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Article

The Air Quality Data–Policy Gap: Institutional, Political, and Behavioral Barriers to Effective Decision-Making

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Abstract: Air pollution remains a critical public health and environmental challenge, despite significant advancements in monitoring technologies and the widespread availability of high-resolution air quality data. This study examines a persistent paradox: why improved data availability does not consistently translate into effective policy action. Adopting a qualitative synthesis approach, the research analyzes evidence from multiple Asian contexts, including China, India, Pakistan, and Southeast Asia, to investigate the structural factors shaping the data–policy relationship. The study develops a conceptual framework that positions air quality data as a necessary but insufficient condition for effective policymaking, emphasizing the mediating role of institutional, political, and behavioral factors. The findings reveal that fragmented governance structures, weak enforcement mechanisms, limited administrative capacity, and misaligned political incentives systematically constrain the translation of data into action. In several cases, data is underutilized, selectively interpreted, or overshadowed by short-term policy priorities and socioeconomic considerations. Additionally, trust deficits and limited technical expertise further weaken the effectiveness of data-driven decision-making processes. The analysis demonstrates that the gap between knowledge and action is fundamentally a governance challenge rather than a technical one. Addressing this gap requires a shift from data-centric approaches toward strengthening the institutional and political conditions under which data is interpreted and applied. The study contributes to the literature by advancing a theoretically grounded framework for understanding the data–policy gap and offers policy-relevant insights for improving air quality governance in complex, multi-level contexts. Beyond air quality governance, the findings have broader implications for climate policy implementation and green economy transitions, highlighting the importance of institutional capacity, governance coherence, and stakeholder trust in translating environmental data into effective policy action.

Keywords: Air Quality Governance; Data–Policy Gap; Environmental Policymaking; Institutional Capacity; Political Economy; Qualitative Synthesis

1. Introduction

Air pollution remains one of the most critical environmental and public health challenges globally. Populations are continuously exposed to harmful pollutants, including fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3), all of which are strongly associated with adverse health outcomes such as respiratory diseases, cardiovascular conditions, and premature mortality. According to the World Health Organization (2021), millions of premature deaths annually are attributable to air pollution exposure. Beyond its health impacts, air pollution also imposes substantial economic burdens [1], including increased healthcare expenditures, reduced labor productivity, and broader challenges associated with climate change mitigation [2]. Over the past two decades, significant advancements in air quality monitoring technologies have enhanced the ability of researchers and policymakers to identify pollution sources, track trends, and quantify exposure levels.

Contemporary air quality governance increasingly relies on integrated monitoring systems, including ground-based stations, satellite observations, and digital platforms. In many contexts, air quality data is publicly accessible in near real time, contributing to greater transparency and public awareness of environmental conditions [3]. This expansion in data availability has reinforced a widely held assumption that improved data quality and accessibility inherently lead to more informed and effective policy decisions [4]. Existing studies suggest that data collection and management systems have become more institutionalized and increasingly integrated within governmental decision-making processes. Moreover, pollution data is now routinely incorporated into broader policy domains, including energy planning and urban development, reflecting its growing role in shaping regulatory and strategic frameworks [5,6].

However, despite these advances in data availability and monitoring capacity, improvements in air quality outcomes have not consistently followed. In many contexts, governments possess detailed and high-resolution data on pollution levels and emission sources, yet policy responses remain delayed, fragmented, or insufficient. Much of the existing literature has concentrated on enhancing monitoring technologies and improving data accuracy, while comparatively less attention has been directed toward understanding how political, institutional, and behavioral factors mediate the translation of data into policy action [7].

Although previous studies have examined environmental governance challenges, political economy constraints, and evidence-based policymaking, these strands of literature have largely developed independently. Existing research has primarily focused either on improving monitoring technologies and data systems or on individual governance barriers affecting policy implementation. Consequently, limited attention has been given to how institutional, political, and behavioral factors interact to shape the translation of air quality data into policy action. This leaves an important gap in understanding why data-rich environments frequently continue to experience ineffective environmental policy outcomes despite substantial advances in monitoring capabilities.

This paper challenges the prevailing assumption that increased data availability inherently leads to improved policy outcomes. It advances a conceptual argument that the effectiveness of air quality governance is not determined solely by the quantity or quality of data, but by the institutional, political, and behavioral contexts through which such data is interpreted and operationalized. Specifically, the study identifies fragmented governance structures, misaligned political incentives, limited administrative capacity, and cognitive and informational constraints as critical mediating factors that shape the translation of data into policy action. This study contributes to the literature in three ways. First, it integrates insights from institutional theory, political economy, and behavioral public administration into a single analytical framework. Second, it identifies three distinct governance pathways, institutional filtering, political distortion, and capacity constraints, through which the data–policy gap emerges. Third, it provides a transferable conceptual model for explaining why improvements in environmental monitoring and data availability do not necessarily result in effective policy action.

2. Literature Review

Urban air pollution exhibits significant spatial heterogeneity, often concentrating in localized "hotspots" characterized by dense traffic, industrial activity, and high population exposure [8]. As a result, uniform, city-wide policy interventions frequently fail to address these localized dynamics effectively, since pollution intensity and sources vary substantially across neighborhoods [8]. This has led to increasing recognition of the importance of granular, context-specific data to inform targeted interventions, particularly in highly affected areas [8]. Empirical evidence supports this approach. For instance, Feng et al. (2022) employed a Positive Matrix Factorization (PMF) model combined with polycyclic aromatic hydrocarbons (PAHs) to analyze $PM_{2.5}$ pollution in Shanghai, demonstrating that multiple sources, including vehicular emissions, industrial activities, coal combustion, and biomass burning, contribute differently across time and pollution episodes [9]. Their findings underscore the importance of precise measurement, source attribution, and temporal analysis in designing effective mitigation strategies, while also highlighting the necessity of sustained regulatory enforcement and long-term policy commitment [9].

However, a growing body of literature suggests that the availability of detailed technical data alone is insufficient to ensure effective policy outcomes. A central challenge lies in the capacity of institutional systems to coordinate, interpret, and act upon such information. Effective environmental governance requires not only accurate data but also robust inter-agency coordination, vertical integration across governance levels, and coherent implementation mechanisms. Where institutional arrangements are fragmented or poorly aligned, even well-designed policies may fail to achieve their intended outcomes. This highlights the critical role of governance structures in mediating the relationship between data and action.

This study is situated within the broader literature examining the "data–policy gap," which emphasizes that the translation of environmental data into effective policy is contingent upon institutional capacity, political support, and coordination mechanisms among agencies [10,11]. Evidence from China illustrates this dynamic. While significant reductions in sulfur dioxide emissions were achieved through strengthened regulatory frameworks and enforcement mechanisms, persistent challenges related to $PM_{2.5}$ and ozone required the introduction of more comprehensive and stringent policies after 2013 [10]. Across many Asian contexts, pollution sources, such as transportation, industry, and biomass burning, are governed by multiple agencies, often resulting in fragmented responsibilities and complex decision-making environments. Consequently, while data can effectively diagnose environmental problems, institutional arrangements ultimately determine whether meaningful policy action is implemented.

Further empirical insights are provided by Huang et al. (2017), who examined the impact of driving restrictions on air quality in Lanzhou, China [12]. Their analysis, which integrated conventional air quality data with digital information sources, found that such policies can produce short-term improvements in air quality. However, these gains were not sustained over time due to inconsistent enforcement and adaptive behavioral responses by the public. This case illustrates a critical limitation in policy design: even when interventions are grounded in robust data and yield initial success, their long-term effectiveness depends on sustained institutional commitment, enforcement capacity, and adaptive policy management. Without these elements, early gains may dissipate rapidly.

The literature indicates that while advances in monitoring technologies have significantly improved the availability and precision of environmental data, the primary constraints on effective air quality management are not technical in nature [13–15]. Instead, they are rooted in political and institutional dynamics, including weak interagency coordination, inconsistent enforcement, competing policy priorities, and structural governance limitations. These factors shape not only how data is interpreted but also whether it is translated into actionable and sustained policy measures.

Accordingly, while high-quality data plays a crucial role in identifying environmental challenges and informing potential solutions, it cannot, in isolation, overcome systemic governance constraints. It does not resolve institutional fragmentation, align political incentives, or ensure effective implementation. The literature therefore supports the central premise of this study: improving air quality outcomes requires not only advancements in data generation and monitoring, but also fundamental improvements in governance structures, institutional capacity, and policy coherence. Without these enabling conditions, even the most sophisticated data systems are unlikely to produce meaningful and lasting environmental improvements.

3. Conceptual Framework

3.1. Core Argument and Central Proposition

The conceptual framework challenges the prevailing assumption that the primary constraint on effective environmental policymaking is the lack of data. While acknowledging the importance of data availability, it argues that the relationship between data and policy effectiveness is not direct, but rather mediated by institutional, political, and behavioral factors [16]. In this context, the mere availability of data does not guarantee its effective utilization, particularly when the institutional and governance environments within which data is produced, interpreted, and operationalized are not conducive to action [17].

The central proposition of this study is that the translation of air quality data into effective policy outcomes is systematically constrained by institutional, political, and behavioral factors. Where such mediating factors act as barriers, the presence of high-quality data alone is insufficient to produce effective decision-making or policy implementation. This proposition shifts the analytical focus from data generation processes toward the broader governance context that shapes how data is interpreted and acted upon.

3.2. Theoretical Framework

The proposed framework is informed by three complementary theoretical perspectives that together provide a multidimensional understanding of the data–policy gap.

First, institutional theory and environmental governance literature emphasize the role of organizational structures, rules, and coordination mechanisms in shaping policy outcomes. Institutional arrangements function as filters that can either facilitate the translation of information into action or contribute to inaction, distortion, or dilution of evidence [16]. Key concepts include institutional fragmentation, characterized by overlapping mandates and diffused accountability across agencies, and institutional capacity, referring to the availability of technical expertise, financial resources, and administrative capability required to act upon available data [18].

Second, political economy perspectives highlight the influence of incentives, power dynamics, and distributional conflicts in environmental decision-making. These include principal–agent problems, where local actors may have incentives that diverge from environmental objectives, and regulatory capture, whereby industrial actors influence regulatory processes to minimize compliance costs [19]. This body of literature also underscores the tendency of policymakers to prioritize short-term, politically visible outcomes over long-term environmental sustainability.

Third, insights from behavioral public administration introduce the role of cognitive and social factors in shaping how information is processed and acted upon. Decision-makers may exhibit confirmation bias, prioritizing information that aligns with pre-existing preferences, even when contradictory evidence is available [20]. Similarly, deficits in public trust can undermine policy effectiveness, as citizens may resist or fail to comply with environmental measures despite clear evidence of their benefits [21].

3.3. Key Variables

The framework conceptualizes the data–policy relationship through four categories of variables, as illustrated in **Figure 1**.

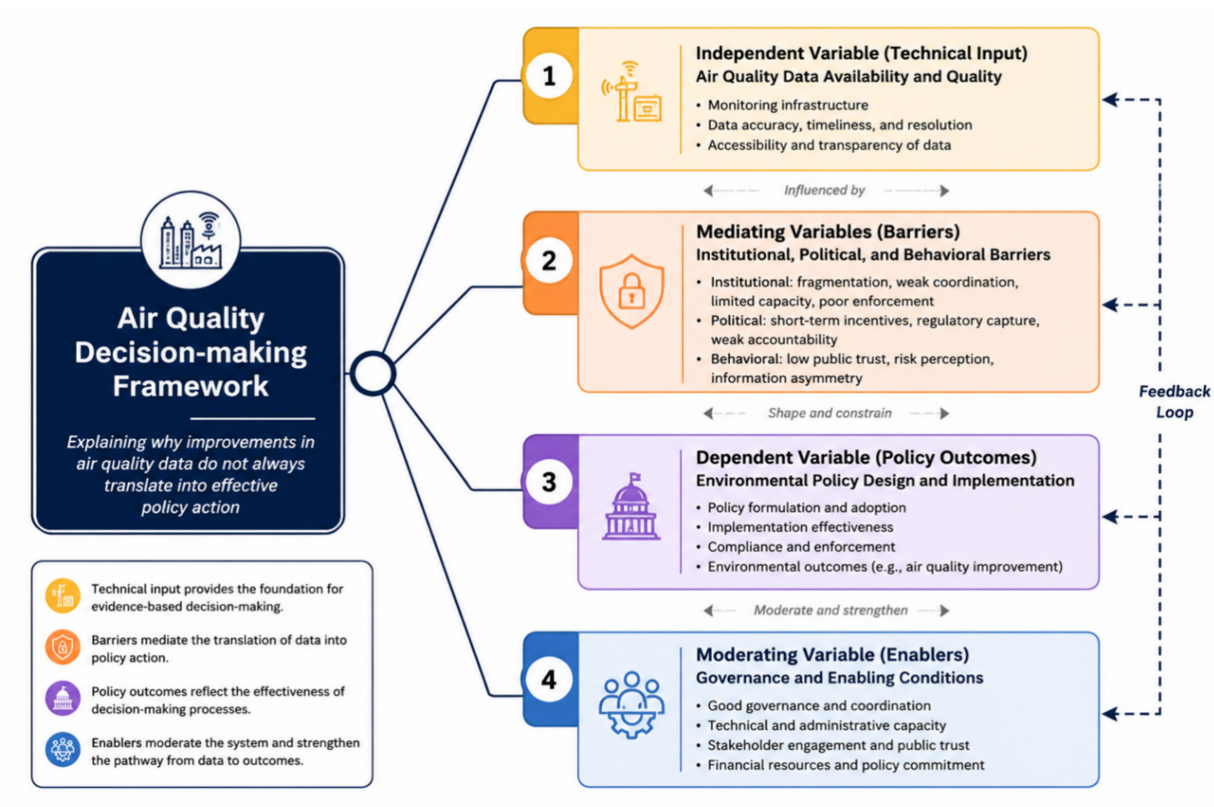

Figure 1. Air quality-making framework.

The independent variable consists of air quality monitoring data, representing the technical input available to decision-makers. This includes ground-based monitoring networks providing real-time pollutant data, Continuous Emission Monitoring Systems (CEMS) deployed in industrial facilities, satellite-based observations, and publicly accessible data platforms [2].

The mediating variables capture the factors that obstruct or shape the translation of data into policy action. These are grouped into three primary dimensions. Institutional variables include fragmented governance structures, weak regulatory enforcement, and limited administrative capacity, where agencies lack the financial, human, or technical resources required to respond effectively to available data [22]. Political variables encompass incentive structures that prioritize short-term, visible outcomes, as well as dynamics such as regulatory capture and strategic data manipulation by state or non-state actors [19]. Behavioral variables include decision-making biases, neglect of comprehensive cost–benefit analysis [8], and public trust deficits that affect policy acceptance and compliance [17]. In addition, transboundary factors, such as cross-border pollution flows and weak regional coordination mechanisms, further complicate governance responses.

The dependent variable refers to policy outcomes, including delayed responses to environmental challenges, reliance on short-term or symbolic interventions, underutilization of available data, and associated health and economic impacts [23]. Finally, moderating variables represent mechanisms that can strengthen the relationship between data and policy effectiveness. These include improvements in administrative capacity, enhanced inter-agency coordination, and increased public participation [23], more robust cost–benefit analysis, and stronger regional cooperation frameworks.

Importantly, the institutional, political, and behavioral dimensions identified in the framework do not operate independently. Rather, they interact dynamically and often reinforce one another in ways that intensify the data–policy gap. For example, limited administrative capacity may weaken regulatory oversight and enforcement, thereby creating opportunities for political distortion, selective implementation, or regulatory capture. At the same time, political incentives that prioritize short-term economic or electoral objectives may discourage investments in institutional strengthening, technical expertise, and monitoring capacity. These dynamics can further undermine public trust in environmental institutions and reduce policy legitimacy and compliance. Consequently, weaknesses in one dimension may trigger or amplify weaknesses in others, creating mutually reinforcing barriers that constrain the effective translation of air quality data into policy action. Understanding these interactions is therefore essential for explaining why improvements in data availability alone frequently fail to produce corresponding improvements in environmental outcomes.

3.4. Causal Pathways

Building on the mediating role of governance factors, the framework identifies three primary causal pathways through which the data–policy gap emerges, as illustrated in **Figure 2**.

The first pathway, institutional filtering, refers to the manner in which data is processed through fragmented governance systems, where overlapping mandates and diffused responsibilities lead to accountability gaps. In such contexts, data may be collected and analyzed, yet no single agency assumes responsibility for translating it into action [22].

The second pathway, political distortion, captures the influence of incentive structures that favor short-term, politically expedient interventions over long-term, evidence-based policies. Decision-makers may prioritize actions that yield immediate visibility or political gains, even when such actions are less effective in addressing underlying environmental challenges [19].

The third pathway, capacity constraints, reflects limitations in technical expertise, institutional capability, and regulatory oversight. In such cases, even when data is available, insufficient capacity to interpret, validate, and act upon that data undermines its effectiveness. This may also enable practices such as data manipulation by regulated entities, particularly in contexts where monitoring and enforcement mechanisms are weak [24].

The framework also incorporates feedback mechanisms that reflect the dynamic nature of environmental governance processes. Unsuccessful policy implementation may generate negative feedback effects that further widen the data–policy gap. For example, weak policy outcomes can reduce public trust in environmental institutions, reinforce political preferences for short-term and highly visible interventions, and discourage investment in institutional strengthening and administrative capacity. These dynamics may create a self-reinforcing cycle in which ineffective governance further weakens the conditions necessary for evidence-based policymaking. Conversely, improvements in inter-agency coordination, administrative capacity, transparency, and public trust can generate positive feedback effects by strengthening the credibility and utilization of environmental data. Over time, these reinforcing mechanisms can improve the translation of data into policy action and contribute to more effective and sustainable environmental governance outcomes.

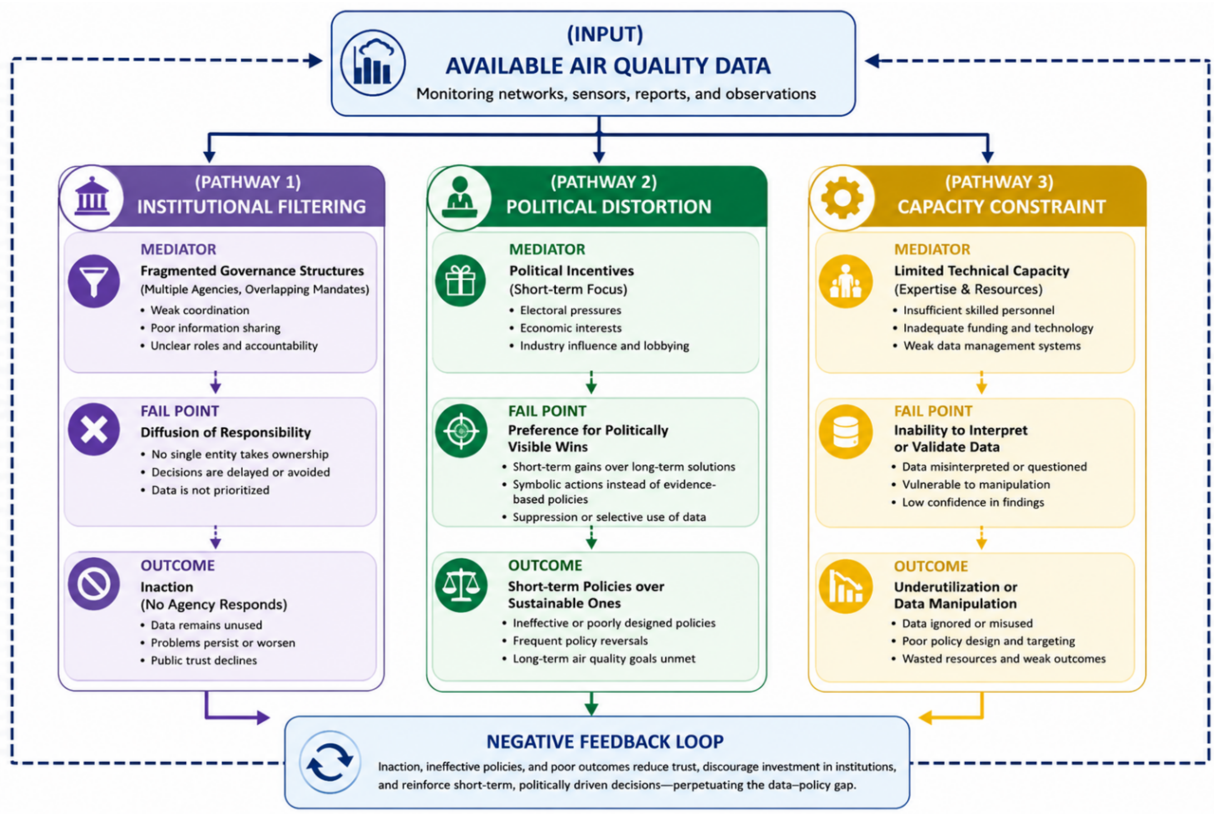

Figure 2. The three pathways to the Data–Policy Gap.

3.5. Propositions for Future Research

To facilitate empirical testing and further development of the proposed framework, a set of propositions is advanced based on the relationships identified in the literature and the conceptual model. These propositions are intended to guide future quantitative and qualitative investigations of the data–policy gap in environmental governance contexts.

Proposition 1 (Institutional Fragmentation): Greater institutional fragmentation reduces the likelihood that environmental data will be translated into effective policy action.

Proposition 2 (Political Incentives): Political incentives favoring short-term economic or electoral outcomes weaken evidence-based environmental decision-making and reduce the implementation of long-term pollution mitigation measures.

Proposition 3 (Administrative Capacity): Limited administrative and technical capacity reduces the effectiveness of environmental monitoring systems by constraining the interpretation, enforcement, and application of available data.

Proposition 4 (Public Trust): Public trust positively moderates the relationship between environmental data availability and policy implementation, such that higher levels of trust strengthen policy acceptance and compliance.

Proposition 5 (Interactive Governance Effects): Institutional, political, and behavioral barriers interact and reinforce one another, thereby amplifying the data–policy gap and reducing the effectiveness of environmental governance systems.

These propositions extend the explanatory value of the framework beyond a descriptive representation and provide a foundation for future empirical research aimed at testing the causal mechanisms underlying the relationship between environmental data and policy outcomes.

3.6. Analytical Application of the Framework

The conceptual framework serves as the primary analytical lens guiding the empirical analysis presented in subsequent sections. The case-based evidence is organized according to the categories of mediating variables identified in the framework, enabling a structured examination of how different factors contribute to the data–policy gap across contexts.

Specifically, evidence from Pakistan is used to illustrate institutional fragmentation, evidence from China to examine political incentives and data manipulation, evidence from India to highlight capacity constraints and limitations in cost–benefit analysis, and evidence from Southeast Asia to demonstrate the challenges associated with transboundary pollution and regional coordination. This structured approach allows for a systematic assessment of the central proposition across multiple contexts.

The discussion section further evaluates the extent to which the identified causal pathways, institutional filtering, political distortion, and capacity constraints are supported by the empirical evidence. It also considers whether additional mediating factors emerge from the analysis. Finally, the policy implications draw upon the moderating variables identified in the framework to propose pathways for strengthening the linkage between data and policy action. Collectively, this approach enables a comprehensive evaluation of the conditions under which air quality data can be effectively translated into sustained policy outcomes.

4. Methodology

This study adopts a qualitative synthesis approach to examine the gap between air quality data availability and policy implementation, with particular focus on the institutional, political, and governance factors that shape this relationship. The methodology is based on a structured and systematic review of existing literature, supported by elements of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to enhance transparency and rigor in the source selection process.

All searches were completed during this period to ensure consistency in source identification and screening. The literature selection process involved identifying relevant academic sources through multiple databases, including the Georgetown University in Qatar Library, Google Scholar, ScienceDirect, and JSTOR. An initial pool of 99 sources was identified, of which 84 were retrieved through database searches and 15 through additional sources. Following this, 25 duplicate records were removed. A further 21 sources were excluded based on publication date criteria, ensuring the inclusion of recent and relevant studies.

Subsequent screening was conducted in two stages. First, 8 sources were excluded during title screening due to a lack of relevance to the research focus. Second, abstract screening of the remaining studies resulted in the exclusion of an additional 5 sources that did not sufficiently address the relationship between air quality data and policy or governance dimensions. This process resulted in a final sample of 40 sources included in the analysis.

These selected sources provide a comprehensive and multidisciplinary foundation for examining air quality governance, particularly in the Asian context, with a focus on the role of institutional fragmentation, political incentives, and behavioral constraints in shaping policy outcomes. A PRISMA flow diagram summarizing the literature selection process is presented in **Figure 3**.

4.1. Search Strategy

The literature search was conducted using a systematic and targeted approach across major academic databases, including the Georgetown University in Qatar Library portal, Google Scholar, ScienceDirect, and JSTOR. The search strategy focused on identifying recent, peer-reviewed literature addressing air quality data, environmental governance, policy effectiveness, and institutional dynamics. A combination of keywords and thematic search strings was used to ensure comprehensive coverage of the topic. These included: "Policy Failures in Air Quality; Air Quality Problems in Asia; Political Incentives for Air Quality Management; The Impact of Poor Air Quality on the National

Economy; The Impact of Poor Policies in Air Quality; Data and Policy; Institutional Barriers for Air Quality Management; Policy Failures for Air Quality Management in Asia".

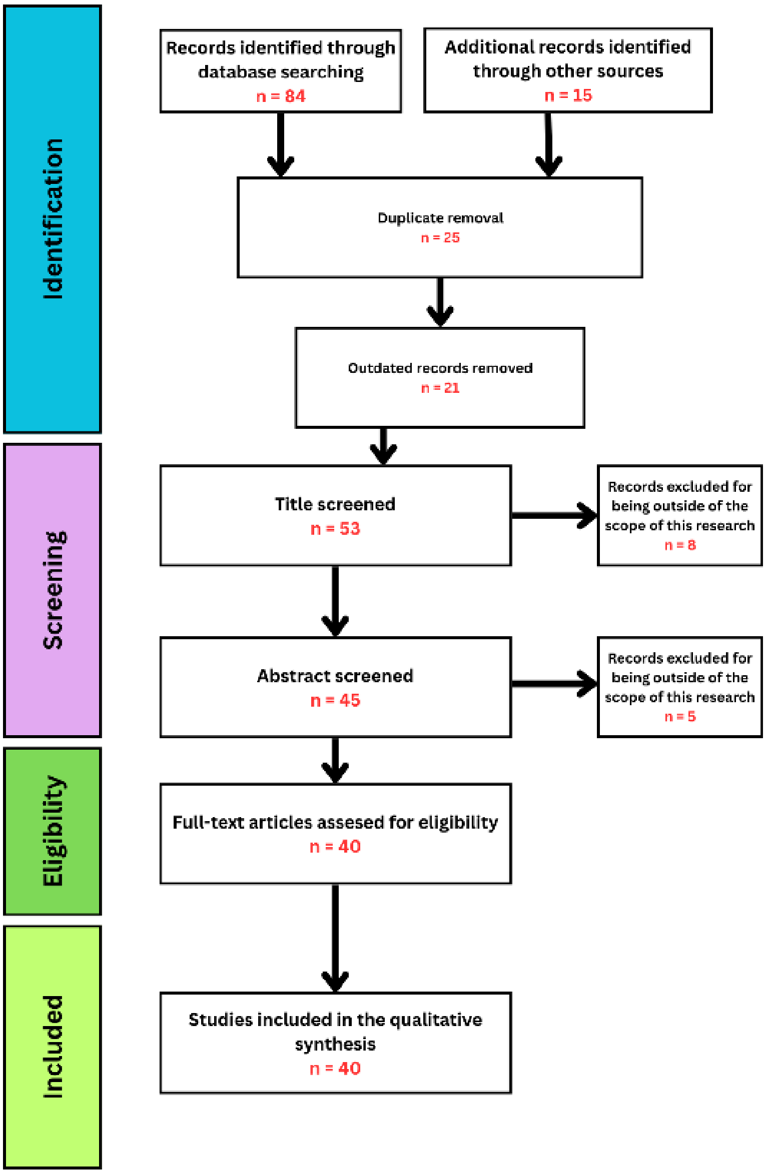

Figure 3. PRISMA diagram of the literature selection process.

4.2. Inclusion and Exclusion Criteria

To ensure the relevance and quality of the selected literature, specific inclusion and exclusion criteria were applied. Included sources were required to be peer-reviewed journal articles, published in English, and within the last ten years, ensuring both academic rigor and contemporary relevance. The review prioritized studies that explicitly addressed air quality data, governance structures, policy implementation, or institutional and political dynamics related to environmental management.

Exclusion criteria included non-peer-reviewed sources, opinion-based articles, inaccessible publications, and studies lacking direct relevance to the research focus. While this study relies exclusively on secondary data through existing literature, this approach is appropriate given the study's objective of synthesizing and critically interpreting established knowledge across multiple contexts. However, it also represents a limitation, as the findings are dependent on the scope and quality of available literature rather than primary empirical data.

This study relies exclusively on secondary literature and adopts a qualitative synthesis approach to examine the relationship between air quality data and environmental policymaking. While this approach enables the integration of evidence across multiple contexts and governance settings, it does not directly capture the perspectives of policymakers, regulators, industry stakeholders, or affected communities. Consequently, the findings and conceptual framework should be interpreted as theory-building rather than empirically validated causal relationships. Future research should incorporate primary data collection methods, including expert interviews, policy-maker surveys, comparative case studies, and governance performance indicators, to empirically test and refine the relationships proposed in the framework.

4.3. Eligibility and Quality Screening

To enhance methodological rigor, all eligible studies were subjected to a quality screening process prior to inclusion in the synthesis. Studies were assessed according to four criteria: (1) relevance to the research objective, (2) methodological transparency, (3) empirical or theoretical contribution to understanding the data–policy relationship, and (4) publication in a peer-reviewed academic source. Studies that did not meet these criteria were excluded during the screening process. This procedure ensured that the final sample consisted of credible and relevant sources capable of informing the conceptual framework and thematic analysis.

4.4. Coding Framework

The selected studies were manually coded by the authors using a deductive thematic approach informed by the study's conceptual objectives. Four primary coding categories were developed: (1) institutional barriers, (2) political barriers, (3) behavioral barriers, and (4) enabling governance mechanisms. During the review process, evidence from each study was assigned to one or more categories. Additional subthemes were identified where recurring patterns emerged across studies. The coding process facilitated systematic comparison across cases and informed the development of the proposed conceptual framework.

4.5. Thematic Evidence Synthesis

Following coding, a thematic synthesis approach was employed to identify recurring governance mechanisms explaining the gap between air quality data availability and policy action (**Table 1**). Findings from individual studies were compared across contexts to identify common institutional, political, and behavioral patterns. These themes were subsequently integrated into the conceptual framework and used to develop the three causal pathways identified in the analysis: institutional filtering, political distortion, and capacity constraints.

Table 1. Coding Categories Used in the Review.

Theme	Examples
Institutional Barriers	Fragmented governance, weak enforcement, poor coordination
Political Barriers	Political incentives, regulatory capture, and short-termism
Behavioral Barriers	Trust deficits, cognitive bias, and selective data use
Governance Enablers	Coordination mechanisms, capacity building, and public participation

4.6. Case Selection Rationale

The geographical cases examined in this study were selected through purposive sampling to capture variation in governance structures, institutional capacity, political systems, and air quality management challenges across Asia. Rather than seeking statistical representativeness, the objective was to examine how the proposed conceptual framework operates under diverse governance conditions. China was selected as an example of a highly centralized governance system with extensive environmental monitoring capacity. India represents a large federal system characterized by complex administrative structures and significant implementation challenges. Pakistan provides insight into contexts where institutional fragmentation and enforcement limitations constrain policy effectiveness. Evidence from Central Asia highlights the influence of structural economic and capacity constraints, while Southeast Asia offers examples of transboundary pollution challenges and multi-jurisdictional governance issues. Collectively, these cases provide analytical diversity that enables examination of the institutional, political, and behavioral mechanisms underlying the data–policy gap across different environmental governance contexts.

5. Institutional Barriers to Policy Action

5.1. Fragmented Governance

Fragmented governance represents a central institutional barrier that constrains the translation of air quality data into effective policy action across Asian contexts. As highlighted in the conceptual framework (Section 3), institutional fragmentation operates as a form of institutional filtering, whereby responsibility for environmental management is dispersed across multiple agencies with overlapping mandates, thereby weakening accountability and coordinated response mechanisms.

Across many Asian cities, responsibilities for air quality management are distributed among agencies overseeing transportation, industry, agriculture, public health, and environmental protection [25]. While such specialization can enhance technical expertise, it simultaneously generates coordination failures, particularly in addressing cross-sectoral pollution sources [25]. As a result, policy responses tend to be fragmented and inefficient, limiting the effectiveness of otherwise well-informed interventions.

A critical manifestation of this fragmentation is the lack of integrated data-sharing systems. Despite the availability of extensive monitoring networks, data is often collected and managed in silos across different departments, undermining its utility for comprehensive policymaking [26]. This institutional disconnection not only delays decision-making processes but also prevents the development of integrated policy responses capable of addressing complex, multi-source pollution dynamics [26]. Consequently, the presence of high-quality data does not translate into effective action, as the governance structures required to synthesize and operationalize this data remain inadequate.

At the regional level, fragmentation is further exacerbated by transboundary pollution dynamics. In South Asia, air pollution frequently crosses national borders, particularly within the Indo-Gangetic Plain, where emissions from agriculture, industry, and transportation interact across jurisdictions [27]. However, the absence of binding regional governance frameworks limits the capacity for coordinated response. Existing cooperation mechanisms are largely voluntary and insufficiently institutionalized, while differences in political priorities and resource availability further hinder collective action [27]. This highlights the role of weak regional governance as an extension of institutional fragmentation.

Evidence from China further illustrates how fragmented governance structures produce uneven enforcement outcomes. Although environmental policies are centrally formulated, their implementation is delegated to local governments, which often prioritize economic growth objectives over environmental compliance [28]. This creates significant variation in enforcement across cities, with wealthier and more industrialized regions demonstrating higher compliance levels compared to less resourced areas [28]. Such disparities underscore how decentralized governance arrangements can weaken the consistency and effectiveness of policy implementation. Hence, these findings demonstrate that fragmented governance structures significantly constrain the effective use of environmental data. Even in contexts where monitoring systems are well-developed, the absence of coordinated institutional mechanisms prevents policymakers from integrating diverse data streams into coherent and actionable strategies.

5.2. Weak Legal Enforcement

Weak enforcement of environmental regulations constitutes a second critical institutional barrier, corresponding to the capacity constraint pathway identified in the conceptual framework. While many Asian countries have established comprehensive legal frameworks to address air pollution, the effectiveness of these policies is frequently undermined by limited enforcement capacity and weak regulatory oversight.

As noted by Zhang (2008), structural challenges such as under-resourced environmental agencies, poor coordination between central and local authorities, and limited compliance by industrial actors significantly reduce the effectiveness of regulatory frameworks [29]. In many cases, local governments prioritize economic growth and industrial development over environmental protection, resulting in inconsistent enforcement and persistent pollution levels despite the existence of formal policies [29]. This enforcement gap is further compounded by institutional weaknesses, including insufficient staffing, limited technical capacity, and inadequate monitoring infrastructure. In some contexts, regulatory agencies lack the authority or resources to impose meaningful penalties on non-compliant actors, thereby reducing incentives for industries to adopt cleaner technologies or adhere to emission standards.

The case of Pakistan provides a clear illustration of these dynamics. Although national regulations exist to control air pollution, enforcement remains weak due to limited institutional capacity and ineffective monitoring systems, allowing widespread non-compliance among polluters [22]. In contrast, evidence from China demonstrates that strengthened enforcement mechanisms can yield measurable improvements in air quality. Following severe pollution episodes, the Chinese government implemented stricter monitoring, increased inspections, and enhanced accountability mechanisms for both local authorities and industrial actors [30]. These interventions resulted in observable reductions in pollution levels, highlighting the importance of enforcement capacity in translating policy into outcomes. However, such improvements remain uneven across the region. In many contexts, weak enforcement persists, and environmental regulations function more as symbolic commitments than effective instruments of change. This reinforces the argument that the existence of policy frameworks alone is insufficient; their effectiveness depends critically on the institutional capacity to enforce them.

5.3. Limited Administrative Capacity

Limited administrative capacity represents a fundamental constraint on the ability of governments to convert environmental data into effective policy action. As emphasized in the conceptual framework, capacity constraints operate as a key mediating factor that weakens the link between data availability and policy outcomes.

Across Asia, rapid economic growth and urbanization have intensified environmental pressures, while simultaneously placing significant demands on governance systems [11]. Although many countries have made progress in strengthening environmental institutions through improved regulations, increased transparency, and greater public participation, substantial gaps remain in administrative capacity, particularly in coordinating actions across multiple governance levels and sectors [11].

Effective air quality management requires substantial investment in monitoring infrastructure, technical expertise, and institutional resources. However, many countries continue to face limitations in these areas. Incomplete monitoring networks, insufficient technical expertise, and inadequate financial resources constrain the ability of governments to accurately assess pollution trends and design evidence-based interventions [30]. As a result, even when data is available, it may not be effectively interpreted or utilized in policy processes.

China provides a complex example of these challenges. Despite the development of an extensive legal and policy framework for air pollution control, including national laws, local regulations, and strategic plans such as the Five-Year Plans, implementation remains uneven [30]. Persistent issues include weak local enforcement, limited public awareness, and insufficient public participation. Addressing these challenges requires strengthening institutional capacity through clearer allocation of responsibilities, enhanced enforcement authority for local agencies, and better integration of policy instruments [30].

Overall, limited administrative capacity constrains the effectiveness of environmental governance by restricting the ability of institutions to interpret, act upon, and sustain responses to environmental data. Even where awareness of air pollution risks is high and data systems are well-developed, insufficient institutional capacity prevents the implementation of effective and lasting solutions.

6. Political and Behavioral Factors

6.1. Cost–Benefit Analysis and Policy Misalignment in India

Political and behavioral factors play a critical role in shaping how environmental data is interpreted and translated into policy outcomes. As outlined in the conceptual framework, these factors contribute to the political distortion pathway, whereby decision-making is influenced by short-term priorities, incentive structures, and incomplete evaluation of policy impacts.

The case of India illustrates how the neglect of cost–benefit analysis can undermine the effectiveness of air quality policies, even in contexts where detailed environmental data is available. This challenge is particularly significant within the broader context of developing economies, where competing priorities, such as economic growth, energy access, and environmental protection, create complex trade-offs [31–33]. As a result, policy decisions are often driven by immediate emission reduction targets, without sufficient consideration of their economic feasibility, social acceptability, or long-term sustainability.

Empirical evidence from Wazirpur, an industrial hotspot in India, demonstrates the consequences of this imbalance. The implementation of national-level policies such as the National Clean Air Programme (NCAP) and the Graded Response Action Plan (GRAP) has proven insufficiently effective at the local level, largely because these policies do not account for the specific pollution sources and spatial characteristics of the area [8]. This highlights a key limitation in policy design: the failure to integrate localized data with context-specific cost–benefit analysis.

A detailed economic assessment of potential interventions in Wazirpur reveals substantial variation in both cost and effectiveness across policy options. As shown in **Table 2**, the estimated monthly costs of interventions range from as low as $76 for operational shifts to as high as $7,010 for replacing traditional tandoors with electric alternatives [8]. **Figure 4** further illustrates these cost disparities, emphasizing the importance of evaluating policy options not only in terms of emission reduction potential but also economic efficiency.

Table 2. Estimated Monthly Cost of Air Pollution Policies in Wazipur [8].

Control Measure	Description	Estimated Monthly Cost (USD)
Mechanized Road Cleaning	Vacuum machines used to remove road dust	2,280
Odd-Even Vehicle Scheme	Road rationing allows vehicles with odd/even license plates to drive on specific days	3,952
Truck Entry Regulation	Restricting truck access to main roads around the Wazipur industrial area	1,672
Increased Stack Height	Increasing the industrial stack height by 50% to improve pollutant deposition	1,323
Cyclone Dust Collectors	Installing dust collectors in industrial stacks	1,155
Operational Shifts	Limiting industrial operations to daytime to improve pollutant dispersion	76
Electric Tandoors	Replacing wood/coal tandoors with electric ones in ~220 restaurants	7,010

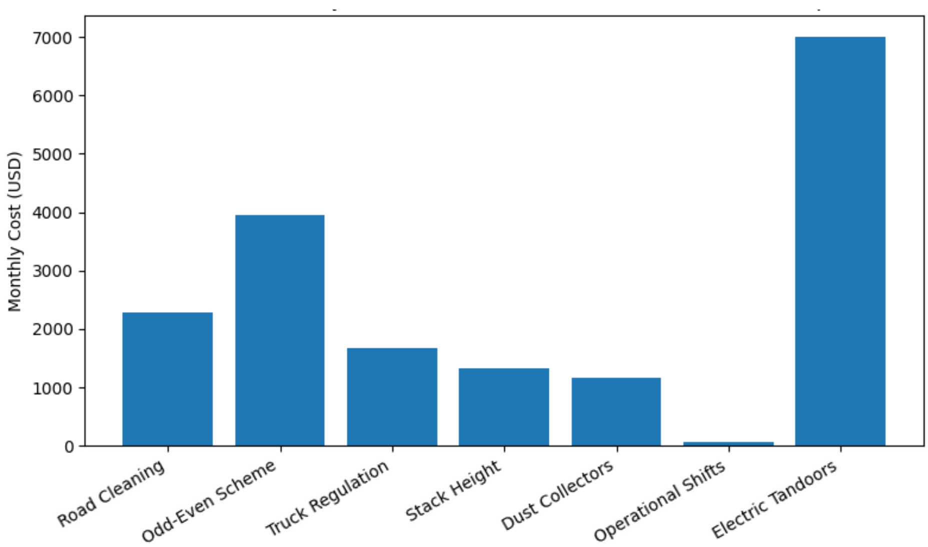

Figure 4. Estimated monthly costs (USD) of air pollution in Wazirpur [8].

However, cost alone does not determine policy effectiveness. The analysis also identifies significant variation in the contribution of different pollution sources. As presented in **Figure 5**, road dust accounts for 53% of total emissions in Wazirpur, followed by industrial activities at 28% [8]. This distribution highlights a critical misalignment in policy prioritization. Despite the availability of data clearly identifying dominant pollution sources, policies are not always designed to target these sources most efficiently.

For example, mechanized road cleaning emerges as the most effective intervention, offering a balance between cost, emission reduction, and ease of implementation. It achieves reductions in $PM_{2.5}$ levels of approximately 31% in summer and 30% in winter at a relatively moderate monthly cost of $2,280 [8]. This contrasts with higher-cost interventions that may yield lower or less consistent environmental benefits. The failure to prioritize such cost-effective measures reflects a broader issue in policy design: the insufficient integration of economic and environmental data in decision-making processes.

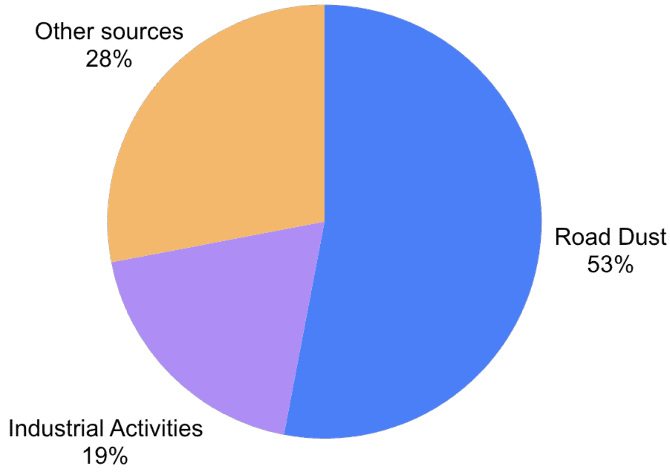

Figure 5. Major Emission Sources in Wazipur [8].

This case demonstrates that policy failure in Wazirpur is not attributable to a lack of data availability or accuracy. Rather, it reflects a behavioral and political limitation in how data is interpreted and utilized. Specifically, the absence of comprehensive cost–benefit analysis leads to suboptimal policy choices that do not align with local environmental conditions or economic realities.

More broadly, this evidence reinforces the argument that air quality management cannot rely on standardized, "one-size-fits-all" policy approaches. Effective interventions require context-specific analysis that integrates environmental data with socio-economic considerations. Without such integration, even data-rich environments may fail to produce meaningful policy outcomes.

6.2. Trust as an Important Factor for Policy Implementation

Trust represents a critical behavioral factor shaping the translation of environmental data into effective policy outcomes. As outlined in the conceptual framework, behavioral variables, particularly trust and perception, mediate how policies are received, interpreted, and ultimately implemented. In this context, trust deficits operate as a key mechanism through which the data–policy gap persists.

As noted by Monks and Williams (2020), air quality policymaking is characterized by an inherent tension between ambition and practical feasibility, where policymakers must balance environmental objectives with economic constraints, technical limitations, and societal acceptance [17]. While substantial emphasis is often placed on the technical and economic dimensions of policy design, the role of public trust is frequently underestimated, despite its decisive influence on policy effectiveness.

Empirical and policy evidence suggests that the success of environmental interventions is not determined solely by their technical robustness or scientific validity but also by the extent to which they are perceived as legitimate and trustworthy by the public. Where trust in government institutions is low, citizens may resist or fail to comply with policies, even when such policies are demonstrably beneficial in reducing pollution and improving public health [21]. This disconnect illustrates a fundamental behavioral constraint: the presence of reliable data and well-designed policies does not guarantee compliance or acceptance.

From an analytical perspective, trust influences policy outcomes through several mechanisms. First, low trust reduces voluntary compliance, increasing reliance on enforcement mechanisms, which may already be weak in many governance contexts. Second, it amplifies resistance to behavioral change, particularly when policies impose visible costs or disruptions to daily life. Third, it undermines the credibility of data itself, as citizens may question the validity or intentions behind government-reported information. These dynamics reinforce the argument that effective air quality governance requires more than technical capacity and regulatory frameworks. It also depends on the social legitimacy of institutions and the degree to which citizens trust both the data being communicated and the policies derived from it. In the absence of such trust, even well-designed, data-driven interventions may fail to achieve their intended outcomes.

6.3. Industrialization and Structural Constraints in Central and Southeast Asia

Industrialization dynamics across Central and Southeast Asia illustrate how structural economic and political conditions shape the effectiveness of air quality policies. As emphasized in the conceptual framework (Section 3), these dynamics reflect a combination of political distortion and capacity constraints, where development priorities and resource limitations mediate the translation of environmental data into policy action.

Developing countries in Asia are particularly vulnerable to environmental degradation due to their rapid economic growth, high population density, and limited financial and technological capacity. In such contexts, the consequences of delayed or ineffective environmental policies are significantly amplified. Empirical evidence from Central Asia highlights the severity of this challenge. According to the World Bank, $PM_{2.5}$ concentrations in several major cities in the region reach levels six to twelve times higher than the limits recommended by the World Bank [34]. These elevated pollution levels are largely driven by the widespread reliance on fossil fuels for heating, industrial production, and transportation, with solid fuel combustion for residential heating identified as the dominant source in urban areas [34].

A similar pattern is observed across Southeast Asia, although the relative contribution of pollution sources varies. Industrial facilities, including power plants and refineries, constitute a major source of urban air pollution and are often located in close proximity to residential areas, thereby increasing exposure risks for surrounding populations [35,36]. In addition, road traffic represents the largest contributor to urban pollution in many Southeast Asian cities, emitting a range of harmful pollutants such as nitrogen oxides (NOx), carbon monoxide (CO), and lead (Pb), all of which are associated with severe health outcomes, including respiratory and cardiovascular diseases, as well as increased mortality [35,36]. Agricultural practices, particularly land and crop burning, further contribute to pollution in specific contexts. These sectoral contributions are summarized in **Figure 6**, which illustrates the relative importance of major pollution sources across Southeast Asia. The figure highlights the complexity of pollution profiles in the region and reinforces the need for context-specific policy interventions rather than standardized approaches.

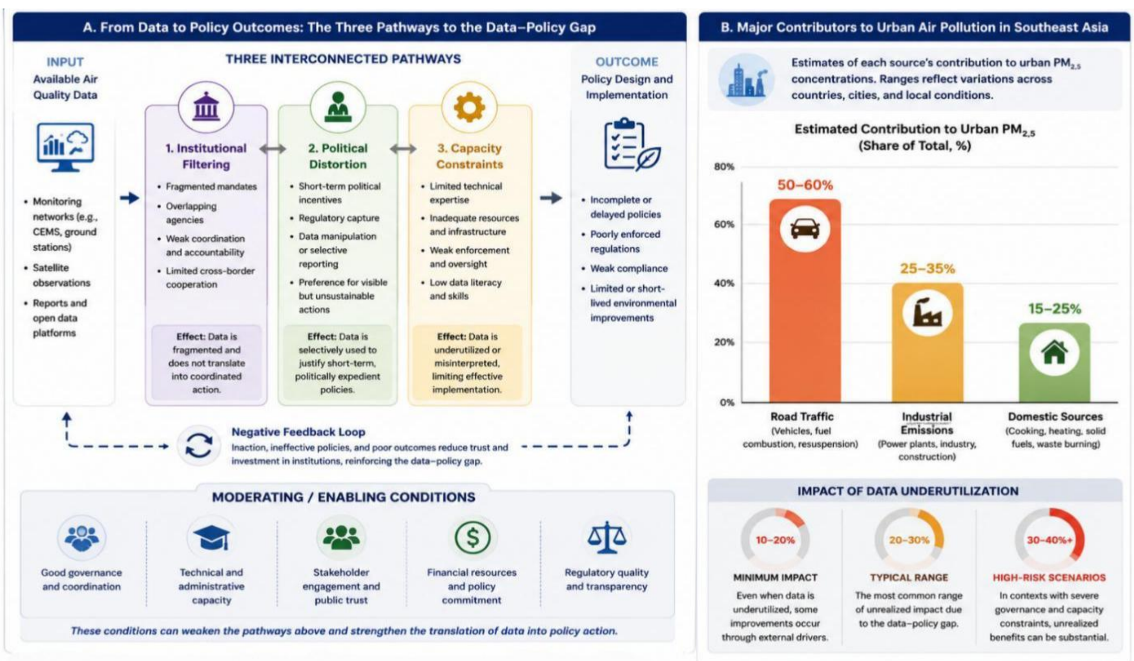

Figure 6. Comparison of the three main air pollution sources in Southeast Asia [36].

Note: The three pathways interact and are influenced by enabling conditions, shaping the effectiveness of the data–policy relationship.

From an analytical perspective, these patterns demonstrate that the persistence of high pollution levels is not due to a lack of data or awareness. Rather, it reflects structural constraints associated with industrialization pathways in developing economies. As noted by Reddy and Assenza (2009), many developing countries are "relatively new entrants" to industrialization and therefore prioritize economic growth, energy access, and poverty reduction, often at the expense of environmental sustainability. This development trajectory is characterized by high dependence on fossil fuels, which account for approximately three-quarters of global CO_2 emissions [33].

This creates a fundamental policy tension: while environmental data clearly identifies the sources and impacts of pollution, political and economic priorities limit the extent to which this data can be translated into stringent regulatory action. Governments may be reluctant to impose strict environmental regulations on key economic sectors due to concerns about growth, employment, and energy security. Consequently, policy responses tend to be delayed, diluted, or selectively enforced.

This evidence reinforces the central argument of the paper: the data–policy gap in air quality management is not primarily a technical issue, but a structural and political one. Even in contexts where pollution sources are well-documented and understood, the broader economic and institutional environment constrains the ability of governments to act decisively. Effective policy responses, therefore, require not only improved data systems but also a reconfiguration of development priorities, institutional capacity, and governance frameworks.

6.4. Oversimplification and Data Manipulation in China

The case of China provides a critical illustration of how political and behavioral factors interact to constrain the effective use of environmental data in policymaking. As outlined in the conceptual framework (Section 3), these dynamics correspond to the political distortion and behavioral bias pathways, whereby decision-making is shaped by incentive structures and selective interpretation of data rather than comprehensive, evidence-based analysis.

Empirical evidence from Lanzhou, one of the most heavily polluted industrial cities in northwest China, demonstrates the complexity of urban air pollution and the limitations of simplified policy responses [12]. Air pollution in the city is driven by multiple interacting factors, including rapid urbanization, increased vehicle emissions (NO_2 and PM_{10}), heavy industrial activity, and unfavorable geographical and meteorological conditions. The city's location within a narrow valley basin, combined with low wind speeds and temperature inversion effects, significantly limits pollutant dispersion, while natural factors such as dust storms further contribute to particulate matter concentrations [12].

Despite the availability of detailed environmental data capturing these multiple pollution sources, policy responses have often been overly simplified. The implementation of driving restriction policies, for example, represents what Huang et al. (2017) describe as a "crude" intervention, targeting only a single source of emissions while neglecting broader structural and environmental contributors [12]. Although such measures may yield short-term reductions in pollution levels, they fail to address the underlying drivers of air quality degradation and are therefore ineffective in the long term.

This oversimplification reflects deeper political dynamics within China's governance system. As noted in the literature, the country's top-down administrative structure incentivizes local officials to prioritize short-term, visible outcomes that align with centrally defined performance targets [19,37]. Under the Target Responsibility System (TRS), promotion prospects are closely tied to the achievement of measurable indicators, encouraging the adoption of policies that deliver immediate results rather than sustained environmental improvements [19]. In this context, driving restrictions represent politically attractive interventions: they are highly visible, relatively easy to implement, and capable of producing short-term gains, even if they lack long-term effectiveness.

In addition to policy oversimplification, behavioral factors, particularly the selective use or manipulation of data, further exacerbate the data–policy gap. Evidence suggests that local governments may engage in systematic misreporting or selective omission of environmental data in order to align reported outcomes with economic or political objectives [20,37]. This behavior is driven by the same incentive structures that shape policy design, as stringent environmental policies may negatively affect economic performance indicators and, consequently, the career advancement of local officials [20].

These dynamics illustrate a critical breakdown in the role of data within the policymaking process. Rather than serving as an objective basis for decision-making, environmental data becomes subject to political filtering and behavioral bias. As a result, policies are not only simplified but also, in some cases, based on incomplete or distorted information. Hence, the case of China reinforces the central argument of this study: the existence of high-quality environmental data does not guarantee effective policy outcomes. Instead, the translation of data into action is mediated by political incentives and behavioral responses that may prioritize short-term gains, institutional interests, or career advancement over long-term environmental sustainability.

6.5. Data Interpretation Challenges, Manipulation, and Capacity Constraints in India

The case of India highlights how limitations in data interpretation, institutional capacity, and data integrity collectively constrain the effective use of environmental monitoring systems in policymaking. As articulated in the conceptual framework (Section 3), these challenges reflect the interaction between capacity constraints and behavioral distortion, which together weaken the translation of data into actionable policy outcomes.

In recent years, India has introduced Continuous Emission Monitoring Systems (CEMS) as an advanced technological solution for real-time pollution tracking. More than 3,500 such systems have been deployed in high-pollution areas, generating continuous streams of emissions data intended to support regulatory enforcement and policy design [24]. In principle, these systems represent a significant advancement in environmental monitoring capacity. However, their practical impact on policymaking remains limited.

A central issue is the lack of trust in the reliability of CEMS data. For regulatory data to be admissible in legal and enforcement contexts, it must meet stringent standards of accuracy and verification. Yet, as documented by Srivastava et al. (2024), many industries fail to properly calibrate monitoring equipment, rely on low-quality calibration gases, or engage in deliberate data manipulation to conceal emissions levels. These practices undermine the credibility of the data and reduce its usability in decision-making processes [24].

In addition to concerns regarding data integrity, a critical constraint lies in the limited availability of skilled personnel capable of interpreting complex environmental datasets. Estimates suggest that only 10–20% of the required technical expertise is currently available, leaving regulatory agencies without sufficient analytical capacity to effectively utilize the data generated by CEMS [24]. As a result, despite the presence of advanced monitoring infrastructure, policymakers often avoid relying on these data systems, thereby weakening the potential for evidence-based interventions.

These barriers are summarized in **Figure 7**, which illustrates the combined impact of data reliability issues, limited technical capacity, and institutional constraints on the use of CEMS data in air quality governance. The figure highlights that technological advancement alone is insufficient; without corresponding improvements in institutional capacity and data governance, the benefits of such systems remain largely unrealized.

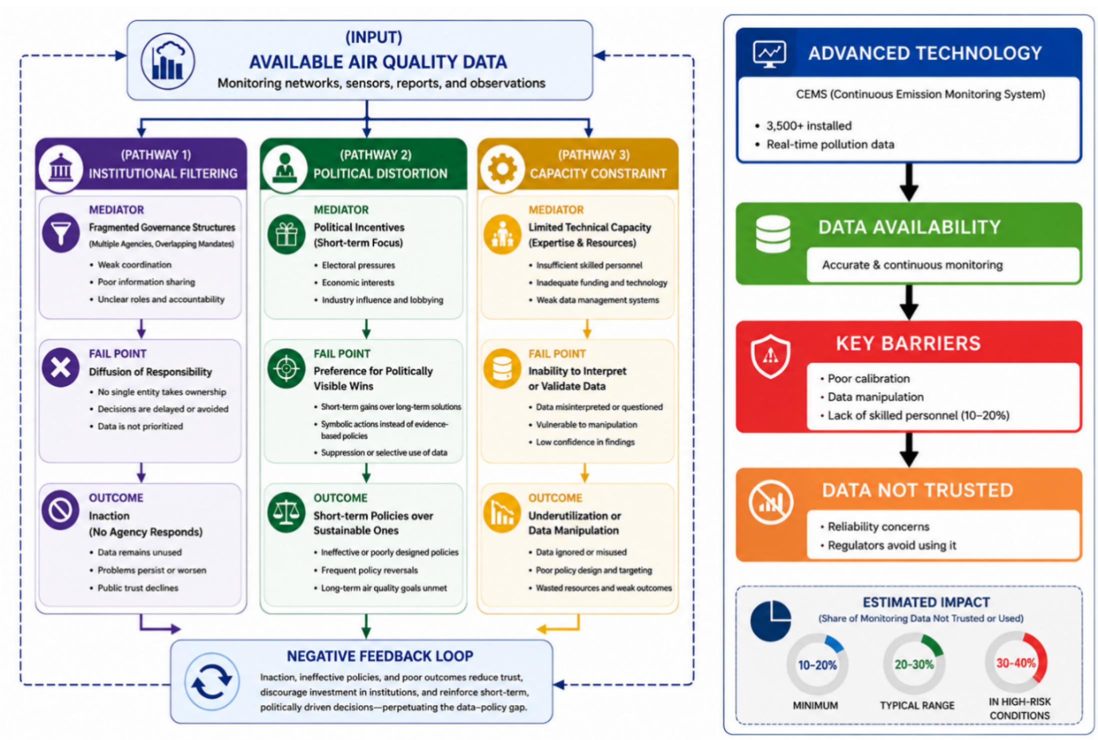

Figure 7. Barriers to using CEMS data in air quality policymaking in India [24].

These findings are consistent with broader regional evidence. Across Asia and the Pacific, many countries continue to face challenges related to insufficient monitoring infrastructure, unreliable data, and limited compliance capacity [18]. Even where monitoring systems are in place, institutional weaknesses, such as fragmented responsibilities, limited staffing, and inadequate technical expertise at the local level, significantly constrain effective implementation [18].

From an analytical perspective, this case underscores a critical dimension of the data–policy gap: the presence of advanced data systems does not guarantee their effective use. Instead, the value of environmental data depends on the integrity of data collection processes, the availability of skilled personnel to interpret it, and the institutional capacity to incorporate it into decision-making. In the absence of these conditions, data remains underutilized, and policy responses continue to fall short of their intended objectives.

7. Discussion

This study sought to explain why substantial improvements in air quality monitoring and data availability have not consistently translated into more effective environmental policymaking. By synthesizing evidence from multiple Asian contexts, the findings demonstrate that the relationship between environmental data and policy outcomes is fundamentally shaped by governance conditions rather than by data availability alone. Across diverse political and institutional settings, the evidence consistently supports the central proposition that institutional, political, and behavioral factors mediate the translation of environmental information into policy action.

Although the selected cases differ in governance systems, economic structures, and environmental challenges, they reveal remarkably similar mechanisms underlying the data–policy gap. Institutional fragmentation limits coordination among agencies and weakens accountability, political incentives often favor highly visible short-term interventions over evidence-based long-term strategies, and administrative capacity constraints restrict the interpretation, validation, and implementation of available environmental information. These mechanisms do not operate independently; rather, they reinforce one another and collectively reduce the effectiveness of environmental governance.

The case studies illustrate these mechanisms in different ways. Pakistan and the broader South Asian context demonstrate how fragmented governance structures and weak regional coordination impede collective responses to shared environmental problems. China's experience highlights the influence of political incentives and performance-based governance systems that encourage simplified policy interventions and, in some cases, selective reporting or manipulation of environmental data. India illustrates that technological advancement, including the widespread deployment of Continuous Emission Monitoring Systems (CEMS), cannot compensate for insufficient institutional capacity, limited technical expertise, and concerns regarding data reliability. Across Central and Southeast Asia, structural economic priorities further constrain governments' willingness to implement stringent environmental policies despite the availability of compelling scientific evidence.

The findings also demonstrate that behavioral factors constitute an important but frequently overlooked dimension of environmental governance. Public trust, policy legitimacy, and socioeconomic acceptability influence whether scientific evidence is translated into meaningful policy implementation. The evidence suggests that technically robust policies alone are unlikely to achieve sustained environmental improvements unless they are supported by credible institutions, transparent governance, and public confidence.

The principal theoretical contribution of this study lies in developing an integrated explanation of the data–policy gap. Previous studies have generally examined institutional barriers, political incentives, or behavioral influences separately. In contrast, the proposed framework synthesizes these perspectives into a unified analytical model that conceptualizes the data–policy gap through three interconnected causal pathways: institutional filtering, political distortion, and capacity constraints. By incorporating dynamic interactions, reinforcing feedback mechanisms, and governance enablers, the framework extends existing environmental governance literature beyond descriptive accounts of policy failure and provides a coherent explanation of how multiple governance processes jointly influence environmental decision-making.

The framework also provides a foundation for empirical research. The five propositions advanced in this study translate the conceptual model into testable relationships that can be examined through quantitative analyses, comparative case studies, expert interviews, governance indicators, or mixed-methods research. Future empirical validation will help assess the relative importance of the proposed pathways and determine how their interactions vary across different governance contexts.

Overall, the findings suggest that improving environmental governance requires a shift in policy priorities. Investments in monitoring technologies should be accompanied by comparable investments in institutional coordination, administrative capacity, regulatory integrity, and stakeholder trust. Without strengthening these governance conditions, advances in environmental monitoring are unlikely to produce proportional improvements in policy implementation or environmental quality. Consequently, narrowing the data–policy gap requires not only better information systems but also governance systems capable of transforming scientific evidence into effective and sustained public policy.

8. Policy Implications

8.1. Reorienting Governance around Public Health Goals

Current air quality management systems often treat data collection as an end in itself. Governments invest heavily in monitoring stations, sensors, and data platforms with the implicit assumption that increased information availability will automatically lead to improved policy decisions. However, as demonstrated across multiple case studies in this paper, greater data availability does not necessarily translate into more effective policymaking.

Policymakers should therefore reorient governance frameworks toward measurable public health outcomes, such as reductions in premature mortality or respiratory disease incidence, rather than focusing solely on pollutant concentrations [38]. This shift would align institutional incentives across sectors and establish accountability for outcomes rather than data production. In doing so, it directly addresses the absence of a unifying policy objective identified as a key barrier in environmental governance systems [16].

8.2. Strengthening Institutional Coordination

Fragmented governance emerged as a consistent barrier to effective policymaking across all case studies. To address institutional filtering effects, this study proposes three reforms. First, governments should establish integrated air-and-health data platforms that combine pollution monitoring with health outcome data, thereby making the human costs of inaction more visible. Second, policymakers should adopt airshed-based governance approaches that coordinate action across jurisdictional boundaries. As noted by the World Bank (2021), pollution sources often span multiple administrative regions, requiring coordinated policy responses. Third, clear accountability mechanisms must be defined to identify which institutions are responsible for enforcement when pollution thresholds are exceeded. This directly addresses the accountability gaps observed in fragmented governance systems, such as Pakistan [22].

8.3. Building Administrative Capacity

Investments in monitoring technologies must be complemented by parallel investments in human and institutional capacity. The case of India's Continuous Emission Monitoring Systems (CEMS) demonstrates that even advanced data infrastructures remain ineffective in the absence of sufficient technical expertise to interpret, validate, and operationalize the data they generate [24]. In this context, governments should prioritize the development of specialized training programs for environmental regulators, alongside the establishment of structured career pathways to attract and retain technical expertise within regulatory institutions. In addition, the creation of dedicated data verification units is essential to detect potential manipulation and ensure the reliability and integrity of environmental data. Collectively, these measures address capacity constraints, which constitute one of the central mechanisms limiting the translation of data into effective policy action, as identified in the conceptual framework [18].

8.4. Incorporating Cost-Benefit Analysis

The Wazirpur case demonstrates that generalized policy solutions often fail when they do not account for local context and socioeconomic conditions [8]. In response, policymakers should institutionalize cost–benefit analysis frameworks that extend beyond a narrow focus on emission reduction metrics. Recent evidence indicates that although cost–benefit analysis is widely applied in evaluating air pollution interventions, there remains a need for more standardized and multidimensional approaches to enhance comparability and policy relevance [39]. Such frameworks should incorporate both capital and recurring costs to ensure long-term financial sustainability, while also evaluating interventions across multiple dimensions, including environmental effectiveness, economic feasibility, administrative practicality, and socioeconomic impact. Furthermore, policy prioritization should be guided by the relative contribution of dominant local pollution sources, rather than relying on generalized or uniform solutions. This approach directly addresses the misalignment between data availability and policy design identified in the study's findings.

8.5. Enabling Meaningful Public Participation

Public participation remains underutilized in current governance frameworks and is often treated as an afterthought. In many cases, communities are consulted only after key policy decisions have already been made [23].

To rebuild trust and improve policy effectiveness, this approach must be fundamentally restructured. First, governments must redefine expertise by recognizing communities as holders of valuable environmental knowledge, rather than passive recipients of information. Second, institutional mechanisms such as citizen panels or participatory governance platforms should be established to ensure continuous engagement. Third, low-cost sensor technologies should be reframed not only as data collection tools but as instruments of community empowerment, enabling citizens to generate and use evidence in policy advocacy [23]. These measures address behavioral constraints, particularly trust deficits, which have been shown to significantly influence policy acceptance [17].

8.6. Regional Cooperation Mechanisms

Given the transboundary nature of air pollution, regional cooperation is essential for effective policy implementation. Countries sharing environmental systems must harmonize monitoring standards and regulatory frameworks to prevent policy fragmentation.

Such coordination is necessary to ensure that pollution generated in one jurisdiction does not undermine mitigation efforts in another. However, as demonstrated in regional case studies, cooperation mechanisms must also account for political and institutional constraints to move beyond dialogue toward enforceable action [40].

9. Conclusions

This study set out to challenge the assumption that improved air quality data naturally leads to improved policy outcomes. Drawing on evidence across multiple Asian contexts, the findings demonstrate that the relationship between data and policy is neither linear nor automatic. Rather, it is mediated by a complex interplay of institutional structures, political incentives, and behavioral dynamics. The persistent gap between knowledge and action is therefore not a failure of information systems, but a failure of governance systems to effectively process, interpret, and act upon that information.

Across the cases examined, a consistent pattern emerges: even where sophisticated monitoring systems exist and data are readily available, policy responses remain fragmented, short-term, or insufficient. This disconnect reflects deeper structural constraints, including fragmented governance arrangements, weak enforcement mechanisms, limited administrative capacity, and misaligned political incentives. In such contexts, data does not function as a neutral input into decision-making, but rather as a resource that is filtered, selectively used, or even disregarded depending on institutional priorities and political considerations.

The analysis further underscores that effective air quality management requires a fundamental shift in focus—from the production of data to the conditions under which data is translated into action. Strengthening the decision-making ecosystem is therefore critical. This includes enhancing institutional coordination, building technical and administrative capacity, aligning incentives with long-term public health objectives, and fostering trust and engagement between governments and citizens. Without these enabling conditions, even the most advanced data systems will remain underutilized and incapable of driving meaningful environmental improvements.

The framework developed in this study provides a foundation for future empirical investigation of the data–policy gap. Future research could test the proposed propositions through cross-country comparative studies, stakeholder interviews, surveys of policymakers and regulators, and the incorporation of governance indicators measuring institutional capacity, policy implementation effectiveness, and public trust. Such approaches would strengthen the empirical validity of the framework and improve understanding of the mechanisms linking environmental data to policy outcomes.

Ultimately, this study highlights that bridging the gap between knowledge and action is not a technical challenge, but a governance challenge. Data can illuminate problems and inform potential solutions, but it cannot compel action. Effective policymaking depends on the ability of institutions to integrate evidence into decision processes, the willingness of political systems to prioritize long-term societal outcomes, and the capacity of governance structures to translate information into sustained and coordinated action. Addressing these dimensions is essential for achieving meaningful progress in air quality management, both in Asia and in other regions facing similar challenges.

Limitations and Future Research

This study is subject to several limitations that point to important directions for future research. First, the analysis adopts a qualitative and case-based approach, which allows for in-depth exploration of patterns but does not quantify the relative influence of institutional, political, and behavioral factors. Future research could develop quantitative or mixed-method frameworks to measure the relative weight of these mediating variables and assess their interaction effects.

Second, the study focuses primarily on instances of policy failure. While this approach is useful for identifying systemic barriers, it provides limited insight into the conditions under which data is successfully translated into effective policy. Comparative research examining successful cases could help identify best practices and transferable governance models.

Third, the dynamics of regional cooperation remain underexplored. Given the transboundary nature of air pollution, further research is needed to understand how political, institutional, and economic conditions influence the transition from voluntary coordination to more binding and effective regional frameworks.

Future work may also explore the role of emerging technologies, data governance frameworks, and institutional innovations in strengthening the data–policy interface. In particular, there is a need to better understand how governance systems can be redesigned to not only generate knowledge but also ensure its consistent and effective use in policymaking.

Author Contributions

Conceptualization, N.Z.T. and R.I.; methodology, N.Z.T., G.A., N.S., and R.I.; literature search and data collection, N.Z.T., G.A., and N.S.; conceptual framework development, N.Z.T. and R.I.; data analysis and interpretation, N.Z.T., G.A., N.S., and R.I.; visualization and figures, N.Z.T., G.A., and N.S.; writing—original draft preparation, N.Z.T.; writing—review and editing, R.I.; supervision, R.I.; project administration, R.I. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The data supporting the findings of this study are available within the article and its referenced sources. As this research is based on a qualitative synthesis of published literature and publicly available reports, no new datasets were generated. All sources used in the analysis are cited in the reference list and may be accessed through the respective publishers, databases, or institutional repositories, subject to their access policies.

Conflicts of Interest

The authors declare no conflict of interest.

AI Use Statement

No generative AI tools were used for content generation or data analysis. AI (Grammarly) was employed solely for language editing and proofreading support. Canva was also used to generate visuals based on authors' conceptual input. The authors subsequently reviewed and edited the content as necessary and take full responsibility for the final content of the published article.

Abbreviations

Abbreviations	Full Term
ASEAN	Association of Southeast Asian Nations
CEMS	Continuous Emission Monitoring Systems
CO	Carbon Monoxide
CO_2	Carbon Dioxide
GRAP	Graded Response Action Plan
IMF	International Monetary Fund
INAF	International Affairs
LPG	Liquefied Petroleum Gas
NCAP	National Clean Air Program
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
O_3	Ozone
OECD	Organization for Economic Co-operation and Development
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PM	Particulate Matter
PM_{10}	Coarse Particulate Matter (≤10 μm)
$PM_{2.5}$	Fine Particulate Matter (≤2.5 μm)
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SO_2	Sulfur Dioxide
TRS	Target Responsibility System
UNEP	United Nations Environment Program
WHO	World Health Organization

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