

Aligning Regional Innovation Ecosystems: The MEAM-3LAM Model and CAM Actor Mapping

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Abstract: This paper presents an integrated framework for analyzing and developing regional innovation ecosystems through the combination of three complementary models: the METRIC Ecosystem Actor Model (MEAM v2), the Three-Layer Alignment Model (3LAM), and the Conceptual Actor Mapping (CAM) methodology. MEAM v2 provides a comprehensive taxonomy of innovation ecosystem actors organized by function (Innovation Development, Innovation Support, and Structural Support) and categorized into ten distinct actor types. The 3LAM model adds vertical dimension by distinguishing between Public Innovation Ecosystems (PIE), Business Innovation Ecosystems (BIE), and Innovation Management Systems (IMS). CAM operationalizes these frameworks through a four-step diagnostic process. The integration of these three models offers practitioners and policymakers a robust toolkit for ecosystem assessment, gap identification, and strategic intervention design. Based on extensive literature review and empirical testing with 1,682 firms across Swedish regions, this framework provides actionable insights for enhancing innovation ecosystem performance through improved actor alignment and orchestration.

Keywords: Innovation ecosystems, Actor taxonomy, Governance layers, Ecosystem diagnostics, MEAM, 3LAM

1. Introduction

Innovation ecosystems have emerged as critical determinants of regional competitiveness and economic development. These complex, multi-actor environments depend on effective interactions between diverse stakeholders to generate value and drive innovation (Stam and Spigel, 2018). However, despite growing recognition of their importance, practitioners and policymakers often struggle with the lack of structured tools to analyze actor configurations, identify systemic gaps, and design targeted interventions that enhance ecosystem performance.

This paper addresses this challenge by presenting an integrated framework that combines three complementary models developed through extensive research and empirical testing. The METRIC Ecosystem Actor Model (MEAM v2) provides a functional taxonomy of innovation actors, categorizing them into ten distinct types across three core functions (Ozan et al., 2024). The Three-Layer Alignment Model (3LAM) adds a vertical governance perspective by distinguishing between public, business, and organizational innovation layers. Finally, the Conceptual Actor Mapping (CAM) methodology operationalizes these frameworks through practical diagnostic tools that enable systematic ecosystem analysis.

The integration of these three models represents a significant advance in innovation ecosystem analysis. Unlike existing approaches that often focus on single dimensions or rely on generic stakeholder categories, this framework offers granular actor classification while maintaining a systemic perspective. It captures both horizontal functional relationships and vertical governance dynamics, providing practitioners with actionable diagnostic tools. This paper demonstrates how the synergistic combination of MEAM, 3LAM, and CAM creates a comprehensive toolkit for ecosystem assessment, gap identification, and strategic intervention design.

The strategic relevance of innovation ecosystems lies in their potential to align diverse stakeholders, drive knowledge exchange, and accelerate regional economic transformation. Yet, persistent analytical blind spots, particularly regarding support roles, governance alignment, and role-based diagnostics, limit their effectiveness. Given the increasing role of regional innovation ecosystems in determining long-term economic resilience and technological competitiveness, the lack of structured and multi-layered analysis tools presents a significant barrier to both public policy effectiveness and firm-level innovation uptake. Without clear diagnostic frameworks, investments risk misalignment and ecosystem initiatives underperform. This paper addresses these challenges by offering a model-based approach that enables more actionable, actor-specific insights for both research and policy application.

2. The MEAM v2 Actor Taxonomy

The METRIC Ecosystem Actor Model version 2 represents a refined taxonomy that emerged from comprehensive literature analysis spanning 2015 to 2025. The model organizes innovation ecosystem actors according to three core functions that capture the essential activities required for effective innovation systems.

Innovation Development encompasses those actors directly involved in generating and commercializing innovations. Within this function, Research actors such as universities, public research organizations, and corporate R&D departments generate new knowledge through basic or applied research (Tolstykh et al., 2021). Entrepreneurship actors, including startups, spin-offs, and corporate venture units, initiate innovation through new venture creation and intrapreneurship (Stam, 2015). Competence actors, comprising technical universities, vocational institutions, and training centers, develop the skills and human capital essential for innovation absorption and implementation.

The Innovation Support function includes actors providing specialized services that enable innovation processes. Advisory actors offer technical, legal, and strategic expertise crucial for navigating complex innovation challenges. Finance actors, ranging from venture capital firms to public funding agencies, supply the capital and de-risking mechanisms necessary for innovation investment. Development actors, including technology parks and prototyping labs, translate research outputs into marketable solutions by bridging the gap between invention and commercialization.

Structural Support comprises actors creating the enabling conditions for innovation to flourish. Networking actors such as industry associations and innovation platforms facilitate information exchange and collaboration across organizational boundaries (Gamidullaeva, 2018). Ecosystem Orchestration actors, including cluster organizations and regional innovation offices, coordinate activities and align ecosystem goals across multiple stakeholders (Masucci et al., 2020). Policy Management actors shape institutional frameworks, priorities, and incentives that guide innovation direction. Education actors provide the foundational knowledge and long-term capability development that underpin innovation capacity.

This functional organization addresses a critical gap identified in the literature review. While existing frameworks adequately represented Knowledge and Market domains, Support functions remained consistently underdeveloped across taxonomies (Madanaguli et al., 2021). MEAM v2 rectifies this through expanded categorization of orchestration, intermediation, and capability-building roles that prove essential for ecosystem effectiveness. This distinction is theoretically important because the effectiveness of an ecosystem often hinges not just on the presence of innovators and funders, but on the strength of enabling actors who connect, guide, and translate across functions and layers. Practically, overlooking these support roles leads to fragmented systems where policies fail to reach firms, and research fails to commercialize. The enhanced taxonomy in MEAM v2 enables policymakers and practitioners to identify structural holes, such as absent IP advisors or weak ecosystem orchestrators that may otherwise remain invisible in standard stakeholder mappings.

3. The Three-Layer Alignment Model (3LAM)

The Three-Layer Alignment Model provides a vertical dimension to ecosystem analysis by distinguishing three nested governance contexts where innovation occurs. This layered perspective recognizes that actors operate within different institutional logics and governance arrangements that fundamentally shape their roles and interactions.

Public Innovation Ecosystems (PIE) represent the outermost layer, encompassing policy frameworks, public funding mechanisms, and strategic coordination at regional or national levels. Within this layer, actors such as ministries, development agencies, and public orchestrators operate under formal mandates and public accountability structures. These actors engage in meta-governance activities, increasingly moving from hierarchical control toward collaborative approaches that promote stakeholder engagement and cross-sectoral alignment (Sørensen and Torfing, 2016). The PIE layer establishes the institutional conditions, regulatory frameworks, and strategic priorities that shape innovation trajectories across the ecosystem.

Business Innovation Ecosystems (BIE) comprise the middle layer, consisting of market-driven networks where firms, intermediaries, and platforms engage in collaborative innovation. This layer includes clusters, accelerators, industry associations, and other entities operating through hybrid governance arrangements that blend market mechanisms with collaborative structures (Wang et al., 2022). BIE actors navigate the tension

between competition and cooperation, creating value through shared resources, knowledge spillovers, and collective capability building. The governance logic here emphasizes flexibility, reciprocity, and mutual benefit rather than hierarchical control.

Innovation Management Systems (IMS) form the innermost layer, representing the internal organizational capabilities through which individual entities manage innovation. This includes R&D units, innovation managers, corporate venture arms, and other functions operating under firm-specific governance. While seemingly contained within organizational boundaries, IMS capabilities fundamentally determine how effectively organizations can absorb external knowledge, participate in collaborative innovation, and translate opportunities into tangible outcomes.

The power of 3LAM lies in recognizing the interdependencies between these layers. Policy frameworks established at the PIE level shape market conditions within BIE, which in turn influence the development of firm-level capabilities in IMS. Conversely, innovations emerging from individual organizations aggregate into business ecosystem dynamics, which inform and sometimes challenge existing policy frameworks (Liu et al., 2022). Understanding these vertical linkages proves crucial for designing interventions that account for systemic effects rather than treating each layer in isolation.

4. The Conceptual Actor Mapping (CAM) Methodology

The Conceptual Actor Mapping methodology transforms the theoretical insights of MEAM and 3LAM into practical diagnostic tools. CAM emerged from the recognition that even well-designed taxonomies often fail to generate actionable insights due to the lack of systematic implementation methods. The methodology provides a structured four-step process that guides practitioners through comprehensive ecosystem analysis.

The process begins with Scope Definition, where analysts establish the geographic or institutional boundaries of their analysis, determine which governance layers to prioritize, and clarify specific analytical goals. This crucial first step ensures that subsequent analysis remains focused and relevant to stakeholder needs. Whether examining a regional innovation system, an industry cluster, or a specific innovation program, clear scope definition prevents the common pitfall of attempting overly broad analysis that yields generic insights.

Actor Elicitation follows, involving the systematic identification and categorization of ecosystem participants. Using MEAM v2 as a template, practitioners map known stakeholders to the ten actor categories while simultaneously tagging them according to their primary and secondary governance layers from the 3LAM model. This dual classification reveals not only what types of actors are present but also where they operate within the governance hierarchy. The process often uncovers previously overlooked actors and highlights those performing multiple roles across categories or layers.

The construction of Role-Interaction Matrices represents the analytical core of CAM. These matrices visualize actor presence, role intensity, and engagement patterns across governance layers. By arranging MEAM categories as rows and 3LAM layers as columns, practitioners can quickly identify where roles are well-populated, where functional redundancy exists, and where structural holes may hinder system performance. The matrices support both qualitative assessment and semi-quantitative scoring, accommodating varying levels of data availability.

Gap-Impact Assessment completes the diagnostic process by interpreting matrix patterns to identify strategic priorities. This step moves beyond simple gap identification to assess the systemic impact of missing or weak actor roles. For instance, the absence of orchestration actors may have cascading effects on collaboration patterns throughout the ecosystem. Similarly, overextended actors attempting to fill multiple roles may indicate systemic vulnerabilities. The assessment generates actionable recommendations for capacity building, institutional development, or strategic recruitment of missing actor types.

CAM's flexibility allows adaptation to various contexts and purposes. The methodology scales from rapid participatory workshops using simplified visual tools to comprehensive multi-stakeholder assessments employing detailed quantitative metrics. This adaptability, combined with its grounding in robust theoretical frameworks, enables CAM to bridge the persistent gap between academic ecosystem models and practical implementation challenges (Talmar et al., 2020).

5. Integration: The MEAM–3LAM–CAM Framework

The true innovation of this research lies not in the individual models but in their integration into a coherent framework that captures the multi-dimensional nature of innovation ecosystems. MEAM provides the

functional taxonomy answering "what types of actors exist," 3LAM adds the governance perspective explaining "where these actors operate," and CAM supplies the methodology for "how to analyze and improve actor configurations." This integration enables comprehensive ecosystem analysis that would be impossible using any single approach.

Table 1 illustrates this integration by mapping MEAM actor categories across 3LAM governance layers, revealing crucial patterns in actor distribution and engagement.

Table 1: Actor categories by layer relevance (PIE, BIE, IMS)

Actor category	PIE	BIE	IMS	Notes on layer engagement
Research	✓	✓	✓	Universities, research institutes span all layers through funding, partnerships, and internal labs
Entrepreneurship		✓	✓	Startups and intrapreneurs mainly drive firm-level innovation and external ventures
Competence	✓	✓		Training centers and universities support both public and business innovation readiness
Advisory	✓	✓	✓	Consultants and legal/technical advisors work across layers via services and contracts
Finance	✓	✓		Venture capitalists, grant agencies, and funders shape PIE and BIE innovation investments
Development		✓	✓	Applied R&D and technical centers enable translation from ideas to implementation
Networking	✓	✓		Clusters and industry groups link public actors and businesses through collaboration
Ecosystem orchestration	✓	✓		Innovation offices, cluster organizations, and intermediaries align actors and strategies
Policy management	✓			Ministries, innovation agencies function primarily at the PIE level
Education	✓		✓	Universities contribute foundational knowledge and internal firm training efforts

This mapping reveals several important insights. Some actors, particularly Research and Advisory categories, operate across all three layers, serving as natural bridges between governance contexts. Others, such as Policy Management, remain firmly anchored in specific layers, reflecting their institutional mandates. The distribution patterns help explain common ecosystem challenges, such as the difficulty of translating policy initiatives into firm-level innovation when intermediary actors are absent or weak (Drori and Lavie, 2023).

The integrated framework supports multiple practical applications that demonstrate its value for ecosystem development. Ecosystem Baseline Assessment uses the framework to map current actor configurations, revealing structural strengths and weaknesses that might otherwise remain hidden. Gap Analysis compares actual versus ideal actor distributions, enabling evidence-based prioritization of capacity-building investments. Orchestration Design identifies missing or weak coordination mechanisms across layers, informing the development of new intermediary institutions or the strengthening of existing ones (Zohar et al., 2021). Policy Alignment ensures that public programs developed at the PIE level match the actual needs and capabilities present in BIE and IMS layers (Yaghmaie and Vanhaverbeke, 2019). For example, a regional development agency used the framework to identify the absence of local IP advisory actors, prompting the launch of a specialized support initiative. Similarly, a startup operating in green tech was able to locate funding and testing resources by navigating CAM maps co-created in its local innovation platform.

6. Empirical Insights and Validation

The literature review underpinning the development of MEAM v2 and the CAM methodology was conducted using Scite.ai alongside academic databases such as Scopus and Web of Science. A total of 108 peer-reviewed publications were identified through keyword-based relevance filtering (e.g., "innovation ecosystem actors," "regional governance," "ecosystem diagnostics") and citation prioritization. The selection emphasized functional diversity (innovation development, support, and structural roles) and ensured topical alignment with the actor-role categories defined in the MEAM framework. The framework underwent extensive empirical testing through regional innovation diagnostics involving 1,682 firms across five Swedish regions (Ozan et al., 2024). This large-scale application provided valuable validation of the framework's diagnostic

power while revealing systemic patterns that would have remained invisible using traditional analytical approaches. The empirical testing was supported by a large-scale survey conducted by the research company Verian (formerly Kantar Public), targeting SMEs and large firms across five Swedish regions. A total of 1,682 companies responded to structured paper survey and follow-up telephone interviews, based on a standardized questionnaire focusing on innovation management practices, support actor interactions, and public program engagement. The survey covered topics such as the use of structured innovation systems, cooperation with intermediaries, and access to innovation support. The results were analyzed by region and sector, providing a consistent dataset for evaluating the presence of capability gaps and validating CAM-based diagnostics. The same questionnaire and sampling methodology can be replicated in other regions to produce comparable insights.

The findings painted a sobering picture of innovation ecosystem maturity. Only 17% of participating firms reported applying systematic innovation management practices, such as those aligned with ISO 56002 standards. Using the integrated framework, this low adoption rate could be traced to specific gaps in the ecosystem architecture. The absence or weakness of competence-building actors meant that firms lacked access to the training and support needed to develop formal innovation management capabilities. Furthermore, the limited presence of advisory actors specializing in innovation management left firms without guidance on implementing systematic approaches.

Public program engagement proved equally revealing. Despite substantial public investment in innovation support, only 22% of firms had engaged with regional programs in the previous year. The framework analysis revealed this was not simply a communication or marketing failure. Instead, it reflected a fundamental misalignment between program design at the PIE level and actual firm needs at the BIE and IMS levels. Specifically, the weak presence of intermediary actors who could translate between policy language and business requirements created a structural barrier to program utilization.

Collaboration patterns provided additional validation of the framework's analytical value. Only 18% of firms reported collaboration with intermediaries, and just 13% had partnered with universities or research organizations. The CAM matrices clearly illustrated how gaps in orchestration roles created isolated pockets of activity rather than the interconnected networks characteristic of thriving innovation ecosystems. Without actors dedicated to relationship building and network facilitation, potential collaborations remained unrealized despite geographic proximity and complementary capabilities.

These empirical findings demonstrate how the integrated framework moves beyond surface-level symptoms to reveal underlying structural causes. Rather than simply noting low collaboration rates, the framework identifies specific missing actor roles and governance misalignments that create systemic barriers to innovation. This diagnostic precision enables targeted interventions addressing root causes rather than symptoms.

7. Discussion and Implications

The MEAM–3LAM–CAM integrated framework represents a significant theoretical and practical advance in innovation ecosystem analysis. Theoretically, it contributes to ecosystem literature by providing the most comprehensive actor taxonomy developed to date, specifically addressing previous gaps in Support function categorization. The framework successfully integrates horizontal functional perspectives with vertical governance considerations, previously treated as separate analytical domains (Cooke, 2016). Most importantly, it bridges the persistent gap between conceptual frameworks and operational diagnostics, offering a pathway from theoretical understanding to practical application.

For practitioners, the framework offers transformative benefits. It enables movement beyond generic "triple helix" or "quadruple helix" approaches toward role-specific analysis that captures the true complexity of modern innovation ecosystems. The systemic perspective helps practitioners understand how actor gaps in one layer cascade through the entire ecosystem, creating bottlenecks and inefficiencies. By transforming complex ecosystem dynamics into concrete intervention targets, the framework supports evidence-based decision-making. The standardized categories and methods also enable meaningful comparative analysis across regions, sectors, or time periods. For example, a start-up navigating a regional innovation ecosystem can use the CAM framework to identify missing support roles, such as seed-stage financing, IP advisory, or prototype testing facilities, and align its partnerships accordingly. Public-private partnerships (PPPs), such as regional energy transitions or health-tech accelerators, can use the integrated MEAM–3LAM–CAM framework

to coordinate actors across governance levels, ensuring policy goals at the public layer translate into business capabilities and innovation adoption at the firm level.

The framework's application reveals several critical insights for innovation policy and practice. First, the prevalent focus on creating new programs or institutions often overlooks the more fundamental need for orchestration and intermediation roles that connect existing actors. Second, the assumption that innovation support can be designed at the policy level and implemented directly at the firm level ignores the crucial translational role of BIE actors. Third, internal innovation management capabilities at the IMS level fundamentally determine whether firms can absorb and benefit from ecosystem resources, suggesting that capability building deserves equal attention to external support provision.

However, the framework also faces limitations requiring acknowledgment. Actor roles may vary significantly by sector or regional context, necessitating adaptive application rather than rigid implementation. The CAM methodology, while comprehensive, remains labor-intensive, requiring significant time and expertise for full implementation. Automation and digital tool development represent important areas for future development. Additionally, while tested in Swedish contexts, the framework requires validation across different cultural and institutional settings to ensure global applicability.

8. Conclusion

The MEAM–3LAM–CAM integrated framework offers a robust solution to the complex challenge of analyzing and developing innovation ecosystems. By combining functional taxonomy, governance layers, and diagnostic methodology, it provides practitioners and policymakers with comprehensive tools for ecosystem assessment and intervention design. The framework's strength lies fundamentally in the synergistic integration of its components rather than their individual contributions. MEAM's granular actor categorization gains strategic relevance through 3LAM's governance perspective, while both become actionable through CAM's diagnostic process (Zheng and Cai, 2022).

As innovation ecosystems grow in complexity and importance for economic development, the need for structured analytical frameworks becomes increasingly critical. This integrated approach offers a foundation for more effective ecosystem governance, supporting the transition from ad hoc coordination to strategic orchestration. It enables evidence-based decision-making by revealing the structural foundations of ecosystem performance and dysfunction (Santos et al., 2015).

Future development should focus on several key areas. Automation of CAM diagnostics would increase accessibility and reduce implementation barriers. Sectoral adaptations could capture industry-specific actor roles while maintaining comparability. Longitudinal studies tracking ecosystem evolution would validate the framework's predictive power. Integration with digital platforms could enable real-time ecosystem monitoring and adaptive governance.

The ultimate value of this framework lies in its potential to enhance innovation ecosystem performance through improved understanding and targeted intervention. By providing a common language and analytical structure, it enables more effective collaboration between researchers, policymakers, and practitioners. As regions worldwide seek to build competitive innovation ecosystems, the MEAM–3LAM–CAM framework offers a scientifically grounded yet practically applicable approach to this critical challenge.

Ethics declaration: This research did not require ethical clearance as it involved no human participants in experimental conditions, no collection of personal or sensitive data, and no interventions that could cause harm. The empirical data used in this study was collected as part of a regional innovation ecosystem assessment where firms participated voluntarily and all data was anonymized at the point of collection. The research was conducted in accordance with standard academic research ethics and institutional guidelines.

AI declaration: Artificial intelligence (AI) tools were used throughout this research project to enhance quality, efficiency, and linguistic clarity, without substituting the intellectual contribution or analytical responsibility of the authors. All key decisions, interpretations, and conclusions presented in the paper were made by the researchers, who retained full academic control and accountability at every stage. Specifically, Scite.ai was used during the literature review phase to assist in the identification and evaluation of relevant academic sources by querying research databases and contextualizing citations. ChatGPT (OpenAI) was employed during the planning process to explore methodological considerations, validate early conceptual design, and—importantly—to improve the academic tone and clarity of the English language throughout the manuscript, as the authors are non-native English speakers. ProWritingAid was used continuously as a proofreading tool to

refine grammar, style, and structure during writing. In the final stages, Claude (Anthropic) was used to support the structural alignment of content and to verify adherence to submission guidelines. The use of these tools was carefully managed to ensure that AI served as a supportive and augmentative resource, not a generative or decision-making agent. The authors affirm that all original ideas, arguments, and scholarly interpretations remain their own.

References

- Cooke, P. (2016) 'The virtues of variety in regional innovation systems and entrepreneurial ecosystems', *Journal of Open Innovation: Technology, Market, and Complexity*, 2(3).
- Drori, I. and Lavie, D. (2023) 'How Do Innovation Ecosystems Emerge? The Case of Nanotechnology in Israel', *Journal of Management Studies*, 61(8).
- Gamidullaeva, L. (2018) 'Towards combining the innovation ecosystem concept with intermediary approach to regional innovation development', *MATEC Web of Conferences*, 212.
- Liu, B. et al. (2022) 'An Evolutionary Analysis of Relational Governance in an Innovation Ecosystem', *Sage Open*, 12(2).
- Madanaguli, A. et al. (2021) 'The innovation ecosystem in rural tourism and hospitality -- a systematic review of innovation in rural tourism', *Journal of Knowledge Management*, 26(7).
- Masucci, M., Brusoni, S. and Cennamo, C. (2020) 'Removing bottlenecks in business ecosystems: The strategic role of outbound open innovation', *Research Policy*, 49(1).
- Ozan, H., Ferry, J. and Bieblad, L. (2024) *Measuring and Developing Regional Innovation Ecosystems - The METRIC Approach*.
- Santos, H.R. et al. (2015) 'Collaborative Innovation in the Public Sector a Case of the Brazilian Federal Government', in *Electronic Government and the Information Systems Perspective*, Springer, pp. 132-145.
- Sørensen, E. and Torfing, J. (2016) 'Metagoverning Collaborative Innovation in Governance Networks', *The American Review of Public Administration*, 47(7).
- Stam, E. (2015) 'Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique', *European Planning Studies*, 23(9).
- Stam, E. and Spigel, B. (2018) 'Entrepreneurial Ecosystems', *The SAGE Handbook of Small Business and Entrepreneurship*.
- Talmar, M. et al. (2020) 'Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model', *Long Range Planning*, 53(4), p. 101850.
- Tolstykh, T., Gamidullaeva, L. and Shmeleva, N. (2021) 'Universities as Knowledge Integrators and Cross-Industry Ecosystems: Self-Organizational Perspective', *Sage Open*, 11(1).
- Wang, C.-H., Chang, C.-H. and Lee, Z.C.R. (2022) 'Business-to-business platform ecosystem practices and their impacts on firm performance: evidence from high-tech manufacturing firms', *Journal of Manufacturing Technology Management*, 33(5).
- Yaghmaie, P. and Vanhaverbeke, W. (2019) 'Identifying and describing constituents of innovation ecosystems', *EuroMed Journal of Business*, 15(3).
- Zheng, X. and Cai, Y. (2022) 'Transforming Innovation Systems into Innovation Ecosystems: The Role of Public Policy', *Sustainability*, 14(12).
- Zohar, T., Parag, Y. and Ayalon, O. (2021) *Weaving an Innovation Network from the Middle Out: the Case of the Renewable Energy Ecosystem*.