

ASM-OPEAX-S.P.I.A³ as a Governance Architecture for Co-Agency in the 5.0 Paradigm

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ABSTRACT: This paper contextualises the ASM-OPEAX-S.P.I.A³ model as a governance architecture for human-AI co-agency in the Paradigm 5.0. The model integrates: (i) ASM, which defines roles, responsibilities, controls and traceability for agentic socio-technical systems; (ii) OPEAX, which structures the cognitive DNA of judgment through ontological, epistemic, axiological and pragmatic dimensions; and (iii) S.P.I.A³, which operationalizes generative action across spatial, polycentric and intelligent domains, enabled by anticipation, ambidexterity and antifragility. We discuss how the F.L.I.P. threshold serves as an inversion mechanism, converting complexity diagnosis into a generative transformation. The contribution is a coherent, multi-level device for governing the quality of judgment and value orientation toward the common good in innovation ecosystems and critical infrastructures under conditions of high interdependence.

KEYWORDS: Co-agency, AI governance, agentic systems, ASM, OPEAX, S.P.I.A³, Paradigm 5.0, common good, antifragility, generative capacity.

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Introduction

The growing integration of artificial intelligence systems into organisational processes has rendered it inadequate to treat the technical dimension in isolation from the institutional, cognitive, and organisational dimensions. In many contexts, what is observed is not only automation or digitization, but a condition of co-agency in which human actors, procedures, platforms, recommendation systems, and intelligent models participate, in asymmetrical yet interdependent ways, in the production of judgment and action (Casale, Fernandez, & Rinaldi, 2025; Casale et al., 2025; Casale & Rinaldi, 2024). In this setting, the key issue is no longer only algorithmic performance, but the quality of organisational coexistence among different agents, the distribution of responsibility, the traceability of decision pathways, and the axiological orientation of the system.

The ASM-OPEAX-S.P.I.A³ model is positioned precisely in this theoretical and operational space and proposes a governance architecture that treats co-agency not as a side effect of technological adoption, but as an explicit object of design and governance (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025). Its scientific relevance lies in its ability to integrate three levels that are often handled separately, namely the cognitive level of judgment, the dynamic level of transformation under complexity, and the institutional level of responsibility. This paper aims to contextualize the model within the body of work related to the 5.0 Paradigm, common-good-oriented innovation governance, organizational antifragility, and the emerging category of generative capacity (Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2024; Casale & Rinaldi, 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b; Casale et al., 2026).

Analysis of recent research and publications

A first axis of contextualization is the 5.0 Paradigm, understood as a framework in which socio-technical transformation cannot be reduced to efficiency, automation, or compliance alone, but requires integration among human centrality, responsibility, sustainability, transformative capacity, and orientation toward the common good (Casale et al., 2025; Casale & Rinaldi, 2024). In this perspective, governance becomes a structural issue because the paradigm must be translated into verifiable organisational architectures. The proposal to formalise Industry 5.0 in governance terms is therefore a crucial reference, and the ASM-OPEAX-S.P.I.A³ model can be read as a coherent operationalisation of that need (Casale et al., 2025; Casale & Rinaldi, 2024).

A second axis is the trajectory that interprets innovation as a process oriented toward the common good and shared value rather than as the mere production of competitive advantage. The works on innovation ecosystems in the 5.0 era and on innovation oriented to the common good show that value emerges from multi-actor configurations, cooperative logics, and governance structures that connect social purpose, organisational capability, and learning (Casale et al., 2025; Casale et al., 2025). This is central for the model because the reference to the common good is not decorative, but functions as a

criterion for the quality of co-agency and for the configuration of knowledge blocks and decision thresholds (Casale, Fernandez, & Rinaldi, 2025; Casale et al., 2025; Casale et al., 2025; Casale & Rinaldi, 2024).

A third axis concerns organisational antifragility and the evolution of innovation management. The antifragility trajectory moves beyond resilience, placing learning from tensions, deviations, and discontinuities at the core of a system's evolutionary capacity (Casale et al., 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b). S.P.I.A³ is fully aligned with this line of thought. It can be seen as a mature generative framework because it integrates antifragility with spatial reading of value, polycentric governance, and the quality of judgment in intelligent decision processes (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b).

Formulation of the purpose of the article

The purpose of the article is to contextualise the ASM-OPEAX-S.P.I.A³ model within the Paradigm 5.0 literature and to define its contribution as a multi-level governance device for traceable, value-oriented co-agency between humans and AI in high-interdependence settings.

Presentation of the main material (research results)

This paper adopts a theoretical-conceptual and interpretive approach. It does not aim to validate the model in a single case study empirically, but to provide a systematic contextualization of its conceptual architecture and its research trajectory across the 5.0 Paradigm, common-good-oriented innovation governance, organizational antifragility, and the category of generative capacity (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2024; Casale & Rinaldi, 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b; Casale et al., 2026).

The analysis is developed on three intertwined levels. The first reconstructs the internal architecture of the model and the functional relations among ASM, OPEAX, S.P.I.A³, and the F.L.I.P. threshold (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025). The second positions the model within the broader theoretical framework of the 5.0 Paradigm and related contributions on governance, common good, and antifragility (Casale et al., 2025; Casale et al., 2024; Casale & Rinaldi, 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b). The third proposes a prospective reading that connects the model to the explicit reference to Industry 6.0 as a meta-systemic horizon of reflexive governance (Casale et al., 2026).

Model architecture and theoretical contextualization

ASM (Agentic System Management) is the outer ring and the overall governance level of the model. It starts from the assumption that contemporary organisations are already agentic environments composed of heterogeneous agents, including people, procedures, platforms, recommendation systems, intelligent models, and formal rules that interact in the production of judgment and action

(Casale, Fernandez, & Rinaldi, 2025). The core governance task is therefore not simply to introduce AI, but to design and govern how human and artificial agents cooperate, enter into tension, and shape responsibilities. ASM operates as a governance stance that makes co-agency visible and governs its institutional and cognitive quality through safeguards such as meaningful human control, traceability of judgment, clarity of responsibilities, and attention to concrete consequences (Casale, Fernandez, & Rinaldi, 2025; Casale et al., 2025; Casale et al., 2025; Casale & Rinaldi, 2024).

OPEAX is the cognitive and value-based core of the architecture and can be understood as the model's cognitive DNA (Casale, Fernandez, & Rinaldi, 2025). It occupies the centre of the concentric structure because it makes explicit the conditions for judging quality before rules and procedures are defined. Its four dimensions are ontological, epistemic, axiological, and pragmatic. Together, they clarify what the system recognises as real and relevant, how knowledge is built and validated, which values orient choices and thresholds, and what concrete effects decisions are expected to generate in practices, relationships, and institutional arrangements (Casale, Fernandez, & Rinaldi, 2025; Casale & Rinaldi, 2024). In this sense, OPEAX formalises a meta-governance level that many governance architectures leave implicit.

A particularly original feature of the model is the notion of knowledge blocks, understood as modular units of knowledge rather than isolated data points. These blocks may include standards, guidelines, ethical frameworks, case repertoires, evidence bases, and structured datasets, and can be combined into different cognitive genomes adaptable to different contexts (Casale, Fernandez, & Rinaldi, 2025). The logic is modular and plug-and-play but not arbitrary, because every composition must remain coherent with the cognitive DNA defined by OPEAX. This makes governance a documentable cognitive architecture capable of integrating heterogeneous sources while preserving a stable orientation toward value and responsibility (Casale et al., 2025; Casale & Rinaldi, 2024).

S.P.I.A³ is the intermediate ring and acts as the model's generative and operational framework. Its function is to translate the reading of complexity into a grammar of transformative action, avoiding both reductive simplification and uncontrolled proliferation of variables (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025). Emerging from the F.L.I.P. trajectory and from engagement with diagnostic complexity frameworks, S.P.I.A³ goes beyond classification and provides a structured way to act under non-linearity and high interdependence with a view to regeneration, learning, and shared value (Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2025; Casale et al., 2024).

The framework is grounded in three integrated domains: spatial, polycentric, and intelligent (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025). The spatial domain reads where value is generated, dispersed, or blocked across physical, environmental, and digital spaces, which is essential in territorial and infrastructure contexts (Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2025; Casale & Rinaldi, 2024). The polycentric domain recognises that decisions are distributed across multiple centres and that governance quality depends on coordination, legitimacy, and proximity to

decisions among different nodes (Casale et al., 2025; Casale & Rinaldi, 2024). The intelligent domain concerns the quality of decision processes rather than technological intensity alone, and includes explainability, traceability of judgment, relevance of information, and meaningful human control in critical passages (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025).

Interwoven with these domains are three enabling capacities, anticipation, ambidexterity, and antifragility (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b). Anticipation involves preparing scenarios, options, and action thresholds before discontinuities fully emerge. Ambidexterity concerns the ability to preserve operational continuity while enabling exploration and innovation. Antifragility concerns the capacity to transform tensions, deviations, weak signals, and discontinuities into learning and design improvement. Their integration avoids hierarchical readings and supports an evolutionary dynamic coherent with the broader antifragility trajectory (Casale et al., 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b).

The F.L.I.P. threshold is a decisive dynamic element of the model and can be understood as the inversion point between diagnostic reading of complexity and governed transformative action (Casale & Fernandez, 2025). At this threshold, pressures, deviations, near misses, and weak signals cease to be treated as noise and become intentional material for learning and regeneration. OPEAX provides the cognitive foundation, S.P.I.A³ provides the grammar of action, ASM governs responsibilities, and the F.L.I.P. threshold makes the passage from observed fragility to designed transformation dynamically possible (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2024).

Scientific discussion

A first scientific implication of the model is that it is not merely a framework for AI adoption but a theory of co-agency governance (Casale et al., 2025; Casale & Rinaldi, 2024). This matters because it shifts the analytical focus from technology alone to the institutional quality of socio-technical integration, placing responsibility, traceability, and orientation toward the common good at the centre. In this sense, the model can productively dialogue with research on socio-technical systems, polycentric governance, and multi-agent organisational architectures (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025).

A second implication concerns OPEAX and the formalisation of the cognitive level of organisational decision-making. OPEAX makes explicit what often remains implicit in governance practice, namely the dependence of decisions on ontological, epistemic, axiological, and pragmatic premises (Casale, Fernandez, & Rinaldi, 2025; Casale & Rinaldi, 2024). This is especially relevant in contexts of high technological intensity and institutional impact, where judgment quality cannot be assessed solely ex post but requires ex ante clarification of the criteria for reality, evidence, value, and expected effects.

A third implication concerns the treatment of complexity. The F.L.I.P.-to-S.P.I.A³ trajectory offers a non-defensive reading in which complexity becomes a field of generative capacity rather than only a risk

condition (Casale & Fernandez, 2025; Casale et al., 2024; Casale & Rinaldi, 2025a; Casale & Rinaldi, 2025b). The strong point is the connection between the three domains and the triad of anticipation, ambidexterity, and antifragility, which links systemic reading, design, and learning in a coherent operational grammar. This is particularly relevant for innovation ecosystems, territorial systems, and critical infrastructures characterised by distributed value and multi-actor decision-making (Casale et al., 2025; Casale & Rinaldi, 2024).

The model also has an explicitly applicative vocation because it is structured to be documentable, verifiable, and transferable across domains while preserving conceptual coherence and operational adaptability (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025). This makes it suitable for dialogue with management systems and regulated environments. At the same time, it opens a research agenda on indicators and metrics coherent with the three architectural levels, with organizational agentic maturity, and with the quality of co-agency in terms of human control, traceability, and shared-value orientation (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2025).

In a prospective view, the model can be further strengthened in light of the contribution "From Productivity to Generative Capacity", where the reference to Industry 6.0 is explicit and conceptually central (Casale et al., 2026). In that work, Industry 6.0 is not framed as a new technological phase, but as a meta-systemic horizon in which the central issue becomes the reflexive governance of generative capacity over the long term. This perspective is highly relevant here because it allows ASM to be interpreted as a governance stance for generative trajectories, OPEAX as a cognitive infrastructure for making and renegotiating the criteria of generativity explicit, and S.P.I.A³ as an operational grammar for translating that orientation into observable and governable transformative capacities (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2026). In this light, the F.L.I.P. threshold can also be read as compatible with a longer-term governance logic in which systems not only learn from shocks but also progressively renegotiate value criteria and direction in light of the effects produced (Casale & Fernandez, 2025; Casale et al., 2026).

The main limitation of this paper is its theoretical and conceptual nature. A robust contextualization does not replace the need for empirical and comparative studies in differentiated application domains such as digital public services, critical infrastructures, production networks, and innovation ecosystems (Casale, Fernandez, & Rinaldi, 2025; Casale et al., 2025; Casale et al., 2025; Casale & Rinaldi, 2024). Future work should also address metric formalisation across the ASM, OPEAX, and S.P.I.A³ levels and further explore the relationship between co-agency and generative capacity in the long-term horizon associated with Industry 6.0 (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2026).

Conclusions

The ASM-OPEAX-S.P.I.A³ model can be interpreted as a theoretically and operationally significant architecture for research on the governance of socio-technical transformation within the 5.0 Paradigm. Its originality lies in integrating, within a single framework, the governance frame of co-agency, the cognitive safeguard of judgment, and the generative grammar of transformation under complexity, while maintaining a clear orientation toward the common good and shared value (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2024; Casale & Rinaldi, 2024).

The contextualization proposed in this paper shows that the model is not only a device for governing AI adoption but a broader architecture for organisations, networks, and ecosystems operating under complexity, polycentricity, and interdependence. From this standpoint, the quality of coexistence between human and artificial agents becomes a major scientific, organisational, and institutional issue (Casale, Fernandez, & Rinaldi, 2025; Casale & Fernandez, 2025; Casale et al., 2025; Casale et al., 2025; Casale et al., 2024; Casale & Rinaldi, 2024).

The prospective opening toward generative capacity and the explicit Industry 6.0 horizon further strengthen the model's relevance, because it allows co-agency to be evaluated not only in terms of efficiency or technological adoption, but also in relation to responsibility, direction of value, and the evolutionary sustainability of socio-technical systems over time (Casale et al., 2026).

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