

Governance under Algorithmic Conditions: Institutional Equilibria in the Public Sector

Mgr. BSc. Thi Ngoc Quynh Huynh, MBA, DBA

Trichester Consultancy, Kuala Lumpur, Malaysia, quynh.huynh@fves.eu,
<https://orcid.org/0000-0002-6772-7621>

Abstract

The integration of algorithmic decisions and spatially differentiated data analyses is changing governance in the public sector. This article conceptualises this development not as a technological implementation issue, but as a process of institutional transformation in which governance robustness is renegotiated through hybrid arrangements between human judgement and algorithmic evidence. Drawing on a systematic interdisciplinary literature review and a comparative qualitative analysis of urban governance contexts, the study reconstructs three institutional equilibria of algorithmic governance: formalised integration, normatively mediated integration, and experimental integration. The findings show that governance quality depends less on the degree of automation than on institutional capacities to reflexively evaluate, contextualise, and govern algorithmic evidence. At the same time, spatially differentiated evidence systems sharpen political prioritisation while also risking territorial inequalities. The article develops an institutional-epistemic governance perspective that explains how authority shifts, organisational learning, and spatial evidence production shape governance robustness under algorithmic conditions.

Keywords: Algorithmic Governance; Institutional Adaptation; Human Judgment; Spatial Data Governance; Smart Cities

1. Instruction

The progressive integration of algorithmic decision-making architectures is permanently changing institutional control logics in the public sector (Janssen & Kuk, 2016; Sun & Medaglia, 2019; Yeung, 2018). Digital technologies increasingly function not only as instruments for increasing administrative efficiency, but also structure processes of evidence production, prioritisation and responsibility allocation (Janssen & Kuk, 2016; Kitchin, 2017; Yeung, 2018). Data-based forecasting models, agentic AI applications and spatially differentiated analytics expand the analytical capacities of public organisations and open up new possibilities for evidence-based governance (Sun & Medaglia, 2019; Vrba et al., 2025; Schlecht et al., 2026). At the same time, new requirements for institutional adaptability, normative framing and democratic legitimisation of data-intensive decision-making processes are emerging (Bullock, 2019; Busuioc, 2021; Moch, 2025; Sun & Medaglia, 2019; Yeung, 2018). Governance is thus increasingly becoming a reflexive negotiation process in which technological innovation, organisational learning capacity and political responsibility structures are newly related to each other (Ansell & Gash, 2008).

In data-intensive policy fields such as urban development, education management or sustainability governance, algorithmically mediated decision-making principles are becoming significantly more important (Meijer & Bolívar, 2016; Ruhlandt, 2018; Calzada, 2020). In higher education systems, ranking-based evaluation and performance benchmarking increasingly shape strategic research prioritisation and institutional resource allocation decisions (Vrba & Quynh Huynh, 2026). Adaptive learning platforms, simulation-based infrastructure planning and geodata-based resource allocation are increasingly changing the operational decision-making processes of public organisations. At the same time, they are transforming professional competence profiles, organisational routines and the epistemic foundations of political priority setting (Vrba et al., 2025; Shehzadi et al., 2026). Data-

based forms of evidence are increasingly structuring perceptions of urgency, feasibility and institutional capacity to act. In this way, they influence fundamental decision-making logics in the public sector (Janssen & Kuk, 2016; Sun & Medaglia, 2019; Yeung, 2018).

As a result, the institutional control logic is shifting from experience-based decision-making practices to data-recursive evidence systems. However, these new decision-making frameworks will only have a lasting effect if their legitimacy and responsibility architectures are organisationally stabilised (Bullock, 2019; Moch, 2025). Governance under data-intensive conditions should therefore be understood less as pure technological modernisation and more as a process of institutional transformation.

Existing research often looks at algorithmic governance from different, sometimes isolated perspectives. Efficiency-oriented implementation studies primarily emphasise the potential of analytical decision support systems to improve performance and coordination (Sun & Medaglia, 2019). Critical contributions, on the other hand, point to the risks of algorithmic distortions, a lack of transparency and possible diffusion of responsibility within complex decision-making arrangements (Binns, 2018; Kitchin, 2017; Yeung, 2018). In parallel, the smart governance literature examines organisational innovation processes, new forms of collaborative governance and networked coordination mechanisms in data-intensive urban contexts (Ansell & Gash, 2008; Meijer & Bolívar, 2016; Ruhlandt, 2018).

However, there has been less systematic research into how these dimensions interact institutionally and which adaptation paths emerge in the interplay between algorithmic evidence production, human judgement and spatially embedded decision-making logic. In particular, the territorial dimension of data-driven governance often remains underexposed, although geospatially based analytics is increasingly influencing political prioritisation processes and potentially generating new distributional effects (Vrba et al., 2025; van Winden et al., 2012).

Against this background, this article aims to conceptualise governance under algorithmic conditions as a multidimensional institutional transformation process. The following research question takes centre stage:

Under which institutional conditions do algorithmically supported and spatially differentiated evidence systems strengthen or weaken the robustness of public governance?

This question focuses on institutional mechanisms of integrating data-based decision-making architectures. It examines how organisations design hybrid decision-making arrangements in which human judgement, algorithmic decision support and spatially embedded data analytics are intertwined (Bullock, 2019; Sun & Medaglia, 2019; Janssen & Kuk, 2016). Governance robustness is understood as the ability to permanently stabilise analytical performance, normative legitimacy and organisational learning capacity in data-intensive governance contexts (Ansell & Gash, 2008; Busuioc, 2021).

The study's original contribution to knowledge lies in the development of an integrated governance model. Algorithmic decision-making architectures are not reconstructed as isolated technological innovations, but understood as institutionally embedded negotiation processes (Yeung, 2018; Janssen & Kuk, 2016). The analysis shows that the quality of data-intensive governance depends less on the degree of technological automation than on the reflexive adaptive capacities of public organisations, the design of epistemic evaluation mechanisms and territorially differentiated evidence structures (Bullock, 2019; Busuioc, 2021; van Winden et al., 2012). By systematically linking shifts in authority, organisational learning modes and spatial prioritisation logics, the study extends existing models of digital governance (Meijer & Bolívar, 2016). At the same time, it explains the conditions under which algorithmic decision support strengthens governance robustness or creates new forms of institutional fragility (Busuioc, 2021; Yeung, 2018).

Methodologically, the article combines a systematic interdisciplinary literature analysis with a comparative qualitative case study strategy in urban governance contexts (Yin,

2017; Ruhlandt, 2018). This research design enables a theory-driven reconstruction of institutional adaptation pathways and the identification of context-specific mechanisms of data-based governance (Ruhlandt, 2018; Meijer & Bolívar, 2016).

On this basis, the study develops proposition-based statements on institutional prerequisites for responsible AI integration and thus contributes to the conceptual advancement of governance research in the digital age (Kitchin, 2017; Yeung, 2018).

2. Theoretical Framework

2.1 *Algorithmic Governance as Institutional Transformation*

The increasing integration of algorithmic decision-making architectures is fundamentally changing the institutional foundations of public governance (Janssen & Kuk, 2016; Yeung, 2018; Sun & Medaglia, 2019). Digital technologies not only function as instruments for increasing the efficiency of administrative processes. They also restructure the production of evidence, mechanisms of prioritisation and forms of responsibility allocation in political decision-making arrangements (Kitchin, 2017; Yeung, 2018). Governance under data-intensive conditions should therefore be understood less as technological modernisation and more as a dynamic of institutional transformation (Bullock, 2019; Busuioc, 2021).

In complex policy fields such as urban development, education governance or sustainability management, data-based forecasting models and simulation-based analyses significantly expand the analytical capacities of public organisations (Meijer & Bolívar, 2016; Ruhlandt, 2018; Sun & Medaglia, 2019). At the same time, new forms of epistemic dependency are emerging. Algorithmically generated evidence increasingly pre-structures perceptions of urgency, feasibility and institutional capacity to act (Janssen & Kuk, 2016; Yeung, 2018). As a result, organisational decision-making logics are shifting from experience-based routines to data-recursive orders of evidence whose legitimacy must first be established through institutional stabilisation (Bullock, 2019; Moch, 2025).

In this context, however, governance transformation does not take place in a linear fashion. Instead, algorithmic systems unfold their effect as institutional drivers by selectively reinforcing existing governance logics, reconfiguring them or making them visible in the first place (Yeung, 2018; Kitchin, 2017). The decisive factor is therefore the way in which organisations embed data-based decision support into their routines, frame it normatively and stabilise it organisationally in the long term (Busuioc, 2021; Ansell & Gash, 2008).

2.2 Epistemic authority and data-driven decision-making systems

With the increasing importance of algorithmic analytics, the epistemic basis of political decision-making processes is undergoing a lasting shift. Data infrastructures structure institutional attention and influence which problems become politically visible and are prioritised (Janssen & Kuk, 2016; Yeung, 2018; Kitchin, 2017). Classification and evaluation processes of algorithmic systems can reproduce or reinforce existing social inequalities by privileging certain forms of evidence and marginalising alternative perspectives (Binns, 2018; Longworth, 2021; Vrba et al., 2026a).

Governance under algorithmic conditions therefore does not only include questions of increasing efficiency or optimising coordination. Rather, new lines of conflict arise with regard to representation, responsibility allocation and institutional legitimacy (Busuioc, 2021; Yeung, 2018). Technological systems remain embedded in social power relations and are not neutral towards organisational contexts (Kitchin, 2017; Binns, 2018). Consequently, the quality of policy decisions increasingly depends on whether organisations establish reflexive evaluation mechanisms that combine analytical performance with critical contextualisation (Bullock, 2019; Busuioc, 2021).

Epistemic authority in data-intensive governance arrangements therefore does not arise from technical precision alone. Rather, it results from institutional processes of interpretation, categorisation and normative framing of algorithmically generated evidence (Yeung, 2018). Under these conditions, governance appears as a negotiation practice between data-based predictive capacity and political

accountability, which must be organisationally stabilised in collaborative and deliberative governance arrangements (Ansell & Gash, 2008; Busuioc, 2021).

2.3 Spatial evidence production and organisational adaptation

In the context of digital transformation, the spatial dimension of data-driven governance is becoming increasingly important (Meijer & Bolívar, 2016; Ruhlandt, 2018). Spatial data analyses enable the territorial localisation of infrastructure deficits, environmental pollution or innovation potential and thus directly influence the prioritisation of political interventions (van Winden et al., 2012; Vrba et al., 2025). As a result, governance is structured in a more localised way (Calzada, 2020).

Smart governance research shows that data-based analytics can increase administrative coordination capacity, but at the same time creates new coordination requirements and potential territorial disparities (Meijer & Bolívar, 2016; Ruhlandt, 2018). Regions with high data availability often benefit more from evidence-based governance than data-poor contexts (van Winden et al., 2012). Institutional adaptation therefore requires strategies for the harmonisation of data standards and continuous evaluation of spatial distribution effects (Vrba et al., 2025; Sun & Medaglia, 2019; Vrba et al., 2026a).

At the same time, the integration of algorithmic decision-making architectures changes organisational competence profiles. Professional judgement is shifting from the primary production of decisions to the contextualisation of algorithmic forecasts, the communication of epistemic uncertainties and the normative weighing up of competing forms of evidence (Bullock, 2019; Busuioc, 2021). Organisational learning capability is thus becoming a central resource of data-intensive governance (Ansell & Gash, 2008; Janssen & Kuk, 2016).

2.4 Limitations of existing governance paradigms

Despite the growing body of research on digital governance, key explanatory gaps remain. Network governance approaches analyse horizontal coordination structures

between groups of actors (Ansell & Gash, 2008), but only capture to a limited extent how algorithmic prioritisation logics reconfigure epistemic decision-making authority (Yeung, 2018; Janssen & Kuk, 2016). Technocratic governance perspectives often interpret data-based governance as a rationalisation of administrative processes (Sun & Medaglia, 2019), but underestimate institutional uncertainties and organisational learning processes (Bullock, 2019).

Research on algorithmic regulation focuses primarily on transparency requirements and accountability of automated systems (Yeung, 2018; Busuioc, 2021). This perspective addresses normative risks, but only partially explains the long-term transformation of organisational knowledge production (Kitchin, 2017). Approaches to experimental governance emphasise adaptive implementation strategies and institutional learning dynamics (Ansell & Gash, 2008), but so far do not offer an integrated theory on the connection between authority shift, learning capacity and territorial evidence structuring (Meijer & Bolívar, 2016; Ruhlandt, 2018).

This means that a perspective is lacking that does not view algorithmic governance in isolation as a coordination, regulation or innovation problem, but rather analyses it as a structural change in institutional decision-making bases (Janssen & Kuk, 2016; Yeung, 2018).

2.5 Institutional-epistemic governance perspective

Against this background, this article develops an institutional-epistemic governance perspective. Algorithmic decision-making architectures are understood as transformation factors of organisational knowledge systems (Kitchin, 2017; Bullock, 2019). Decision-making authority is increasingly mediated by data-based evidence, whose institutional interpretation and normative evaluation themselves become central governance tasks (Busuioc, 2021; Moch, 2025).

This perspective shifts the analytical focus from the coordination of collective action to the question of how organisations process epistemic uncertainty and translate algorithmic evidence into stable decision-making arrangements (Yeung, 2018;

Janssen & Kuk, 2016). Governance thus appears as a dynamic balance between analytical performance, safeguarding legitimacy and organisational learning capacity (Ansell & Gash, 2008; Busuioc, 2021).

Digital technologies do not have a deterministic effect on governance structures. They reinforce existing control logics, open up new room for manoeuvre and at the same time create lines of conflict between efficiency orientation, political responsibility and territorial justice (Kitchin, 2017; Yeung, 2018). Governance under algorithmic conditions is therefore conceptualised as a long-term institutional negotiation process (Ansell & Gash, 2008; Busuioc, 2021).

Through this theoretical extension, the article provides conceptual added value for governance research. Algorithmic transformation is not understood as a sectoral innovation, but as a fundamental shift in epistemic governance principles in the public sector (Janssen & Kuk, 2016; Sun & Medaglia, 2019). This perspective forms the basis for the following research design, which empirically reconstructs institutional adaptation paths of algorithmic decision integration (Yin, 2017; Ruhlandt, 2018).

3. Research methodology

The investigation of institutional adaptation processes under algorithmic decision-making conditions follows a qualitative theory-developing research design that combines a systematic literature analysis with a comparative case study strategy (Yin, 2017). The aim of this approach is to reconstruct governance mechanisms through which organisations institutionally integrate, normatively frame and organisationally stabilise algorithmic evidence systems. The contribution is epistemologically located in an interpretative governance perspective. Algorithmic decision-making architectures are not understood as technically determining variables, but as socially embedded control instruments whose effect unfolds in interaction with organisational routines, professional competence structures and political negotiation processes (Yeung, 2018; Kitchin, 2017). The focus of the analysis is therefore not on hypothesis testing in the sense of causal proof of effect, but on the theory-based identification of

institutional adaptation paths through which data-based decision-making logics are processed organisationally (Janssen & Kuk, 2016; Bullock, 2019).

A systematic literature analysis was first carried out to provide a theoretical foundation. Interdisciplinary contributions from administrative science, organisational research, sociology of technology, urban research as well as education and sustainability governance were considered (Meijer & Bolívar, 2016; Ruhlandt, 2018; Sun & Medaglia, 2019). The search was conducted in the databases Scopus, Web of Science Core Collection, ScienceDirect, SpringerLink and Taylor and Francis Online. The search period covered publications between 2008 and 2025 in order to reflect both the phase of early institutional digitalisation and the increasing integration of algorithmic decision-making architectures. The search strategy was based on combined keyword searches in title, abstract and keywords. The search combinations used included algorithmic governance, AI-supported decision support in the public sector, institutional adaptation in digital governance contexts, human judgement in data-based decision-making processes and spatial data analytics in political governance (Janssen & Kuk, 2016; Yeung, 2018).

Only peer-reviewed journal articles and scientific monographs with an explicit reference to governance were included in the analysis. Purely technical implementation studies without an institutional analysis perspective, short articles without methodological transparency and policy-oriented commentaries without an analytical foundation were excluded. The initial search identified 312 publications. After a systematic title and abstract screening, 127 articles were analysed in depth. The final synthesis included 64 studies that explicitly addressed institutional adaptation processes or epistemic governance implications of data-based decision-making systems.

In addition to the conceptual analysis, a comparative qualitative case study strategy was used to reconstruct institutional adaptation mechanisms in a context-sensitive manner (Yin, 2017). The case selection followed a theoretical sampling approach with the aim of mapping the variance of different governance modes. Urban governance

contexts with advanced integration of algorithmic decision-making tools, deliberative embedding of data-based evidence and experimental use of digital innovation platforms were analysed (Ruhlandt, 2018; Meijer & Bolívar, 2016). The selection criteria were the institutional integration of algorithmic decision support into political or administrative routines, the use of spatial data analytics to prioritise public interventions, documented organisational adaptation processes and international comparability (Vrba et al., 2025; van Winden et al., 2012).

The empirical data basis of the case analysis included scientific case studies, municipal strategy documents, evaluation reports of digital governance programmes and secondary analytical policy studies. The evaluation was theory-led along an analytical category scheme that distinguishes four central dimensions of institutional governance transformation: adaptation logics of organisational integration, transformation of professional judgement, epistemic decision bases of data-based evidence production, and spatial prioritisation mechanisms in political governance (Bullock, 2019; Busuioc, 2021; Moch, 2025). These categories enable the systematic reconstruction of governance pathways through which algorithmic decision-making architectures are organisationally stabilised, normatively moderated or experimentally tested (Busuioc, 2021; Yeung, 2018).

The combination of systematic literature analysis and comparative case study analysis is methodologically appropriate, as it enables both theoretical integration and empirical contextualisation (Yin, 2017). The qualitative theory-developing approach makes it possible to visualise emergent institutional dynamics that often remain underexposed in quantitative impact analyses. Particularly in the case of technologically induced governance transformations, which are characterised by uncertainty, experimental logics and normative negotiation processes, this approach offers the opportunity to reconstruct institutional mechanisms in a differentiated manner and to condense them conceptually (Ansell & Gash, 2008; Kitchin, 2017).

4. Comparative case analysis: institutional mechanisms of algorithmic governance

The empirical analysis shows that algorithmically supported decision-making architectures do not uniformly transform institutional governance logics, but instead produce different governance equilibria (Yeung, 2018; Janssen & Kuk, 2016; Bullock, 2019). These equilibria arise from the specific combination of the degree of integration of algorithmic evidence, shifts in epistemic authority, organisational learning capacity and spatial prioritisation logic (Busuioc, 2021; Meijer & Bolívar, 2016). Algorithmic systems do not primarily act as technical determinants of institutional change, but rather as amplifiers of existing control rationalities (Kitchin, 2017; Yeung, 2018).

An initial adaptation path can be seen in centralised governance contexts in which algorithmic decision-making instruments are integrated into operational routines in a highly formalised manner. In such constellations, spatial data analyses and simulation-based forecasting models structure prioritising decisions in near real time (Sun & Medaglia, 2019; Vrba et al., 2025). Visual decision interfaces reduce coordination costs between planning units and operational authorities and increase administrative responsiveness under complex conditions (Meijer & Bolívar, 2016). At the same time, this operational algorithmisation leads to a consolidation of epistemic authority in data-analytical units (Bullock, 2019; Busuioc, 2021). Decision-making processes are increasingly orientated towards model-based plausibility orders, as a result of which deliberative spaces for negotiation become relatively less important (Yeung, 2018). This governance equilibrium increases steering efficiency and operational coherence in the short term, but creates long-term risks of epistemic path dependency and reduced institutional sensitivity to contextual deviations (Janssen & Kuk, 2016; Kitchin, 2017).

A second adaptation path emerges in deliberative governance arrangements in which algorithmic evidence is systematically communicated politically. Spatially visualised scenarios serve as important orientation aids in this context. They influence prioritisation decisions without fully defining them and thus open up scope for different assessments and trade-offs (Ansell & Gash, 2008; Meijer & Bolívar, 2016). Transparency practices and diverse forms of evidence presentation help to ensure the

legitimacy of data-based governance by keeping alternative perspectives institutionally visible (Busuioc, 2021; Binns, 2018).

This balance strengthens democratic accountability and reduces the risk of technical analyses unilaterally dominating political decisions (Yeung, 2018). At the same time, decision-making processes are lengthened and the coordination effort between administration, politics and civil society increases (Ansell & Gash, 2008).

In this context, governance robustness arises less from increased efficiency than from the stabilisation of reflexive decision-making arrangements that make uncertainty politically manageable (Bullock, 2019).

A third adaptation path becomes visible in experimentally organised governance constellations in which algorithmic innovation is designed as an iterative learning process. Pilot projects, temporary innovation platforms and scenario-based spatial analyses enable the explorative use of data-intensive decision-making tools (Ruhlandt, 2018; Vrba et al., 2025). Algorithmic systems function primarily as knowledge generators for organisational transformation (Kitchin, 2017). Institutional adaptability increases, technological path dependencies are reduced and new competence profiles are created (Bullock, 2019; Janssen & Kuk, 2016). At the same time, this mode makes the long-term standardisation of decision-making architectures more difficult and can result in fragmented responsibility structures (Busuioc, 2021). Decision-making authority remains distributed, while organisational reflexivity increases (Ansell & Gash, 2008). In this equilibrium, governance stability is not generated through formalisation, but through continuous learning processes (Janssen & Kuk, 2016).

The systematic comparison of these adaptation paths makes it clear that algorithmic governance can produce three different institutional equilibria. Formalised integration increases governance speed and operational coherence, but reduces epistemic plurality (Yeung, 2018; Bullock, 2019). Normatively framed integration strengthens legitimacy and political accountability, but generates higher coordination costs (Busuioc, 2021; Ansell & Gash, 2008). Experimental integration promotes

organisational learning capacity and resilience, but makes it more difficult to institutionalise data-based decision-making logics in the long term (Janssen & Kuk, 2016; Ruhlandt, 2018).

Overall, it can be seen that the quality of data-driven governance depends less on technological system architecture than on institutional capacities for the reflexive use of algorithmic evidence (Kitchin, 2017; Yeung, 2018). Spatial data governance gains strategic importance here, as territorial evidence directs political attention and structures the distributional effects of public interventions (van Winden et al., 2012; Vrba et al., 2025). Differences in data availability or analytical infrastructure can reinforce existing regional disparities and create new lines of conflict between analytical precision and normative inclusion (Meijer & Bolívar, 2016).

Algorithmic decision-making architectures thus act as institutional amplifiers that make existing governance rationalities visible and at the same time create new requirements for the allocation of responsibility, transparency practices and competence development (Busuioc, 2021; Bullock, 2019). Governance under data-intensive conditions must therefore be understood as a dynamic process of institutional equilibrium-building in which efficiency, legitimacy and learning capacity are continuously rebalanced (Ansell & Gash, 2008; Yeung, 2018).

5. Comparative Case Study Analysis: Institutional Mechanisms of Algorithmic and Spatial Governance

In order to empirically substantiate the theoretical framework, a comparative qualitative case study analysis will be conducted with the aim of reconstructing institutional mechanisms of algorithmic governance in different governance contexts (Yin, 2017). In particular, case studies enable the analysis of complex decision-making arrangements in which technological systems, organisational routines and normative expectations are intertwined.

The selection of cases follows a logic of theoretical variation of institutional modes of adaptation. Smart cities are particularly suitable fields of analysis for this, as they

function as experimental governance spaces in which data-intensive decision-making instruments are implemented at an early stage and institutional adaptation processes become visible (Meijer & Bolívar, 2016; Ruhlandt, 2018).

Analytically, it is assumed that algorithmic decision-making architectures do not replace institutional governance logics, but rather reinforce or reconfigure them (Janssen & Kuk, 2016; Yeung, 2018). Spatial data management strategies play a central role in this, as they can produce territorial evidence and structure political prioritisation (Vrba et al., 2025; van Winden et al., 2012).

Singapore: Centralised Capacity and the Mechanism of Operational Algorithmisation
In Singapore, the integration of data-based decision-making tools takes place in the context of a highly centralised governance architecture based on long-term strategic planning and high administrative coordination capacity. Digital technologies are used in a targeted manner to standardise decision-making processes and increase operational control capability (Janssen & Kuk, 2016; Sun & Medaglia, 2019).

A central mechanism is the operationalisation of algorithmic forecasts. Spatial data analyses on traffic flows, environmental pollution or infrastructure requirements are integrated directly into administrative decision-making routines (Sun & Medaglia, 2019; Vrba et al., 2025). This partially shifts decision-making authority from discursive negotiation processes to model-based prioritisation logics (Yeung, 2018).

Augmented reality-based visualisation systems reinforce this effect by translating complex data sets into situational decision-making interfaces (Moch et al., 2026). This visual governance enables accelerated coordination between planning units and operational authorities, but at the same time reduces the visibility of epistemic uncertainties (Kitchin, 2017).

Institutional adaptation thus takes place in the mode of controlled integration, which is characterised by clear allocation of responsibility, high standardisation and performance-oriented evaluation logics. Algorithmic systems function here primarily as instruments for increasing administrative capacity (Bullock, 2019; Busuioc, 2021).

Barcelona: Democratic Mediation and the Mechanism of Normative Re-Embedding
Barcelona represents a governance logic in which algorithmic decision-making tools are consciously embedded in deliberative political processes. Digital city strategies are linked to questions of democratic legitimacy and public value creation, whereby technological evidence does not guide action autonomously, but must be mediated politically (Meijer & Bolívar, 2016).

A central mechanism is the normative re-embedding of algorithmic evidence. Spatial data analyses on urban development or environmental pollution are supplemented by participatory processes in which alternative interpretations and prioritisations are discussed (Ruhlandt, 2018). Visual decision-making tools act as communicative interfaces between administration, politics and civil society (Calzada, 2020).

This governance practice increases transparency and legitimacy, but leads to a temporal extension of decision-making processes. Studies on collaborative governance show that although deliberative arrangements can increase the robustness of decision-making, they also increase coordination costs and the potential for conflict (Ansell & Gash, 2008).

Institutional adaptation takes place here in the mode of normatively framed integration, in which algorithmic systems function as evidence-producing but not decision-dominating elements (Busuioc, 2021; Yeung, 2018).

Amsterdam: Experimental Iteration and the Mechanism of Institutional Learning
Amsterdam exemplifies a governance logic that organises algorithmic innovation as an iterative learning process. Digital technologies are often implemented in pilot projects in order to test their impact under real conditions and develop organisational adaptation strategies (Ruhlandt, 2018).

A central mechanism is institutional iteration through data-based experiments. Spatial data analyses and simulation-based decision-making tools are used to generate alternative planning scenarios, which are then evaluated politically and administratively (Vrba et al., 2025). This results in a form of explorative evidence

production that is aimed less at direct decision optimisation and more at knowledge generation (Kitchin, 2017).

This governance logic strengthens organisational learning capacity and reduces technological implementation risks. At the same time, it makes the long-term standardisation of data-based decision-making architectures more difficult, as pilot projects often create fragmented responsibility structures (Bullock, 2019; Busuic, 2021).

Institutional adaptation thus takes place in the mode of experimental learning, which is characterised by high flexibility, network coordination and reversible implementation strategies (Ansell & Gash, 2008).

Comparative Mechanisms: Authority, Evidence and Spatial Prioritisation
The systematic comparison of the three cases shows that algorithmic governance does not lead to a uniform transformation of administrative control, but activates different institutional mechanisms (Janssen & Kuk, 2016; Yeung, 2018).

In centralised contexts, spatial data analyses strengthen operational governance and enable performance-oriented prioritisation of political interventions (Sun & Medaglia, 2019). In deliberative governance arrangements, on the other hand, spatial evidence systems function primarily as discursive resources that structure political decision-making processes without completely determining them (Meijer & Bolívar, 2016; Ansell & Gash, 2008). Finally, in experimental contexts, algorithmic systems are used to initiate organisational learning processes and increase institutional adaptability (Ruhlandt, 2018; Bullock, 2019).

Overall, it can be seen that the quality of data-driven governance depends less on technological system architecture than on institutional capacities for reflecting on algorithmic evidence (Kitchin, 2017; Yeung, 2018). Spatial data governance becomes a crucial factor, as territorial prioritisation decisions can have a direct impact on resource allocation, innovation pathways and social justice (van Winden et al., 2012; Vrba et al., 2025).

Algorithmic decision-making architectures thus act as institutional amplifiers that make existing governance logics visible and at the same time create new requirements for transparency, accountability and organisational learning capacity (Busuioc, 2021; Bullock, 2019).

6. Theoretical Model and Proposition Development: Institutional Governance under Algorithmic and Spatial Conditions

The comparative analysis of institutional adaptation paths of algorithmic decision integration suggests that data-intensive governance does not lead to a uniform transformation of political control logics, but rather produces differentiated institutional configurations depending on integration modes, authority shifts and organisational learning dynamics (Janssen & Kuk, 2016; Yeung, 2018; Bullock, 2019). On this basis, several theoretically derived propositions can be formulated that are empirically testable and enable the systematic further development of governance research.

Proposition 1

A high degree of formalisation of algorithmic decision integration increases operational coordination and decision-making speed in the short term, but reduces epistemic plurality in political decision-making processes in the long term (Yeung, 2018; Bullock, 2019; Busuioc, 2021).

This proposition can be empirically verified by indicators such as the proportion of algorithmically generated decision bases in administrative routines, the standardisation of decision-making processes, documented deviation decisions from algorithmic recommendations and the institutional diversity of the groups of actors involved in prioritisation processes (Janssen & Kuk, 2016). In addition, the duration of inter-organisational coordination cycles can be used as a measure of operational coordination capability (Meijer & Bolívar, 2016).

Proposition 2

Normatively framed integration of algorithmic evidence increases the institutional legitimacy of data-based governance, but leads to longer decision-making cycles and increased coordination effort (Ansell & Gash, 2008; Busuioc, 2021).

An empirical examination can be carried out using transparency mechanisms, participation intensity, the number of deliberative decision-making formats and documented conflict resolution processes. In addition, the duration of decisions, number of necessary coordination loops and institutional perception of responsibility can be analysed as indicators of governance legitimacy (Yeung, 2018; Meijer & Bolívar, 2016).

Proposition 3

Experimentally organised implementation strategies of algorithmic decision-making architectures promote organisational learning ability and institutional adaptability, but make the long-term standardisation of data-based control logics more difficult (Ruhlandt, 2018; Bullock, 2019; Janssen & Kuk, 2016).

This dynamic can be measured by the number of temporary pilot projects, iterative adaptations of algorithmic systems, institutionalised evaluation mechanisms and changes in the competence profiles of public organisations (Kitchin, 2017). At the same time, the stability of formalised decision-making routines can serve as an indicator of standardisation potential (Busuioc, 2021).

Proposition 4

The spatial structure of data-based evidence production systematically influences political prioritisation processes and can reinforce or reduce existing territorial disparities (van Winden et al., 2012; Vrba et al., 2025).

This assumption can be empirically verified by analysing geospatial decision-making instruments, regional differences in data availability, variation in public investment decisions and changes in the visibility of specific problems within political decision-

making processes (Meijer & Bolívar, 2016). The distribution of infrastructural resources can also serve as an indicator of territorial governance effects.

Proposition 5

Institutional governance robustness under algorithmic conditions arises from the ability of public organisations to achieve a dynamic balance between increasing efficiency, securing legitimacy and organisational learning processes (Ansell & Gash, 2008; Busuioc, 2021).

This overarching proposition can be operationalised through indicators such as adaptability to technological change, stability of political decision-making processes under uncertainty, institutionalised reflection mechanisms and long-term governance outcomes (Yeung, 2018; Bullock, 2019). Changes in responsibility allocation, transparency practices and organisational competence development provide additional indications of the stability of data-driven decision-making architectures (Janssen & Kuk, 2016).

In summary, these propositions enable a systematic empirical development of the institutional-epistemic governance perspective. They structure future research designs, create connectivity for quantitative and comparative studies and contribute to the theoretical specification of data-intensive governance transformations (Sun & Medaglia, 2019; Kitchin, 2017). Algorithmic decision-making architectures are thus conceptualised not only as the subject of normative debates, but also as empirically investigable mechanisms of institutional equilibrium formation (Yeung, 2018; Busuioc, 2021).

7. Discussion

The analysis makes it clear that algorithm-supported decision-making architectures do not transform institutional control logics in a linear fashion, but rather trigger differentiated adaptation processes. Governance under data-intensive decision-making conditions is characterised by a dynamic field of tension between efficiency

orientation, safeguarding legitimacy and organisational learning ability. Technological innovation expands analytical room for manoeuvre, but at the same time creates new requirements for the allocation of responsibility, epistemic transparency and normative framing.

A central result concerns the reconfiguration of epistemic decision-making authority. Algorithmic forecasting models and spatially visualised evidence systems structure perceptions of political urgency and influence the setting of priorities in organisations. In contexts of controlled integration, data-based evidence is increasingly embedded in operational decision-making routines, which can increase administrative coordination capabilities. At the same time, there is a growing dependence on model-based plausibility orders whose assumptions are not always fully comprehensible. Governance quality therefore depends largely on whether institutions establish reflexive evaluation mechanisms that combine analytical efficiency with critical contextualisation.

The comparative analysis also shows that institutional modes of adaptation significantly determine how algorithmic systems work in governance arrangements. In deliberative contexts, data-based decision-making tools are politically mediated and embedded in pluralised evidence formats. This practice strengthens transparency and democratic legitimisation, but increases coordination efforts and prolongs decision-making cycles. Experimentally organised governance constellations, on the other hand, use algorithmic systems primarily as learning instruments. Iterative pilot projects enable the gradual development of organisational competencies, reduce implementation risks and promote institutional resilience. At the same time, this mode of adaptation makes long-term standardisation more difficult and can create fragmented responsibility structures.

Another central point of discussion concerns the transformation of professional roles. The integration of data-intensive decision-making architectures shifts skills requirements in administration, education and planning. In addition to technical expertise, skills for interpreting algorithmic models, communicating epistemic

uncertainty and interdisciplinary coordination are becoming increasingly important. Governance is thus increasingly becoming a learning-oriented practice in which organisational reflexivity is a central resource. The danger of informal delegation to technical systems arises in particular where algorithmic recommendations are uncritically adopted due to their apparent objectivity. Institutional mechanisms to ensure human accountability are therefore becoming a crucial component of responsible AI integration (Busuioac, 2021; Bullock, 2019; Ritter et al., 2025).

The spatial dimension of data-based control is particularly relevant. Spatial data management strategies enable more precise territorial prioritisation of political interventions and can increase the effectiveness of public programmes. At the same time, there is a risk that differences in data availability or digital infrastructure will reinforce existing regional disparities. Governance under algorithmic conditions must therefore also be understood as a question of territorial justice. Institutional adaptation requires transparent data bases, continuous evaluation of spatial distribution effects and mechanisms for harmonising data standards.

The results thus confirm the central theoretical findings of this article. Algorithmic decision-making architectures do not have a deterministic effect on governance structures, but act as institutional amplifiers of existing control logics. Governance robustness arises where organisations reflexively design hybrid decision-making arrangements, make epistemic uncertainties visible and systematically promote organisational learning processes. Efficiency gains from data-based governance can only be sustainably stabilised if they are complemented by legitimising strategies and clear responsibility structures.

Furthermore, the analysis shows that the combination of algorithmic decision support with spatial data analytics creates new lines of conflict between analytical precision and normative inclusion. Evidence-based prioritisation mechanisms can make political interventions more targeted, but at the same time distribute territorial attention unevenly. This ambivalence emphasises the need for a governance perspective that understands technological innovation as an institutional negotiation process.

Overall, the discussion shows that governance under algorithmic conditions must be understood as a multidimensional transformation dynamic. Technological systems expand possibilities for action, but at the same time change the epistemic foundations of political decision-making processes. The quality of data-intensive governance therefore depends less on technological system architecture than on institutional capacities for the reflexive use of algorithmic evidence.

8. Theoretical contribution and governance implications

This analysis contributes to the further development of governance research by conceptualising algorithm-based decision-making architectures not primarily as technological innovations, but as institutional transformation dynamics (Janssen & Kuk, 2016; Yeung, 2018). While existing studies often consider efficiency potentials or automation risks in isolation, studies on algorithmic governance show that data-based decision-making structures primarily change epistemic and organisational control logics (Kitchin, 2017; Busuioc, 2021). Algorithmic systems produce new forms of evidence-based forecasts and recommendations for action, which are increasingly being integrated into political and administrative decision-making processes (Sun & Medaglia, 2019).

A central theoretical contribution of this article therefore lies in the connection between epistemic transformation and institutional adaptation. Governance under algorithmic conditions changes the way knowledge is generated, interpreted and legitimised (Yeung, 2018). Forecasting models, ranking mechanisms or visually prepared scenarios structure perceptions of political urgency and influence the setting of priorities in organisations (Vrba et al., 2025). This shifts the epistemic basis of governance from document- and experience-based decision-making routines to data-recursive orders of evidence (Janssen & Kuk, 2016).

Furthermore, the analysis shows that organisations do not adopt algorithmic innovations homogeneously, but develop different modes of adaptation. Research on smart city governance and algorithmic regulation illustrates that technological systems

are often integrated incrementally and only stabilise in interaction with existing institutional routines (Meijer & Bolívar, 2016; Ruhlandt, 2018; Yeung, 2018). These modes of adaptation range from controlled integration to deliberative governance arrangements and experimental learning processes. Technological transformation is therefore not deterministic, but is mediated by organisational learning capacity, regulatory frameworks and political priorities (Ansell & Gash, 2008).

A further theoretical added value results from the conceptualisation of hybrid decision-making arrangements. While algorithmic systems extend analytical reach and forecasting capabilities, central governance functions remain with human actors. These assume tasks of contextualisation, normative evaluation and assumption of responsibility (Bullock, 2019; Busuioc, 2021). Governance quality therefore does not depend on the degree of automation, but on the design of relational human-machine constellations.

At the same time, the literature points to the risks of epistemic shifts. Visualised forecasts or data-based rankings can structure political perceptions and change decision-making priorities without their underlying model assumptions being fully transparent (Kitchin, 2017; Yeung, 2018; Vrba et al., 2025). This results in new requirements for auditability, transparency and accountability of algorithmic systems in sensitive policy fields (Binns, 2018; Busuioc, 2021).

Another theoretical contribution lies in the integration of spatial decision-making logics in governance analyses. Spatial data management strategies enable a more precise identification of territorial problems and a targeted allocation of political resources (Vrba et al., 2025). At the same time, unequal data availability between regions can reinforce existing social disparities. Governance must therefore increasingly be understood as a question of territorial justice (Ruhlandt, 2018).

Several governance policy implications arise from these findings. Firstly, organisations must establish clear responsibility structures and binding documentation standards in order to avoid informal delegation of political decisions to algorithmic systems (Busuioc, 2021). Secondly, skills development is becoming a key prerequisite for the

responsible integration of AI-supported decision support. Administrative actors increasingly need skills to interpret data-based models and to critically reflect on algorithmic uncertainties and assumptions (Bullock, 2019). Thirdly, transparency should be understood as a multidimensional category that encompasses both modelling logics and visual decision frameworks (Yeung, 2018).

Overall, the analysis makes it clear that governance under algorithmic conditions must be understood as a long-term institutional learning process. Technological innovation only has a sustainable impact where hybrid decision-making arrangements are stabilised and reflexive governance capacities are built up (Ansell & Gash, 2008).

9. Conclusion

This study has shown that governance under algorithmic conditions should not be understood as technological modernisation, but rather as an institutional transformation process. Algorithmically supported and spatially differentiated evidence systems permanently change decision-making logics, responsibility structures and forms of evidence-based prioritisation in the public sector. The central research question aimed to clarify under which institutional conditions these systems strengthen or weaken the robustness of public governance.

The analysis shows that governance robustness is strengthened in particular where organisations reflexively integrate algorithmic evidence into existing decision-making arrangements. Three institutional conditions prove to be decisive. Firstly, a controlled but non-deterministic integration of data-based decision-making tools increases the analytical performance of public governance without completely suppressing epistemic plurality. Secondly, normatively framed mediation mechanisms stabilise the legitimacy of data-intensive governance by institutionally anchoring transparency practices, deliberative decision-making formats and clear assignments of responsibility. Thirdly, an experimental implementation logic promotes organisational learning capacity and adaptability in the face of technological uncertainty.

At the same time, the study identifies institutional constellations under which algorithmic evidence systems can weaken governance robustness. Strong formalistic integration can lead to epistemic path dependency and reduce sensitivity to contextual deviations. Insufficient normative framing of data-based prioritisation logics increases the risk of informal delegation of political responsibility to technical systems. Furthermore, spatially unevenly distributed data infrastructures can reinforce territorial disparities and systematically distort political attention.

Overall, it can be seen that the quality of data-intensive governance depends less on the degree of automation of technological systems than on institutional capacities for the reflexive use of algorithmic evidence. Governance robustness arises from the ability of public organisations to strike a dynamic balance between increasing efficiency, safeguarding legitimacy and organisational learning processes. Algorithmic decision-making architectures act as institutional amplifiers of existing governance logics, which both open up new room for manoeuvre and generate new lines of conflict.

The theoretical contribution of the study lies in the development of an institutional-epistemic governance perspective that conceptualises algorithmic transformation as a process of balancing analytical precision, political accountability and adaptive learning. The systematic integration of spatial evidence production also makes it clear that governance in the digital age is increasingly territorially structured and that questions of distributive justice must be given greater consideration.

For governance practice, this results in the need to consciously design hybrid decision-making arrangements, promote competence development and institutionalise transparent evaluation mechanisms for algorithmic systems. Future research should in particular analyse long-term institutional path dependencies of data-intensive governance, the political impact of visual evidence systems and governance dynamics in resource-poor contexts.

Overall, the study shows that responsible governance under algorithmic conditions is not determined by the speed of technological innovation, but by institutional reflexivity,



organisational learning capacity and the ability to contextualise data-based evidence in a normatively and spatially differentiated way.

References

- Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory*, 18(4), 543-571. <https://doi.org/10.1093/jopart/mum032>
- Binns, R. (2018). Algorithmic Accountability and Public Reason. *Philos. Technol.*, 31, 543-556. <https://doi.org/10.1007/s13347-017-0263-5>
- Bullock, J. B. (2019). Artificial Intelligence, Discretion, and Bureaucracy. *The American Review of Public Administration*, 49(7), 751-761. <https://doi.org/10.1177/027507401985612>
- Busuioc, M. (2021). Accountable Artificial Intelligence: Holding Algorithms to Account. *Public Admin Rev*, 81, 825-836. <https://doi.org/10.1111/puar.13293>
- Calzada, I. (2020). *Smart city citizenship* (1st ed.). Elsevier. ISBN 9780128153000
- Janssen, M., & Kuk, G. (2016). The challenges and limits of big data algorithms in technocratic governance. *Government Information Quarterly: an international journal of information technology management, policies, and practices*, 33(3), 371-377. <https://doi.org/10.1016/j.giq.2016.08.011>
- Kitchin, R. (2017). Thinking critically about and researching algorithms. *Information, Communication & Society*, 20(1), 14-29. <https://doi.org/10.1080/1369118X.2016.1154087>
- Longworth, J. (2021). Benjamin Ruha (2019) *Race After Technology: Abolitionist Tools for the New Jim Code*. Medford: Polity Press. 172 pages. eISBN: 9781509526437. *Science & Technology Studies*, 34(2), pp. 92-94. <https://doi.org/10.23987/sts.102639>
- Meijer, A., & Bolívar, M. P. R. (2016). Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences*, 82(2), 392-408. <https://doi.org/10.1177/0020852314564308>

Moch, E. (2025). Algorithms as Judges: Constitutional Limits to Automated Decision-Making in Public Administration. *East African Journal of Law and Ethics*, 8(1), 178-188. <https://doi.org/10.37284/eajle.8.1.3044>

Moch, E., Vrba, J., Oberdieck, T., & Ritter, L. A. (2026). AI-Supported Augmented Reality in Smart Cities: Administration Between Innovation and Institutional Adaptation. In J. Vrba, T. Huynh, & O. Hájek (Eds.), *AI-Powered Augmented Reality for Public Administration* (pp. 53-76). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-7804-6.ch003>

Ritter, L. A., Barenkamp, M., & Moch, E. (2025). Plattform und Kontrolle: Technischer Datenschutz in digitalen Lernsystemen. *Wirtsch Inform Manag*, 17, 251-258. <https://doi.org/10.1365/s35764-025-00571-4>

Ruhlandt, R. W. S. (2018). The Governance of Smart Cities: A Systematic Literature Review. *Cities*, 81, 1-23. <https://doi.org/10.1016/j.cities.2018.02.014>

Schlecht, P., Oberdieck, T., & Moch, E. (2026). Use of agent-based AI applications in research institutions. *International Journal of Research and Review*, 13(1), 202-218. <https://doi.org/10.52403/ijrr.20260119>

Shehzadi, I., Vrba, J., Sajin, S. K., & Xabibullayevich, S. S. (2026). Interdisciplinary Insights: Cognitive Science, Sociology, and AI in Learning Systems. In M. Ahmad (Ed.), *Multidisciplinary Perspectives on Agentic AI in Educational Systems* (pp. 43-62). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-4621-2.ch003>

Sun, T. Q., & Medaglia, R. (2019). Mapping the challenges of artificial intelligence in the public sector: Evidence from public healthcare. *Government Information Quarterly*, 36(2), 368-383. <https://doi.org/10.1016/j.giq.2018.09.008>

van Winden, W., de Carvalho, L., van Tuijl, E., van Haaren, J., & van den Berg, L. (2012). *Creating Knowledge Locations in Cities: Innovation and Integration Challenges* (1st ed.). Routledge. <https://doi.org/10.4324/9780203127162>

Vrba, J., Akbar, M., Eze, E. E., & Ahmad, M. (2025). Spatial Data Management Strategies to Improve Green Innovation. In A. Khalil, H. Bousselmi, & I. Ben Slimene (Eds.), *Digital Technologies for Sustainability and Quality Control* (pp. 247-272). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-4373-9.ch011>

Vrba, J., & Quynh Huynh, T. N. (2026). The Impact of Universities Rankings on Academic Research. In J. Vrba & M. Mohd Sofian (Eds.), *Academic Research Challenges for Modern Society* (pp. 79-90). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-0897-5.ch004>

Vrba, J., Reza, S. A., Ahmad, M., Rajabov, K., & Sapaeva, B. (2026a). Policy, Equity, and Governance: Shaping the Future of Agentic AI in Education. In M. Ahmad (Ed.), *Multidisciplinary Perspectives on Agentic AI in Educational Systems* (pp. 25-42). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-4621-2.ch002>

Yeung, K. (2018). Algorithmic regulation: A critical interrogation. *Regulation & Governance*, 12, 505-523. <https://doi.org/10.1111/rego.12158>

Yin, R. K. (2017). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications, Inc. ISBN 978-1506336169