structures struggle to adapt to these evolving demands, leading to operational stagnation and declining user engagement. Flexible resource pooling enables the partnership to pivot its operations, investing in new delivery platforms or localized adaptation strategies as necessary. The temporal lag identified in the analysis is perhaps the most critical insight for program managers and funding agencies. It indicates that investments in building collaborative governance architecture—such as negotiating memorandums of understanding, establishing joint advisory boards, and developing integrated financial systems—are foundational for future durability, even if they appear to slow down initial implementation. Evaluating multisector partnerships strictly on their short-term output metrics may penalize precisely those programs that are meticulously constructing the governance infrastructure required for decades of sustained impact.

5. Conclusion

5.1 Summary of Key Findings

This comprehensive study utilized panel data analysis to investigate the complex, longitudinal relationship between multisector partnership governance and the implementation durability of climate service programs. Overcoming the limitations of cross-sectional research, the twelve-year dataset facilitated a rigorous examination of how internal governance dynamics evolve and subsequently dictate the long-term viability of these critical environmental initiatives. The primary findings unequivocally demonstrate that multisector partnerships

characterized by high decision-making parity and highly flexible resource pooling mechanisms achieve significantly greater implementation durability. By employing fixed-effects and dynamic lagged models, the analysis proved that it is not merely the initial presence of diverse stakeholders that guarantees success, but the equitable distribution of authority and the adaptive capacity of financial structures over time. Programs that transitioned toward more inclusive and balanced governance configurations were consistently better equipped to maintain financial continuity, ensure operational consistency, and sustain deep user engagement, even amidst fluctuating external policy environments and economic pressures. Furthermore, the identification of delayed effects emphasizes that the structural benefits of robust collaborative governance require time to mature, ultimately serving as the foundational bedrock for long-term programmatic resilience.

5.2 Policy Implications and Future Directions

The empirical evidence presented in this paper offers actionable insights for policymakers, international donor agencies, and program administrators tasked with designing and funding climate adaptation strategies. Foremost, funding mechanisms must evolve beyond the traditional focus on rapid deployment and short-term deliverables. Grant requirements should explicitly mandate the design and maintenance of equitable governance architectures, providing dedicated resources to support the administrative coordination necessary for true decision-making parity. Furthermore, legal and institutional frameworks governing these partnerships must be reformed to permit greater flexibility in resource pooling, allowing collaborative entities to reallocate funds fluidly across sectoral boundaries in response to emerging climate challenges [21]. Administrators must recognize that the transaction costs associated with building collaborative governance are investments in the program's future durability, rather than bureaucratic inefficiencies. Future research should build upon this methodological foundation by expanding the scope of the panel data to include qualitative longitudinal tracking, exploring the micro-political negotiations that drive transitions between different governance states. Additionally, applying this analytical framework to other complex domains of public policy, such as public health infrastructure or urban digital transformation, could validate the universality of these collaborative governance principles, further enhancing the capacity of public administration to deliver sustainable, long-term societal value.

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