



Prospects for Implementing the Digital Twin of an Organization Concept in Corporate Governance

Victor Plotnikov

Founder and CEO, Farsight Management Group of Companies, Denpasar, Indonesia.

Abstract

The article examines the prospects of adopting a Digital Twin of an Organization (DTO) as an instrument of corporate governance in data-intensive firms, with a focus on AI-enabled real-estate operations. Relevance is determined by the governance gap between fast decision cycles and weak traceability of managerial actions, where informal, unrecorded decisions reduce accountability and impair learning from outcomes. Scientific novelty stems from integrating DTO logic with governance mechanisms that treat every interaction, document, and decision as a structured digital trace suitable for model synchronization and controllable execution. The article aims to develop an analytical framework that links DTO architecture to corporate control loops and to the transition from human-in-the-loop to human-on-the-loop oversight for critical interventions. The study applies comparative analysis of recent research, conceptual synthesis, and governance mapping of data, process, and oversight requirements. The conclusion formulates practical design principles for DTO deployment in corporate governance and identifies conditions under which semi-autonomous decisioning becomes organizationally and legally manageable.

Keywords: Digital Twin of an Organization, Corporate Governance, Enterprise Digital Twin, Decision Traceability, Process Mining, AI Oversight, Human-on-the-Loop, Data Governance, Real Estate Management, Autonomous Organization.

INTRODUCTION

Corporate governance in AI-mediated firms increasingly depends on the capacity to reconstruct why a decision was taken, which signals were used, who approved an exception, and how feedback reshaped subsequent actions. In real estate management—customer support, sales pipelines, and guest communication in short-term rentals—decision cycles compress to minutes, while audit requirements, compliance constraints, and reputational exposure persist. The practical problem arises when managerial intent and operational judgments remain outside information systems (corridor decisions, verbal approvals, non-logged exceptions), producing discontinuities in accountability and limiting the organization's ability to learn from outcomes.

The article aims to substantiate the prospects of implementing the DTO concept as a governance instrument that binds operational reality to a synchronized digital representation and enables controlled, reviewable actuation of decisions through enterprise systems. The tasks of the study are:

- 1) to define DTO governance functionality through the logic of digital traces, synchronization, and actuation;
- 2) to identify architectural and data-management

prerequisites that allow DTO use in corporate control loops;

3) to justify an oversight regime that shifts routine decision-making toward semi-autonomy while reserving human intervention for critical situations (human-on-the-loop).

Scientific novelty is provided by a governance-oriented DTO framing that treats the DTO not as a visualization but as an auditable decision substrate connecting evidence, policy constraints, and execution pathways.

MATERIALS AND METHODS

Materials for the study are recent research on DTO realization through action-oriented process mining and enterprise event data (G. Park; W. M. P. van der Aalst [9]), DTO conceptual boundaries and organization-design implications (K. Lyytinen; Y. Yoo; R. J. Boland Jr.; L. Berente [6]), enterprise digital twin support for strategic decisioning via knowledge visualization and simulation (M.-R. Yan; L.-Y. Hong; K. Warren [11]), digital-twin data management architectures and challenges (E. B. Ouedraogo; A. Hawbani; X. Wang; Z. Liu; L. Zhao; M. A. A. Al-qaness; S. H. D. Alsamhi [8]), governance implications and maturity staging for digital twin technologies (M. Haraguchi; T. Funahashi; F. Biljecki [3]), governance gaps in intelligent digital twin systems with

Citation: Victor Plotnikov, "Prospects for Implementing the Digital Twin of an Organization Concept in Corporate Governance", Universal Library of Business and Economics, 2026; 3(2): 26-30. DOI: <https://doi.org/10.70315/uloap.ulbec.2026.0302005>.

emphasis on standards and cybersecurity (S. Hananto; K. H. Lee; A. Lee; M. O. Kwon; J. Kim [2]), systematic evidence on AI integration patterns in digital twins (T. Kreuzer; P. Papapetrou; J. Zdravkovic [5]), facility-management digital twin frameworks relevant to real-estate operationalization (T. D. H. N. Nguyen; D. H. Ly; H. Jang; H. N. N. Dinh; Y. Ahn [7]), operational framing of AI oversight as a governance mechanism (J. Salgado-Criado [10]), and empirically grounded risks of human reliance on erroneous algorithmic support in human-in-the-loop settings (U. Agudo; K. G. Liberal; M. Arrese; H. Matute [1]), and methodological approaches to business process formalization and IT implementation in enterprise environments (A. Kovalchuk [4]).

The methods applied are analytical review, comparative synthesis of conceptual models, and governance mapping that links the DTO architecture to corporate control loops, data lineage requirements, and oversight regimes.

RESULTS

The analytical synthesis shows that DTO deployment for corporate governance can be represented as a shift from “systems of record” to “systems of trace,” in which every operational action and managerial judgment yields a machine-readable trail. DTO feasibility depends on three coupled capabilities: (i) continuous capture of digital traces from enterprise interactions; (ii) synchronization of a digital representation with operational state; (iii) controlled actuation—translating model outputs into executable changes in workflows and policies. This triad aligns with the strict interpretation of DTO requirements. In contrast, research cautions against rhetorical overreach that assumes frictionless two-way causality between the model and the organization without specifying mediation layers or control rights [6].

Empirical and design-oriented literature supports the proposition that DTO governance value arises when the enterprise can bind decisions to evidence and simulate consequences before committing resources. Enterprise digital twin decision systems grounded in visualization and system dynamics illustrate how a synchronized representation can support strategic choices through scenario exploration and feedback reasoning, turning dispersed operational data into decision-relevant structures [11]. For corporate governance, this implies a measurable gain in decision explainability: a board-level query (“why was an exception granted?”) becomes answerable by reconstructing the trace—signals, constraints, approvals, and downstream effects—rather than relying on narrative memory.

Operationalization of DTO requires event-level representations of processes, objects, and commitments. Action-oriented process mining provides a mechanism for realizing DTOs by combining diagnostics of current process states with “valves,” or configurable intervention points, that allow experts to constrain or redirect execution based

on real-time evidence [9]. In governance terms, such valves instantiate enforceable control levers: approval thresholds, pricing corridor constraints, escalation rules, and exception pathways. The DTO is then not only observational, but regulatory—its utility increases when model states map to concrete governance actions routed through enterprise systems rather than informal channels.

A further result concerns data foundations: DTO governance collapses if trace capture is partial, inconsistent, or non-interoperable. A comprehensive review of digital twin data management identifies recurring bottlenecks—heterogeneous schemas, streaming/latency constraints, data quality control, security, and lifecycle governance of twin data—indicating that DTO deployment is primarily a data management program with architectural consequences, not a visualization add-on [8]. When mapped to corporate governance, these issues translate into explicit requirements: standardized event semantics, lineage-preserving storage, access controls that align with governance tiers, and retention rules aligned with compliance.

Governance maturity staging strengthens the argument that DTO adoption should proceed through incremental capability levels rather than a single “autonomy leap.” A maturity model approach, though developed for city-scale digital twins, formalizes governance implications across stages—interoperability, participation, accountability, and inclusivity—offering a transferable logic for corporate DTO roadmaps: early stages prioritize reliable sensing and representation, intermediate stages integrate AI and decision services, and later stages address participation, oversight, and legitimacy at scale [3]. For firms managing real estate assets and tenant/guest interactions, the maturity logic implies that DTO-driven automation should expand only after trace completeness and policy enforcement mechanisms reach stable performance.

AI integration patterns in digital twins exhibit an asymmetry: many solutions emphasize the AI component while under-specifying the twin’s real-time coupling to operational data and the virtual-to-real actuation channel [5]. For corporate governance, that asymmetry is not a minor technicality; it defines accountability. If the twin lacks robust coupling, the organization cannot prove which evidence was available at the time of the decision. If actuation lacks controlled pathways, the organization cannot prove who authorized change. Therefore, DTO governance requires explicit “evidence-to-action” binding.

The risk profile of semi-autonomy is clarified by oversight research and HITL error studies. Operational oversight frameworks conceptualize oversight as a recursive governance mechanism embedded within organizational control loops, extending beyond safety to encompass compliance, ethics, and business objectives [10]. Complementarily, experimental evidence shows that human judgment accuracy can degrade when people receive incorrect algorithmic advice, especially

when such advice precedes independent judgment, indicating that naïve human-in-the-loop designs do not automatically protect governance quality [1]. Consequently, DTO-centered corporate governance benefits more from human-on-the-loop: humans supervise system behavior through dashboards, audits, thresholds, and exception handling, intervening when critical triggers fire, rather than routinely co-deciding every micro-decision.

A domain-specific implication for AI-enabled real-estate operations follows. Customer support, sales qualification, and guest messaging are information-dense and repetitive; they generate high-volume traces suitable for DTO learning

and control, while error costs vary by decision class. Facility-management digital twin frameworks integrating BIM, IoT, and GIS demonstrate that real-estate operational layers can be synchronized with a digital representation to support lifecycle decisions, monitoring, and reconfiguration, offering a concrete pathway for DTO expansion from asset-level twins toward organizational governance twins that unify operational and managerial traces [7]. This supports a staged DTO strategy: begin with trace discipline in customer and operations workflows, extend to property and facility telemetry integration, then consolidate into DTO governance loops (see figure 1).

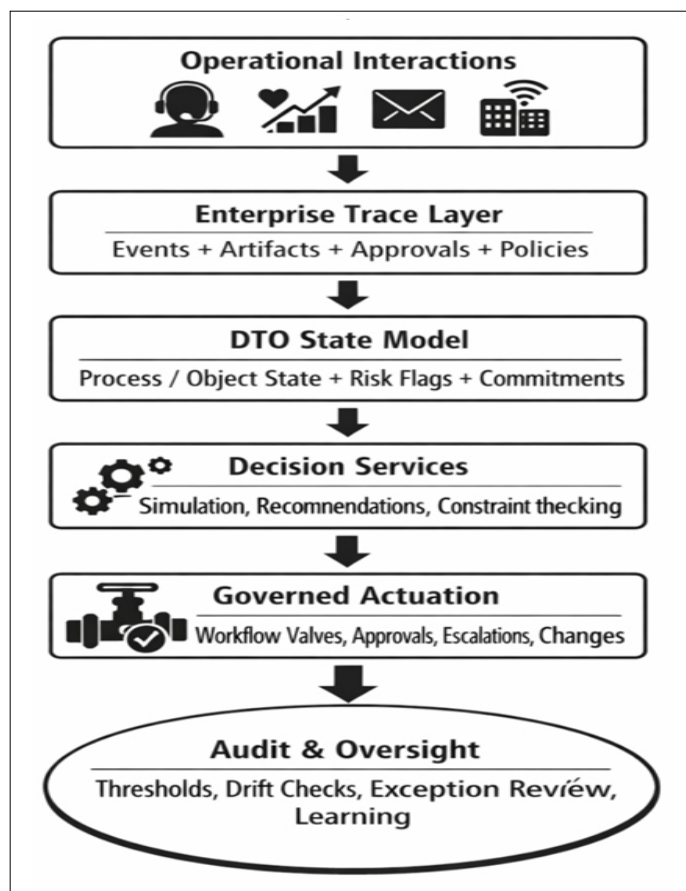


Figure 1. Digital-trace-driven DTO governance loop for AI-enabled real-estate operations (conceptual synthesis, adapted from [9], [11], and aligned with data-management requirements [8]).

DTO governance becomes credible when trace capture, model synchronization, and actuation are connected through controlled enterprise pathways, enabling post-hoc reconstruction and ex-ante constraint enforcement, while maintaining data quality, lineage, and security needed for auditability, and supporting decision simulation for strategic and operational alignment.

DISCUSSION

DTO implementation for corporate governance can be interpreted as a redesign of the organizational control architecture: decisions migrate from informal human coordination to traceable, policy-bound execution [4]. The literature indicates that governance failures in digital twin programs often originate in non-technical gaps—fragmented standards, unclear incentives, and cybersecurity weaknesses—rather than in the modeling layer alone [2]. For corporate DTOs, these gaps become amplified because the DTO concentrates governance authority: once actuation pathways exist, weaknesses propagate faster. The maturity perspective suggests that governance legitimacy and stakeholder trust scale only when interoperability and accountability mature in parallel with technical capability [3]. The DTO governance control map for corporate implementation is shown in table 1.

Table 1. DTO governance control map for corporate implementation (synthesized from governance-gap pillars and maturity staging) [2], [3], [8], [10]

Governance focus	DTO requirement in practice	Control mechanism in corporate governance
Trace completeness	Every decision leaves a structured trail	Mandatory logging of approvals, exceptions, and artifacts; “no-corridor-decision” rule operationalized through systems
Interoperability	Shared semantics across tools and units	Standard event taxonomy; canonical identifiers for deals, properties, tenants, tasks
Policy enforceability	Rules bind decisions before execution	Action-oriented “valves,” approval thresholds, and automated escalation for high-risk actions
Cybersecurity & access tiers	Governance authority protected from misuse	Role-based access, segregation of duties, and audit trails for policy edits
Model credibility	DTO reflects the current operational state	Real-time coupling; drift detection; data-quality gates
Oversight design	Human supervision targets critical points	Human-on-the-loop dashboards, exception queues, periodic audits

DTO governance success depends on coupling technical architecture with enforceable organizational rules. Without controls on trace discipline and policy edits, DTO centralization can weaken governance by creating opaque automation. Oversight research frames this problem as recursive control: oversight must apply not only to model outputs, but to model updates, data pipelines, and actuation pathways [10]. HITL error evidence further implies that “keeping a human in the loop” is insufficient when workflow design biases human judgment toward algorithmic suggestions; governance gains emerge when the system forces independent human assessment for critical cases, and reserves routine flows for automated execution under strict constraints [1].

A specific corporate-governance pathway for the заказчик’s specialization—AI in real-estate management—follows from combining DTO actuation with human-on-the-loop escalation. Customer support and guest communication can be governed through response policy libraries, escalation triggers, and compliance checks. In contrast, e-sales decisions can be governed through risk-tiered approvals (pricing exceptions, contractual deviations, identity verification anomalies). AI-twin evidence indicates that many digital twin solutions emphasize AI testing while leaving real-time coupling and actuation weak [5]; therefore, a DTO program in real estate should treat trace-first implementation as the dominant workstream, then add AI decision services only when trace coverage and policy enforcement reach stable maturity [3], [8] (see table 2).

Table 2. Governance-oriented DTO implementation roadmap for AI-enabled real-estate operations (analytical synthesis) [3], [7–11]

Stage	What is implemented	Governance deliverable	Oversight regime
Stage 1: Trace discipline	Unified event capture across support, sales, and guest ops	Auditable decision records, lineage for artifacts, and approvals	Manual audits + sampled reviews
Stage 2: DTO state model	Process/object state reconstruction from events	Near-real-time operational visibility, responsibility attribution	Oversight dashboards for exceptions
Stage 3: Controlled actuation	Valves, escalation rules, policy-bounded automation	Enforceable constraints; reduced informal decision channels	Human-on-the-loop for high-risk triggers
Stage 4: AI decision services	Recommendations, anomaly detection, simulation	Evidence-backed guidance with traceable rationales	Independent review for critical categories
Stage 5: Semi-autonomy	Routine decisions are executed automatically under constraints	Stable governance loop with measurable compliance	Human intervention only for critical incidents

The roadmap implies a governance threshold for moving toward semi-autonomy: (i) verifiable trace completeness for decision-critical flows; (ii) stable data-management practices for DTO pipelines; (iii) explicit actuation controls that prevent silent policy drift; (iv) oversight mechanisms that monitor system behavior rather than rubber-stamping outputs. Data-management evidence supports the centrality of lineage and quality controls as persistent requirements across stages. Facility-management digital twin frameworks provide a concrete anchor for real-estate operational synchronization, enabling DTO expansion beyond messaging and workflows into asset- and facility-telemetry integration, thereby strengthening governance by connecting operational reality to financial and compliance decisions.

CONCLUSION

The analysis supports three conclusions aligned with the study tasks. First, DTO adoption for corporate governance is justified when the organization commits to trace-centric governance: every managerial and operational decision must be recorded as a structured digital trail, enabling reconstruction, accountability attribution, and feedback learning. Second, DTO feasibility depends on architectural and data prerequisites—such as semantic interoperability, lineage-preserving storage, security tiers, and synchronization routines—because weak data governance undermines any claim of auditable decision-making. Third, the transition toward semi-autonomous organizational decision-making is more defensible under human-on-the-loop oversight than under routine human-in-the-loop participation, since governance quality depends on exception-based intervention, rigorous control levers, and systematic audits rather than on constant co-decisioning.

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