A Transdisciplinary Framework for Evidence-Based Governance

Jasmine E. Rios
jrios@umich.edu
Gerald R. Ford School of Public Policy, University of Michigan, Ann Arbor, USA

Caleb N. Whitaker
cwhitaker@berkeley.edu
School of Information, University of California, Berkeley, USA

Priya S. Nanduri
pnanduri@cmu.edu
Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, USA

Marcus L. Hargrove
mhargrove@utexas.edu
Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, USA

Abstract

Evidence-based governance has become a pervasive aspiration across public administration, regulatory policy, and socio-technical oversight, yet its operational meaning remains fragmented across disciplines and implementation contexts. This paper develops a transdisciplinary framework for evidence-based governance that treats evidence not as a static input to decision-making but as a continuously managed socio-technical infrastructure. Drawing on systems engineering, public policy, science and technology studies, organizational theory, and responsible artificial intelligence, we conceptualize evidence production and use as an end-to-end lifecycle spanning problem framing, data generation, model construction, evaluation, deployment, and iterative revision under conditions of uncertainty, contestation, and asymmetric power. The proposed framework foregrounds structural trade-offs among legitimacy and efficiency, robustness and adaptability, transparency and privacy, fairness and feasibility, and central coordination and local autonomy. We argue that evidence-based governance requires architectural commitments—standards, institutions, accountability mechanisms, and participatory channels—that stabilize epistemic quality while remaining resilient to shifting objectives, adversarial behavior, and distributional impacts. We elaborate design principles for evidence infrastructures, discuss governance patterns for complex systems, and offer case illustrations from public health, climate risk governance, algorithmic regulation, and urban service delivery. The paper concludes with an agenda for sustainable evidence ecosystems that integrate continuous evaluation, democratic contestability, and operational robustness, enabling governance systems to learn while preserving public trust.

Keywords：

evidence-based policy; governance architecture; socio-technical systems; public sector analytics; algorithmic accountability; robustness; fairness; legitimacy; infrastructure; transdisciplinarity

1. Introduction

Evidence-based governance is often invoked as a corrective to politicized decision-making, institutional inertia, and crisis-driven improvisation. It promises a more rational public sphere in which decisions are grounded in credible data, evaluated interventions, and systematic learning. Yet the practical experience of governments suggests that "using evidence" is neither straightforward nor inherently depoliticizing. Evidence itself is produced within institutions, shaped by incentives, and constrained by measurement regimes. It is interpreted through professional paradigms, contested by stakeholders, and frequently repurposed for symbolic legitimacy rather than instrumental improvement. These realities are not failures of implementation alone; they reflect deeper structural tensions between the epistemic ideals of science and the normative, distributive, and coercive features of governance.

In contemporary governance environments, the challenge is amplified by large-scale socio-technical infrastructures. Governments rely on data platforms, digital identity systems, surveillance and compliance tools, procurement marketplaces, and algorithmic decision-support systems that mediate service delivery at scale. In these settings, evidence is not merely a report consulted before action. It becomes embedded in operational pipelines, automated classifications, resource allocation routines, and performance metrics. This embedding changes the ontology of evidence: it becomes infrastructural, continuously executed, and consequential in real time. When evidence becomes operational, its errors and biases become operational as well, affecting citizens through allocation, enforcement, and access. The governance question shifts from "Did decision-makers consult evidence?" to "How is evidence produced, validated, governed, updated, and contested across its lifecycle as part of a functioning system?"

This paper advances a transdisciplinary framework for evidence-based governance designed for complex, large-scale systems. The framework integrates insights from public policy scholarship on evidence use, institutional analysis of governance, systems engineering approaches to reliability and lifecycle management, and socio-technical perspectives emphasizing legitimacy, power, and contestability. We treat evidence-based governance as an architectural problem: the design of institutions, standards, workflows, accountability channels, and technical infrastructures that enable high-quality evidence to be generated and used responsibly under uncertainty. Rather than presuming that more data yields better decisions, we examine how evidence infrastructures can be made robust to adversarial dynamics, distributional harms, and shifting societal objectives.

The framework is motivated by recurring implementation pathologies. First, many evidence initiatives focus on analytics capacity while neglecting problem framing, which determines what counts as success and whose outcomes matter. Second, evidence is often produced as one-off evaluations, without mechanisms for continuous monitoring, model updating, and adaptation to changing conditions. Third, evidence infrastructures frequently privilege what is measurable over what is important, creating governance distortions such as target fixation and gaming. Fourth, algorithmic tools intensify these problems by embedding measurement and prediction into operational decisions while obscuring contestability and accountability. Finally, evidence-based reforms sometimes erode legitimacy when they appear technocratic, exclude affected communities, or fail to address fairness.

To respond to these challenges, we propose a set of conceptual building blocks. Evidence is treated as an end-to-end lifecycle; governance is treated as a multi-level institutional system; and the link between them is treated as socio-technical architecture. We focus on structural trade-offs that cannot be eliminated by better data alone and therefore must be managed through explicit design and political choice. We also emphasize sustainability: evidence ecosystems must persist across administrations, crises, and technological change. Sustainable evidence-based governance requires institutions that can learn while remaining accountable, resilient to shocks, and attentive to equity.

The remainder of the paper proceeds as follows. Section 2 situates the argument within the literature on evidence use, governance, and socio-technical systems, highlighting why a transdisciplinary synthesis is necessary. Section 3 defines evidence-based governance as an architectural undertaking and introduces the core elements of the proposed framework. Section 4 elaborates the evidence lifecycle and the infrastructural requirements for quality, traceability, and revision. Section 5 addresses governance patterns for complex systems, including multi-level coordination, legitimacy, and institutional capacity. Section 6 examines fairness and distributional impacts as central design constraints, not peripheral ethical add-ons. Section 7 develops robustness and resilience perspectives, focusing on uncertainty, adversarial behavior, and operational failure modes. Section 8 provides case illustrations across domains to show how the framework applies in practice. Section 9 proposes evaluation and accountability mechanisms suited to continuous, socio-technical evidence infrastructures. Section 10 outlines a forward-looking research and policy agenda. The conclusion synthesizes the argument and articulates practical implications.

2. Background and Motivation: Why Evidence-Based Governance Requires Transdisciplinarity

The idea that governance should be informed by evidence is not new, but its contemporary prominence reflects both opportunities and pressures. Advances in data collection, administrative digitization, remote sensing, and machine learning have expanded the feasible scope of measurement and prediction. Concurrently, fiscal constraints and public demands for accountability have increased reliance on performance management and evaluative rationales. These developments have encouraged governments to adopt evidence initiatives ranging from

randomized policy trials to predictive analytics and “what works” centers. Yet the evidence movement has also encountered persistent barriers described in classic accounts: politics and values shape decision-making; evidence is filtered through institutional routines; and learning is constrained by bounded rationality, attention scarcity, and organizational incentives.

Policy scholarship has long emphasized that evidence rarely “speaks for itself.” Theories of agenda setting and policy change highlight the role of framing, coalitions, and institutional venues in determining which knowledge becomes influential. Evidence use is often conceptualized as instrumental, conceptual, or symbolic; in practice, these modes overlap, and evidence can be mobilized to legitimize choices already made. Moreover, evidence is plural. Quantitative impact evaluations, qualitative community knowledge, legal precedent, ethical reasoning, and experiential expertise all function as evidence within governance, though they differ in epistemic status and institutional recognition. Attempts to standardize evidence can therefore create legitimacy tensions by privileging some forms of knowledge while marginalizing others.

Science and technology studies deepen this critique by examining how knowledge is co-produced with social order. From this perspective, evidence is shaped by institutional authority, boundary work between experts and publics, and the design of classification systems. Governance regimes often stabilize certain metrics and categories that then structure policy reality, shaping which populations are visible and which harms are legible. This is not merely a philosophical point; it affects how administrative data are collected, how eligibility is defined, and how policy success is measured. As a result, evidence-based governance cannot be reduced to a technical capacity-building project; it is a form of institutional design with distributional consequences.

Systems engineering and reliability perspectives introduce additional insights that are often absent from policy debates. In complex operational systems, performance depends not only on component quality but also on interactions, feedback loops, and failure cascades. Evidence infrastructures—data pipelines, models, decision rules, and monitoring systems—exhibit similar properties. They can drift over time as incentives change, as populations shift, and as systems are gamed. They can fail silently when monitoring is weak, or catastrophically when rare events stress the system. They require lifecycle management, including version control, testing, incident response, and redundancy. These operational concerns are inseparable from governance because they affect citizens through service reliability, error rates, and crisis response.

The rise of algorithmic governance makes transdisciplinarity even more necessary. Machine learning systems promise efficiency and consistency, but they also introduce new problems: opacity, bias, feedback loops, and contestability deficits. Algorithmic tools can embed historical inequities and amplify them through scale, especially when used in policing, welfare, housing, and healthcare. They can create “automation bias” in which decision-makers defer to model outputs, even when contextual judgment is needed. They can shift accountability from elected officials to contractors and technical experts, complicating

democratic oversight. These issues have motivated calls for algorithmic accountability, impact assessments, and governance frameworks that integrate fairness, transparency, and human rights.

Taken together, these literatures suggest that evidence-based governance is best understood as a socio-technical governance system rather than as a technocratic aspiration. It involves epistemic questions of credibility, operational questions of reliability, institutional questions of authority, and normative questions of justice. A framework that treats evidence as an input to policy choice, without addressing infrastructure, incentives, contestation, and lifecycle dynamics, will remain incomplete. Conversely, purely technical frameworks that focus on data and models without addressing legitimacy and distribution will fail to secure sustainable adoption. The purpose of this paper is to articulate an integrated framework that can guide both scholarly analysis and practical design.

3. Evidence-Based Governance as Socio-Technical Architecture

A transdisciplinary framework must begin with definitions that capture the complexity of practice. We define evidence-based governance as the design and operation of public decision-making and implementation systems in which claims about the world and the consequences of action are generated, validated, and revised through systematic methods, and are institutionally integrated into authoritative choices in ways that are legitimate, accountable, and equitable. This definition treats evidence as a managed process rather than a static artifact. It also centers governance, which entails coercive authority, distributive outcomes, and public accountability.

The architectural perspective emphasizes that evidence-based governance requires durable arrangements that shape how evidence is produced and used across time. These arrangements include technical infrastructures such as data standards, interoperable platforms, and monitoring systems; institutional infrastructures such as evaluation offices, audit bodies, and regulatory agencies; and civic infrastructures such as participatory forums and grievance mechanisms. Architecture matters because it stabilizes expectations and constrains behavior. Without architecture, evidence initiatives tend to become episodic: a pilot program, a report, a dashboard. With architecture, evidence becomes part of routine governance, enabling continuous learning and correction.

The proposed framework consists of three interlocking layers. The first is the evidence lifecycle layer, which covers how data and knowledge are generated, curated, analyzed, interpreted, and updated. The second is the governance layer, which covers institutions, authority structures, accountability mechanisms, and legitimacy pathways. The third is the socio-technical integration layer, which covers how evidence processes are embedded into operational systems, procurement arrangements, professional practices, and public contestation. The framework emphasizes that failures often occur at interfaces: evidence that is methodologically strong but institutionally irrelevant, governance processes that demand evidence but lack capacity to interpret it, or operational systems that embed evidence without

accountability.

A core contribution of this framework is its treatment of trade-offs as fundamental design constraints. Evidence-based governance is frequently presented as a win-win endeavor, promising both better outcomes and greater legitimacy. In practice, governance systems face trade-offs that cannot be eliminated, only managed. Transparency can conflict with privacy and security, especially in systems handling sensitive personal data. Standardization can enable comparability but can reduce local flexibility and suppress contextual knowledge. Rapid adaptation can improve responsiveness but can undermine stability and public trust if policies change too frequently. Fairness objectives can require complex constraints that reduce efficiency or accuracy in predictive systems, and different fairness notions can conflict. Political accountability can demand clear lines of responsibility that are difficult to maintain in interagency networks and contractor-driven technology ecosystems.

Treating trade-offs explicitly changes the role of evidence. Evidence does not decide trade-offs; it clarifies them, quantifies impacts where possible, and reveals uncertainty. The governance task is then to choose among trade-offs through legitimate processes, informed by evidence but accountable to values. This framing avoids both naive technocracy and cynical relativism. It affirms that evidence can improve governance, while recognizing that governance requires normative judgment.

The framework also highlights sustainability. Evidence infrastructures degrade without maintenance, and institutions lose capacity without investment. Moreover, evidence systems can be politically fragile if they are associated with a particular administration or ideology. Sustainable evidence-based governance therefore requires institutional insulation combined with democratic accountability, analogous to the design of credible fiscal institutions or independent statistical agencies. It also requires attention to workforce development, procurement governance, and data stewardship. Sustainability further requires adaptability to technological change, including the evolution of AI capabilities and the emergence of new data sources.

4. The Evidence Lifecycle: From Problem Framing to Continuous Revision

Evidence-based governance begins not with data but with problem framing. Framing determines what is being optimized, which outcomes are measured, and whose welfare is prioritized. In complex governance problems, framing is contested because it encodes values and distributional stakes. For example, framing homelessness as a service delivery problem emphasizes shelter capacity and case management, while framing it as a housing market problem emphasizes affordability and zoning. Evidence can inform framing by identifying causal pathways and documenting lived experience, but framing also shapes what evidence is collected. An evidence lifecycle must therefore include explicit processes for deliberating frames, documenting assumptions, and revisiting definitions as new information emerges.

Once a problem is framed, data generation and collection become central. Governments

increasingly rely on administrative data, which are collected for operational purposes rather than research validity. Administrative data can offer scale and timeliness, but they carry biases tied to eligibility rules, enforcement priorities, and reporting incentives. They can also embed historical inequities through differential surveillance and access. Evidence-based governance requires data stewardship that makes these limitations explicit. Stewardship includes metadata standards, provenance tracking, quality audits, and mechanisms to correct systematic missingness. It also requires attention to representativeness when administrative data are used to infer broader social conditions, as well as safeguards against privacy harms and mission creep.

Modeling and analysis constitute the next phase. In some domains, evidence takes the form of causal evaluation, estimating the effects of interventions under specified conditions. In other domains, evidence takes the form of predictive risk assessment, forecasting outcomes to guide resource allocation. Both forms require methodological rigor, but their governance implications differ. Causal evidence supports decisions about which interventions to scale, while predictive evidence supports decisions about whom to target or how to allocate scarce capacity. Predictive systems are particularly sensitive to feedback loops because predictions can influence the outcomes they predict through changes in behavior and enforcement. Evidence-based governance must therefore evaluate not only model performance on historical data but also system-level effects once the model is deployed.

Interpretation and translation are often treated as communication tasks, but they are deeper epistemic processes. Decision-makers need to understand uncertainty, external validity, and distributional heterogeneity. A result that is statistically significant in one context may be irrelevant in another due to different institutional capacities or population characteristics. Similarly, an algorithm with high average accuracy may perform poorly for specific subgroups, creating inequities. Translation therefore requires institutional roles that bridge technical analysis and policy judgment, such as chief evaluation officers, analytics translators, and interdisciplinary review boards. These roles must have credibility with both technical staff and political leadership, and they must operate within governance structures that reward learning rather than punishing transparency about uncertainty.

Deployment is where evidence becomes infrastructural. When evidence is embedded in operational systems, it becomes a component of service delivery and regulatory enforcement. Deployment introduces new risks: implementation drift, data pipeline failures, vendor lock-in, and unintended behavioral responses. It also introduces governance issues: who is accountable for errors, how citizens can contest decisions, and how updates are governed. An evidence lifecycle suitable for governance must therefore include operational controls such as versioning, change management, monitoring, and incident response. It must also include democratic controls such as transparency requirements, explainability appropriate to context, and accessible appeal mechanisms.

Continuous monitoring and revision complete the lifecycle. Evidence-based governance is often imagined as a sequence of discrete decisions, but complex systems require continuous

learning. Policies interact with evolving social conditions, and models degrade due to concept drift. Monitoring must therefore track both technical metrics and normative outcomes, including distributional impacts and legitimacy indicators. Revision processes must define thresholds for intervention, procedures for pausing or rolling back systems, and governance bodies authorized to make changes. Crucially, revision must be legitimate; constant changes can undermine trust if they are perceived as arbitrary or politically motivated. Governance architecture must balance adaptability and stability through transparent rules, stakeholder engagement, and clear accountability.

A transdisciplinary lifecycle approach also recognizes the role of plural evidence. Quantitative models can be complemented by qualitative assessments, ethnographic insights, and participatory knowledge. For example, community reports can reveal harms not captured by administrative metrics, such as dignitary harms from surveillance or the burdens of compliance. Integrating plural evidence requires institutionalized channels, not ad hoc consultations. It also requires epistemic humility: governance systems must acknowledge that what can be measured is not identical to what matters.

5. Governance Layer: Institutions, Authority, and Legitimacy in Evidence Systems

Evidence infrastructures operate within governance institutions that allocate authority and responsibility. In many jurisdictions, evidence functions are distributed across agencies, audit bodies, legislative committees, and external partners. This distribution can create coordination problems and accountability gaps, but it can also provide checks and balances. A central question for evidence-based governance is how to structure institutional arrangements so that evidence processes are credible, influential, and democratically accountable.

Institutional credibility depends on autonomy, professionalism, and transparency. Statistical agencies, inspector generals, and evaluation offices often rely on institutional designs that provide some insulation from political pressures while maintaining accountability through oversight and public reporting. Evidence-based governance can learn from these designs by establishing independent or semi-independent bodies responsible for methods, standards, and audits. However, independence is not a panacea. It can create technocratic distance and provoke political backlash if it is perceived as undermining elected authority. The challenge is to design institutions that can maintain epistemic integrity while being responsive to democratic priorities.

Authority structures must also address the reality of multi-level governance. Many governance problems span local, state, and federal levels, as well as public-private partnerships. Evidence produced at one level may not transfer easily to another due to differences in context and capacity. Moreover, data sharing across levels raises privacy, security, and sovereignty concerns. Evidence-based governance therefore requires federated architectures that support interoperability while respecting local autonomy. Federated approaches can include shared standards, common evaluation protocols, and interoperable data schemas, combined with local control over implementation and contextual adaptation.

Legitimacy is a central constraint. Evidence can enhance legitimacy when it improves outcomes and demonstrates accountability, but it can also erode legitimacy when it is used to justify unpopular decisions or when it privileges expert authority over lived experience. Legitimacy challenges are acute in domains involving coercive power, such as policing and immigration enforcement, where evidence-based tools can appear as mechanisms for more efficient control rather than for public benefit. Legitimacy also depends on procedural justice: whether affected communities have voice, whether decisions are explainable, and whether there are meaningful avenues for redress.

Participatory mechanisms are therefore not optional supplements but core elements of evidence-based governance architecture. Participation can inform problem framing, identify harms, and shape acceptable trade-offs. Yet participation must be designed carefully to avoid tokenism and capture. Effective participatory designs include clear mandates, resourcing for community engagement, transparent documentation of how input influences decisions, and protections for marginalized groups. Participation also raises epistemic questions about how to integrate different forms of knowledge, which must be addressed through deliberative processes rather than through simplistic aggregation.

Governance capacity is another critical factor. Evidence-based governance requires skilled personnel, stable funding, and organizational routines that support learning. Capacity includes technical skills in data management and evaluation, but also institutional skills in procurement, stakeholder engagement, and legal compliance. Capacity constraints can distort evidence initiatives by pushing governments toward vendor-provided solutions that promise turnkey analytics but create dependency and reduce transparency. Procurement governance is thus part of evidence-based governance, requiring contract structures that mandate auditability, data access, and accountability for harms.

Finally, governance institutions must manage incentives. Evidence can be undermined by performance management regimes that create incentives for gaming, data manipulation, or risk avoidance. When agencies are punished for negative findings, they may resist evaluation or selectively report favorable results. Evidence-based governance architectures must therefore include incentive designs that reward learning, including safe-to-fail experimentation in appropriate contexts, and that distinguish between accountable performance and blame-driven metrics. Creating such cultures is difficult, but it is essential for sustainable evidence ecosystems.

6. Fairness, Equity, and the Distributional Politics of Evidence

Fairness is often invoked in evidence debates, but evidence infrastructures can easily reproduce inequity if fairness is treated as an external ethical concern rather than as an internal design constraint. Evidence-based governance shapes who is seen, what is measured, and how resources are allocated. These processes have distributional consequences even when they appear neutral. A transdisciplinary framework must therefore treat equity as constitutive

of evidence quality and governance legitimacy.

A key issue is differential visibility. Administrative data are often richer for populations that are more heavily surveilled or more intensely engaged with public systems. This can create an illusion of precision for marginalized groups while leaving advantaged groups comparatively unmeasured. In predictive systems, such data asymmetries can lead to differential error rates, with marginalized groups experiencing more false positives or false negatives depending on the context. Evidence-based governance must therefore assess not only model accuracy but also measurement bias, including how data collection regimes reflect power and institutional priorities.

Fairness also involves normative choices about what outcomes matter. For example, in welfare administration, evidence might focus on fraud detection to reduce improper payments, but such a frame can overshadow harms from erroneous denials and administrative burden. In criminal justice, evidence might focus on predicting recidivism, but this can legitimize risk-based incapacitation while neglecting structural drivers of crime and the harms of surveillance. Evidence-based governance must therefore incorporate fairness into problem framing, ensuring that metrics reflect a balanced set of public values rather than the narrow interests of institutional actors.

In algorithmic governance, fairness has been formalized into multiple definitions that can conflict, such as equalized error rates, calibration, and demographic parity. These conflicts are not merely technical; they reflect different moral intuitions and legal constraints. Evidence-based governance must recognize that selecting a fairness criterion is a policy choice that requires legitimacy. Governance architectures can support this by requiring impact assessments, public documentation of chosen fairness objectives, and periodic review as social priorities evolve. It can also support fairness through participatory governance, enabling affected communities to influence what fairness means in context.

Equity considerations also affect sustainability. Systems that generate visible inequities tend to provoke contestation, litigation, and political backlash, undermining their durability. Conversely, systems designed with equity in mind can build trust and resilience, even if they entail some efficiency costs. This is a central trade-off: optimizing for short-term efficiency can be self-defeating if it erodes legitimacy. Evidence-based governance should therefore evaluate policies using multi-dimensional criteria that include equity, procedural justice, and social trust, not only cost-effectiveness.

A further dimension concerns administrative burden and dignity. Evidence infrastructures can create new burdens through documentation requirements, compliance checks, and automated eligibility verification. These burdens are often unevenly distributed, falling more heavily on disadvantaged populations with less capacity to navigate bureaucracy. Dignitary harms can also arise when individuals are subjected to intrusive data collection or automated suspicion. Such harms are often invisible to conventional performance metrics. A transdisciplinary framework therefore encourages the inclusion of qualitative evidence and experiential

knowledge to surface burdens and dignity impacts, integrating them into governance evaluations.

Legal and constitutional considerations intersect with fairness. Anti-discrimination law, due process requirements, and privacy protections shape what evidence practices are permissible. Yet legal compliance alone is insufficient, because many inequities are lawful but unjust, and many harms arise from lawful discretion. Evidence-based governance must thus go beyond minimal compliance, using legal constraints as baselines while adopting broader equity commitments. This requires institutions capable of normative reasoning and stakeholder engagement, not only technical optimization.

7. Robustness, Resilience, and Failure Modes in Evidence Infrastructures

Governance systems must operate under uncertainty, shocks, and strategic behavior. Evidence-based governance therefore requires robustness, understood as the capacity of a system to maintain acceptable performance under plausible perturbations, and resilience, understood as the capacity to recover and adapt after disruption. These concepts, developed in systems engineering and complex systems research, are essential for designing evidence infrastructures that can function in real governance environments.

Uncertainty is intrinsic to policy problems. Causal relationships are context-dependent, and social systems exhibit nonstationarity due to economic cycles, demographic change, and technological innovation. Evidence infrastructures that assume stability will fail through drift. For predictive models, concept drift can degrade performance as relationships between predictors and outcomes change. For evaluation evidence, external validity can fail when interventions are scaled to new contexts. Robust governance therefore requires monitoring systems that detect drift, evaluation designs that test generalizability, and institutional routines that support revision.

Shocks such as pandemics, financial crises, and natural disasters stress evidence systems. During crises, decision-makers demand rapid evidence, but data may be incomplete and models may be unreliable. Crisis contexts also involve high stakes and political pressure, increasing the risk of premature certainty and biased interpretation. Evidence-based governance architectures should therefore include crisis protocols: rapid data mobilization pathways, pre-established ethical review procedures, and mechanisms for communicating uncertainty transparently. They should also include redundancy, such as multiple independent data sources and analytic teams, to reduce single points of failure.

Adversarial behavior is another failure mode. When evidence is used for allocation or enforcement, actors may game metrics, manipulate data, or change behavior strategically. Performance management literature documents how targets can distort behavior, and similar dynamics appear in algorithmic systems where individuals and institutions adapt to model-based decisions. Robust evidence governance therefore requires adversarial thinking, including stress testing of metrics, audits for manipulation, and designs that reduce incentives

for gaming. It also requires accountability mechanisms that can detect and sanction malfeasance without discouraging legitimate adaptation.

Operational failures can also arise from technical and organizational issues: data pipeline breaks, mismatched definitions across agencies, model deployment errors, and misinterpretation by frontline staff. These failures often occur at interfaces between systems and institutions. Reliability engineering suggests that robust systems require clear specifications, testing regimes, incident reporting, and learning from near misses. Translating these insights to governance implies that evidence infrastructures should adopt practices such as documentation, version control, access logging, and structured incident response. However, these practices must be adapted to public sector contexts where transparency, rights, and democratic oversight are paramount.

Robustness also has a normative dimension. A system can be robust in achieving its operational goals while being harmful or unjust. For example, a highly reliable fraud detection system can robustly deny benefits, even if it produces inequitable burdens. Evidence-based governance must therefore define robustness relative to multi-dimensional objectives that include equity and legitimacy. This requires governance bodies that can adjudicate trade-offs and revise objectives as societal values evolve.

Finally, resilience requires learning mechanisms. Systems that can adapt after failure must have feedback loops, not only technical monitoring but also civic feedback through complaints, appeals, and public scrutiny. Appeals and grievance mechanisms serve as sensors for harms that metrics miss. Independent audits and investigative journalism can also function as resilience mechanisms by surfacing failure modes. Evidence-based governance should therefore treat contestability as a feature, not a bug, designing systems that can absorb critique and improve rather than defensively denying problems.

8. Case Illustrations and Cross-Domain Comparisons

The value of a transdisciplinary framework is its capacity to illuminate diverse governance contexts while identifying common structural patterns. This section offers illustrative applications in public health, climate risk governance, algorithmic regulation, and urban service delivery. The aim is not exhaustive empirical analysis but conceptual demonstration of how the framework guides design and diagnosis.

In public health, evidence-based governance is often associated with clinical research and epidemiological modeling, yet governance challenges arise in translating evidence into policy under uncertainty and political contestation. During infectious disease outbreaks, models guide decisions about non-pharmaceutical interventions, vaccination strategies, and resource allocation. However, models depend on data quality, behavioral assumptions, and evolving pathogen dynamics. Evidence-based governance in this domain requires infrastructures for rapid data integration across hospitals, laboratories, and public agencies, coupled with transparent communication about uncertainty. It also requires legitimacy mechanisms to

manage trade-offs between public health benefits and civil liberties. Participatory engagement can be difficult in crisis settings, but legitimacy can be supported through transparent criteria, consistent decision rules, and robust accountability for errors.

Climate risk governance presents a different evidence structure. Evidence involves long-term projections, deep uncertainty, and irreversible harms. Traditional evidence paradigms focused on statistical certainty are ill-suited to contexts where delaying action can be catastrophic. Evidence-based governance here requires decision frameworks that can act under uncertainty, using scenario planning, robustness analysis, and adaptive management. Infrastructure includes climate data platforms, risk mapping, and standards for disclosure and resilience planning. Governance challenges include distributional impacts, as adaptation investments and climate harms are unevenly distributed. Legitimacy requires inclusive processes that consider environmental justice, recognizing that technical risk assessments can obscure lived vulnerabilities.

Algorithmic regulation illustrates evidence becoming operational infrastructure. Regulatory agencies increasingly use data analytics to target inspections, detect fraud, and monitor compliance. Evidence-based targeting can improve efficiency, but it can also concentrate enforcement on already monitored populations, reinforcing inequalities. Moreover, when agencies rely on vendor-built models, transparency and accountability can be compromised. Evidence governance in this domain requires procurement rules mandating auditability, documentation, and access to model logic. It requires impact assessments that evaluate not only accuracy but also distributional outcomes and error burdens. It also requires due process protections, including explanations and appeals for individuals affected by automated or semi-automated decisions.

Urban service delivery offers examples where evidence systems intersect with frontline practice. Cities deploy data platforms for 311 complaints, predictive maintenance, and resource allocation for sanitation, street repairs, and emergency response. Evidence-based prioritization can improve responsiveness, but it can also privilege neighborhoods with higher reporting capacity, producing inequitable service distribution. Evidence governance thus requires mechanisms to correct for reporting bias, such as proactive sensing combined with equity weighting and community engagement. It also requires attention to operational constraints, including workforce capacity and infrastructural interdependencies. Continuous monitoring and revision are crucial because urban systems evolve rapidly and are sensitive to feedback loops, such as how service improvements affect reporting behavior.

Across these domains, common patterns emerge. Problem framing shapes what is measured and which harms are visible. Data infrastructures reflect power and institutional priorities. Deployment embeds evidence into operational routines, creating new accountability challenges. Equity and legitimacy are central constraints, not optional considerations. Robustness requires monitoring, stress testing, and adaptive capacity. These patterns support the argument that evidence-based governance is fundamentally an architectural undertaking requiring integrated technical and institutional design.

9. Evaluation, Accountability, and Public Contestability

A transdisciplinary framework must specify how evidence-based governance can be evaluated and held accountable. Traditional evaluation approaches often focus on program outcomes, such as cost-effectiveness or impact estimates. While important, these approaches are insufficient when evidence systems themselves become infrastructures shaping ongoing decisions. Accountability must therefore address both the outcomes of policies and the properties of evidence infrastructures: their transparency, fairness, robustness, and legitimacy.

Evaluation should be continuous and multi-layered. At the technical layer, data quality and model performance must be monitored, including subgroup performance and drift detection. At the operational layer, implementation fidelity, workload impacts, and error correction processes must be assessed. At the governance layer, transparency, accountability, and procedural justice must be evaluated through audits, stakeholder feedback, and legal compliance reviews. These layers interact: a technically accurate model can be operationally harmful if it increases administrative burden or if staff interpret it incorrectly. Conversely, strong procedural safeguards can mitigate harms even when evidence is imperfect.

Accountability mechanisms should match the risk profile of evidence applications. High-stakes decisions affecting rights, liberty, or essential benefits warrant stronger safeguards: independent review, pre-deployment impact assessments, public documentation, and meaningful appeals. Lower-stakes decisions may allow lighter governance while still requiring basic transparency and monitoring. Risk-based governance aligns with emerging approaches in responsible AI and regulation, but it must be adapted to public sector contexts where power asymmetries and vulnerability are salient.

Public contestability is essential for legitimacy and learning. Evidence systems should be designed so that affected individuals and communities can understand and challenge decisions. Contestability requires more than technical explainability; it requires accessible communication, procedural avenues for appeal, and institutional willingness to revise systems when harms are identified. Contestability also interacts with transparency and security. Full disclosure of models can enable gaming, but secrecy can enable abuse. Governance must therefore navigate this trade-off by disclosing information sufficient for accountability while protecting system integrity, potentially through mechanisms such as independent auditors with privileged access.

Auditing plays a central role. Audits can evaluate data provenance, model logic, performance disparities, and compliance with stated objectives. In public governance, audits must also assess procurement arrangements, contractor accountability, and institutional conflicts of interest. Effective auditing requires standards and capacity. Without standards, audits become inconsistent; without capacity, they become symbolic. Evidence-based governance architectures should therefore invest in audit institutions and develop shared protocols.

Finally, accountability requires clear responsibility allocation. In complex interagency systems and public-private partnerships, responsibility can become diffuse, enabling blame shifting. Governance architectures should define roles and responsibilities across the evidence lifecycle, including who owns data stewardship, who authorizes deployment, who monitors impacts, and who can pause or retire systems. Clear responsibility supports both democratic accountability and operational effectiveness.

10. Future Directions: Toward Sustainable Evidence Ecosystems

The future of evidence-based governance will be shaped by technological change, evolving public expectations, and the increasing complexity of governance challenges. A forward-looking agenda must address both opportunities and risks.

First, evidence infrastructures must evolve toward interoperability and federated learning across jurisdictions while respecting privacy and sovereignty. Cross-jurisdictional challenges such as pandemics, migration, and climate risk require shared data standards and collaborative analytics. Yet centralized data aggregation can be politically and ethically problematic. Federated approaches, privacy-preserving computation, and standardized metadata can support collaboration without excessive centralization, though they require significant institutional investment.

Second, evidence governance must adapt to generative AI and advanced decision-support systems. These tools can assist in policy analysis, summarization, and scenario exploration, but they can also introduce new risks of hallucinated evidence, opaque reasoning, and automation of persuasive narratives. Governance systems will need standards for provenance, verification, and responsible use, ensuring that generative tools augment rather than replace accountable reasoning. This will also require workforce development so that public servants can critically evaluate AI outputs.

Third, legitimacy challenges will intensify as evidence systems become more embedded in everyday governance. Citizens may experience evidence-based systems through automated eligibility checks, targeted enforcement, and personalized service delivery. Trust will depend on procedural fairness, transparency, and the perceived alignment of systems with public values. Evidence-based governance must therefore invest in civic infrastructure: participatory mechanisms, transparency portals, and accessible appeal systems. These investments are not peripheral; they are necessary for sustainability.

Fourth, the evidence movement must broaden its epistemic commitments beyond narrow hierarchies of evidence. While rigorous causal inference remains essential, complex governance often requires integrating diverse forms of knowledge, including qualitative insights and community expertise. Transdisciplinary evidence ecosystems should develop methods and institutions for integrating plural evidence while maintaining standards of credibility. This may involve deliberative review processes, mixed-method evaluation norms, and institutional roles that bridge epistemic communities.

Fifth, sustainability requires attention to political economy. Evidence infrastructures can be undermined by privatization of data and analytics, vendor lock-in, and fragmented procurement. Public sector evidence capacity should therefore be treated as strategic infrastructure, analogous to transportation or cybersecurity. This implies stable funding, career pathways for technical talent, and procurement reforms that prioritize transparency and accountability. It also implies that governments should develop internal capacity to evaluate and govern vendor systems, rather than outsourcing core epistemic functions.

Finally, research must focus on the empirical study of evidence architectures. Much scholarship examines evidence use at the level of individual decision-makers or discrete programs. There is a need for research on institutional design patterns, failure modes, and comparative governance models for evidence infrastructures. Such research should be action-oriented, integrating insights from engineering, policy, and social science to guide practical reforms.

Conclusion

Evidence-based governance is best understood not as a slogan or a commitment to consult research, but as the design and operation of socio-technical architectures that generate, validate, and revise knowledge claims in ways that are operationally effective, democratically legitimate, and distributively just. In large-scale governance systems, evidence becomes infrastructural: embedded in data pipelines, analytic models, performance regimes, and automated decision processes. This embedding increases the stakes of evidence quality and shifts attention from episodic evidence use to continuous lifecycle management.

The transdisciplinary framework developed in this paper integrates an evidence lifecycle perspective, a governance institutional perspective, and a socio-technical integration perspective. It emphasizes structural trade-offs—between transparency and privacy, robustness and adaptability, standardization and contextual sensitivity, efficiency and equity—that must be managed through explicit design and legitimate choice rather than assumed away. It also highlights that fairness and legitimacy are not external ethical considerations but internal constraints shaping sustainability. Systems that ignore distributional impacts and contestability will provoke resistance and fail to endure.

The framework implies concrete design commitments. Evidence infrastructures require data stewardship, provenance tracking, monitoring, and revision mechanisms. Governance institutions require capacity, independent auditing, clear accountability, and participatory channels. Integration requires procurement governance, professional translation roles, and operational controls for reliability and incident response. Across domains—from public health to climate governance, algorithmic regulation, and urban services—these commitments support resilient learning while respecting rights and public values.

Ultimately, evidence-based governance is a learning project under democratic constraint. The

challenge is not to remove politics from governance but to build institutions and infrastructures that can learn responsibly, acknowledge uncertainty, correct errors, and justify trade-offs in ways that sustain public trust. A transdisciplinary approach is necessary because the problem is not purely technical, purely institutional, or purely normative. It is all of these at once, and only integrated architectures can make evidence-based governance more than aspiration.

References

1. Barocas, S., Hardt, M., & Narayanan, A. (2019). Fairness and machine learning: Limitations and opportunities. fairmlbook.org.

2. Boyd, D., & Crawford, K. (2012). Critical questions for big data. Information, Communication & Society, 15(5), 662–679.

3. Cartwright, N., & Hardie, J. (2012). Evidence-based policy: A practical guide to doing it better. Oxford University Press.

4. Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., Jäger, J., & Mitchell, R. B. (2003). Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences, 100(14), 8086–8091.

5. Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. Administrative Science Quarterly, 17(1), 1–25.

6. Donabedian, A. (1988). The quality of care: How can it be assessed? JAMA, 260(12), 1743–1748.

7. Dourish, P. (2016). Algorithms and their others: Algorithmic culture in context. Big Data & Society, 3(2), 1–11.

8. Eubanks, V. (2018). Automating inequality: How high-tech tools profile, police, and punish the poor. St. Martin’s Press.

9. Fischer, F. (2003). Reframing public policy: Discursive politics and deliberative practices. Oxford University Press.

10. Gelman, A., & Loken, E. (2014). The statistical crisis in science. American Scientist, 102(6), 460–465.

11. Gebru, T., Morgenstern, J., Vecchione, B., Vaughan, J. W., Wallach, H., Daumé III, H., & Crawford, K. (2021). Datasheets for datasets. Communications of the ACM, 64(12), 86–92.

12. Giddens, A. (1990). The consequences of modernity. Stanford University Press.

13. Head, B. W. (2016). Toward more “evidence-informed” policy making? Public Administration Review, 76(3), 472–484.

14. Howlett, M., & Ramesh, M. (2003). Studying public policy: Policy cycles and policy subsystems (2nd ed.). Oxford University Press.

15. Jasanoff, S. (2004). States of knowledge: The co-production of science and social order. Routledge.

16. Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.

17. Kingdon, J. W. (1995). Agendas, alternatives, and public policies (2nd ed.). HarperCollins.

18. Kroll, J. A., Huey, J., Barocas, S., Felten, E. W., Reidenberg, J. R., Robinson, D. G., & Yu, H. (2017). Accountable algorithms. University of Pennsylvania Law Review, 165(3), 633–705.

19. Lipsky, M. (1980). Street-level bureaucracy: Dilemmas of the individual in public services. Russell Sage Foundation.

20. Merton, R. K. (1973). The sociology of science: Theoretical and empirical investigations. University of Chicago Press.

21. Mitchell, M., Wu, S., Zaldivar, A., Barnes, P., Vasserman, L., Hutchinson, B., Spitzer, E., Raji, I. D., & Gebru, T. (2019). Model cards for model reporting. In Proceedings of the Conference on Fairness, Accountability, and Transparency (FAT*) (pp. 220–229). ACM.

22. National Research Council. (2014). Proposed revisions to the common rule for the protection of human subjects in the behavioral and social sciences. The National Academies Press.

23. Nutley, S. M., Walter, I., & Davies, H. T. O. (2007). Using evidence: How research can inform public services. Policy Press.

24. O’Neil, C. (2016). Weapons of math destruction: How big data increases inequality and threatens democracy. Crown.

25. Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective action. Cambridge University Press.

26. Parkhurst, J. (2017). The politics of evidence: From evidence-based policy to the good governance of evidence. Routledge.

27. Pawson, R., & Tilley, N. (1997). Realistic evaluation. Sage.

28. Popper, K. (1959). The logic of scientific discovery. Hutchinson.

29. Raji, I. D., Smart, A., White, R. N., Mitchell, M., Gebru, T., Hutchinson, B., Smith-Loud, J., Theron, D., & Barnes, P. (2020). Closing the AI accountability gap: Defining an end-to-end framework for internal algorithmic auditing. In Proceedings of the Conference on Fairness, Accountability, and Transparency (FAT*) (pp. 33–44). ACM.

30. Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. Policy Sciences, 4(2), 155–169.

31. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.

32. Saltelli, A., & Giampietro, M. (2017). What is wrong with evidence-based policy, and how can it be improved? Futures, 91, 62–71.

33. Simon, H. A. (1957). Administrative behavior (2nd ed.). Macmillan.

34. Sabatier, P. A., & Jenkins-Smith, H. C. (1993). Policy change and learning: An advocacy coalition approach. Westview Press.

35. Weiss, C. H. (1979). The many meanings of research utilization. Public Administration Review, 39(5), 426–431.

36. Wildavsky, A. (1979). Speaking truth to power: The art and craft of policy analysis. Little, Brown.

37. Wynne, B. (1992). Uncertainty and environmental learning: Reconceiving science and policy in the preventive paradigm. Global Environmental Change, 2(2), 111–127.