

# Networked Architectures and Stakeholder Engagement in Innovation Ecosystems: The Case of Spoke 5 in the NRRP Rome Technopole Project

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## Abstract

This paper analyzes Rome Technopole<sup>1</sup> as a case study of a territorial innovation ecosystem, with particular attention to internal governance mechanisms and stakeholder engagement strategies promoted within the framework of the Italian National Recovery and Resilience Plan (NRRP). Following a review of the regulatory and theoretical background, the article examines the project's organizational architecture and the network-based logic underlying the hub-and-spoke model, highlighting the role of thematic spokes and project flagships. A specific focus is devoted to Spoke 5—responsible for coordinating public engagement, lifelong learning, and social impact activities—where the authors of this paper are actively involved. The paper explores the mechanisms for activating internal collaborations, the operational tools employed, and a selection of high social-impact case studies launched through independently designed calls. Finally, it discusses the structural challenges posed by cooperation among heterogeneous actors—universities, research centers, and industries—highlighting the resulting tensions and opportunities. The experience of Spoke 5 underscores the need to develop systematic practices and adaptive tools for internal stakeholder engagement as a key condition for ensuring the long-term sustainability of complex partnerships beyond the emergency-driven framework of the NRRP.

**Keywords:** Public Engagement; Innovation Ecosystems; NRRP; Stakeholder Engagement; Networked Governance; Internal Stakeholders; Participatory Models; Rome Technopole; Spoke 5; Multi-level Coordination

## Abbreviations

COM: Commission Communication.

DNSH: Do No Significant Harm.

ERA: European Research Area.

EU: European Union.

KPIs: Key Performance Indicators.

MIUR: Ministry of Education, University and Research (Italy).

MUR: Ministry of University and Research (Italy).

NRRP: National Recovery and Resilience Plan.

PE: Public Engagement.

RRI: Responsible Research and Innovation.

## Introduction

In recent years, the concept of the innovation ecosystem has gained increasing importance in both academic discourse and public policy, as it represents a dynamic and collaborative configuration of actors, activities, resources, and institutions oriented toward the production and dissemination of innovation (Granstrand & Holgersson, 2020). This approach, which finds its roots in the concepts of National Innovation Systems (Freeman, 1987; Lundvall, 1992) and the Triple Helix (Etzkowitz & Leydesdorff, 2000), has progressively evolved to include more complex and multilayered models such as the Quintuple Helix (Carayannis et al., 2012), which emphasizes the role of civil society and the environment. In the Italian context, the National Recovery and Resilience Plan (NRRP) acts as an unprecedented catalyst for the construction of such ecosystems, with the aim of promoting the country's digital, ecological, and social transition. Mission 4 of the NRRP, in particular, allocates significant resources to the creation of innovation ecosystems through territorial public-private partnerships, based on co-design and technology transfer logics (Meliciani & Pini, 2021). Unlike more centralized models adopted in other European countries, the Italian approach emphasizes the development of distributed, multidisciplinary, and territorially rooted networks (MUR, 2021). Within this framework, Rome Technopole constitutes an emblematic case of a territorial innovation ecosystem. It is a complex and articulated initiative, led by Sapienza University of Rome, involving a wide range of institutional, academic, and industrial actors. The project aims to strengthen the regional infrastructure for applied research and to reinforce the interconnection between scientific research, production needs, and emerging social challenges. In particular, it represents a laboratory for multi-level governance, in which the distribution of responsibilities between the hub and the spokes allows for the exploration of innovative models of coordination and interaction among internal stakeholders.

A distinctive feature of Rome Technopole is the integration of Public Engagement (PE) into the strategic design of the ecosystem. While PE is often confined to institutional communication or dissemination practices, in the case of Rome Technopole it plays a more structural role, aligned with the principles of Responsible Research and Innovation (RRI) promoted by the European Commission (Owen et al., 2012; Von Schomberg, 2013). Within this framework, PE is conceived as a lever to make research more responsible, open, and inclusive, including through digital tools and formalized participatory processes (Kumpu, 2022). A specific case of structural application of PE is represented by the activities of Spoke 5 of Rome Technopole, which is dedicated to Engagement, Outreach, and Lifelong Learning. This spoke develops methodologies aimed at actively involving the various actors of the ecosystem, not only externally (towards the community and territory) but especially internally, by promoting co-design logics among universities, research centers, and industrial partners. This approach is consistent with the most recent findings in the literature on internal communication in complex systems, which highlight the importance of organizational infrastructures capable of enabling participation and reflexivity among the actors involved (Mazzei & Quaratino, 2020). This article proposes an analysis of Rome Technopole as a territorial innovation ecosystem, focusing on internal governance dynamics and models of stakeholder interaction, with particular attention to the transversal dimension of Public Engagement. After a review of the theoretical and regulatory framework, the paper will present the organizational architecture of Rome Technopole and the specific role of Spoke 5, which will be further examined in the following sections.

## The Regulatory Framework and Organizational Model of Innovation Ecosystems: Rome Technopole within the NRRP Context

The concept of the innovation ecosystem has been adopted by European and national policies to support technological, economic, and social transformation through cooperation among public and private actors, universities, research centers, companies, and citizens (Rinkinen et al., 2022). The ERA strategy and the European Commission's Communication COM(2020) 628 final promote territorial and interdisciplinary ecosystems based on partnerships between academic and economic institutions. In the Italian context, the NRRP, through Mission 4 - Education and Research, and in particular Component 2, provides for the creation of 11 territorial

innovation ecosystems, with €1.61 billion allocated to promote technology transfer and local competitiveness (MIUR, 2021). These ecosystems are organized using a hub-and-spoke structure: a lead university coordinates multiple thematic spokes, each responsible for a strategic intervention area (Bianchi & Labory, 2022). This model enables the combination of central coherence and operational flexibility, clearly distributing roles and responsibilities between the central node (hub), in charge of strategic supervision and reporting, and the peripheral nodes (spokes), responsible for operational implementation and direct interaction with the territory and project partners. The model requires both vertical and horizontal coordination capabilities among partners, following a polycentric governance approach that balances managerial autonomy and strategic coherence (Pellizzoni & Ylönen, 2020). The open innovation 4.0 approach integrates sustainability, digitalization, and civic participation into the innovation process (Vanhaverbeke et al., 2018).

The implementing decrees of the NRRP include indicators related to the ability to generate territorial impact, engage stakeholders, ensure sustainability and transparent reporting, and promote lifelong learning (MUR, 2022). From a comparative perspective, European models such as the Fraunhofer Institutes (Germany) and the Pôles de Compétitivité (France) show structural and strategic differences (Delanghe et al., 2011). The Italian model emphasizes organizational flexibility and the integration of social sustainability. Rome Technopole is one of the territorial innovation ecosystems activated under the NRRP. Coordinated by Sapienza University of Rome, it involves 39 partners including universities, public research institutions, large companies, and public bodies. Its structure follows the hub-and-spoke model: the central node oversees strategic and administrative coordination, while six thematic spokes, assigned to partner universities, carry out interventions in applied research, sustainable mobility, professional training, technology transfer, and public engagement. In line with the modular and thematic logic of the model, each spoke operates as a specialized node, with managerial autonomy and coordination capacity with territorial actors. Their respective lines of action were defined during the planning phase and represent the operational basis of the activities, as summarized in the following table.

<i>Spoke</i>	<i>Thematic Area</i>	<i>Lead University</i>
Spoke 1	Applied Research, Technological Development, and Innovation	Sapienza University of Rome
Spoke 2	Technology Transfer, New Entrepreneurship, Business Incubation, and Acceleration	University of Rome “Tor Vergata”
Spoke 3	University Education, Industrial PhD Programs, and Internationalization	Roma Tre University
Spoke 4	University-Based Professional Training in Technology	University of Cassino and Southern Lazio
Spoke 5	Public Engagement, Outreach and Lifelong Learning	University of Tuscia
Spoke 6	Open Research Infrastructures and Industrial Higher Education Collaboration	Sapienza University of Rome

**Table 1:** Thematic Areas and Lead Institutions of the Spokes.

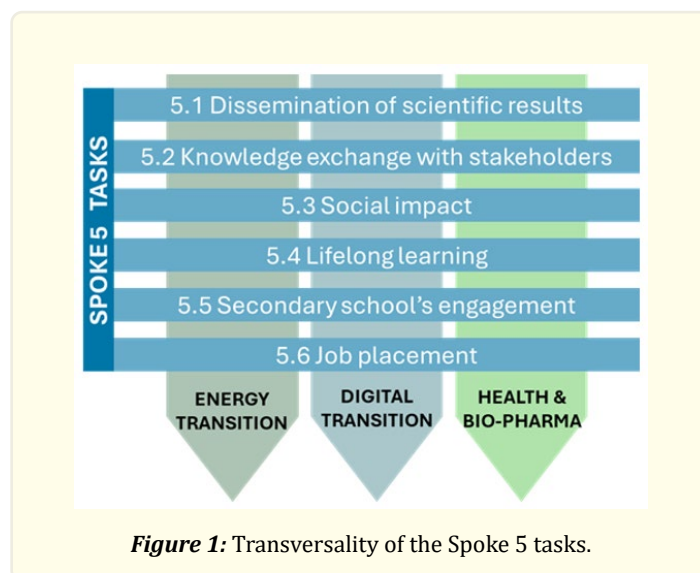
From a strategic perspective, the spoke model allows for the adaptation of project implementation to the technical and sector-specific features of each area, while maintaining systemic coherence. In particular, the presence of transversal spokes—such as the one dedicated to public engagement and lifelong learning—enables the integration of participation and social impact dimensions across all ecosystem activities, thus overcoming a simple thematic silo logic. Eight flagship projects, developed in the areas of energy transition, digital transformation, and health and biopharmaceuticals, are coordinated by companies and integrated with academic activities. The spokes operate with managerial autonomy, acting as intermediaries between the hub and the operational units, following a distributed governance model (Suboticki et al., 2023). The presence of heterogeneous actors requires internal communication tools, information management mechanisms, and trust-building processes (Mazzei & Quaratino, 2020). Communication flows are bidirectional: bottom-up (collection of needs and constraints) and top-down (strategic alignment) (Public Engagement in NRRP, 2023). The diversity of the profiles involved demands the adoption of cognitive and organizational mediation practices (Gomes et al., 2018).

The spoke dedicated to public engagement and lifelong learning plays a transversal role within Rome Technopole, fostering the integration of social impact and participatory dimensions across all project domains. As part of a broader institutional experiment, the initiative tests the capacity of universities to act as orchestrators within complex multi-actor systems. The adoption of flexible hub-and-spoke architecture, together with the formalization of engagement processes, the digitalization of management tools, and targeted investment in internal communication, represent critical levers for ensuring long-term sustainability and effectiveness. Within this framework, Spoke 5 serves as a strategic driver of collaborative coordination, advancing innovative practices that align with the ecosystem's overarching goals. The following sections examine in detail the specific strategies implemented by Spoke 5 in the fields of public engagement and lifelong learning.

## Spoke 5 as a Cross-Cutting Mechanism for Public Engagement and Lifelong Learning

### *General Framework and Operational Mandate*

Spoke 5 of Rome Technopole operates as a transversal infrastructure designed to integrate public engagement, scientific outreach, and lifelong learning across the ecosystem's core pillars: research, technology transfer, and social impact. In line with Mission 4 of the NRRP—particularly components 1.4 and 1.5—its mandate supports open, responsible, and inclusive innovation through the promotion of knowledge accessibility and stakeholder participation (Baffo et al., 2025; Taverna et al., 2025). Functioning as an enabling platform, Spoke 5 coordinates methodological and strategic support across all spokes, with actions aimed at strengthening collaborative networks, enhancing scientific culture as a public good, and enabling organizational interoperability. A central operational tool is the digital platform for managing public engagement activities, which allows partners to collect, monitor, and evaluate initiatives in real time. This infrastructure ensures traceability, compliance with the DNSH principle, and alignment with shared Key Performance Indicators (KPIs), thus supporting accountability and consistent documentation across the project (Suboticki et al., 2023).



To operationalize its strategic mandate, Spoke 5 integrates a set of concrete KPIs that guide both monitoring and implementation. These include the annual production of at least five open access publications, aimed at fostering wide-ranging knowledge transfer within academic and societal contexts. A second KPI targets stakeholder engagement, with a defined objective of involving no fewer than 300 stakeholders by the end of the project through inclusive communication strategies and structured dissemination plans. Additionally, in line with European Commission guidelines, the spoke contributes to the regular evaluation of the Do No Significant Harm (DNSH) principle, ensuring environmental and social sustainability through positive scoring on the EC checklist. These indicators reflect Spoke 5's dual focus on measurable impact and systemic integration, supporting the ecosystem's broader trajectory toward

transparency, inclusiveness, and innovation-driven transformation. In parallel, the spoke promotes a unified framework for internal PE practices and assists partners in defining and validating engagement strategies, responding to the institutional marginalization historically associated with public engagement. This structured approach enables the embedding of PE within the decision-making and evaluation systems of complex innovation ecosystems. A second strategic axis concerns lifelong learning, developed through a dedicated e-learning environment offering 18 university-level courses tailored to diverse audiences—students, professionals, public sector workers, and citizens. Delivered in certified or open-access formats, these courses address themes aligned with the UN 2030 Agenda (Goals 4, 5, 10, 17), particularly digital, environmental, and energy transitions. In this perspective, lifelong learning becomes a tool of ecosystem identity-building and knowledge co-production, echoing the most advanced models of education-based engagement (Felt & Fochler, 2010).

Spoke 5 also supports experimental initiatives in Citizen Education, delivering short and interactive modules to enhance public awareness and participation in innovation. These programs reflect the principles of Responsible Research and Innovation (RRI) and foster circular learning dynamics, where scientific knowledge evolves through engagement with societal needs. As such, Spoke 5 represents both a methodological engine and a cultural catalyst within Rome Technopole, offering a replicable model for future territorial partnerships oriented toward openness, reflexivity, and impact.

### ***Operational Procedures for Activation and Collaboration***

Spoke 5 operates as a transversal methodological and strategic infrastructure, offering Rome Technopole partners a set of tools and procedures for the design and implementation of activities aligned with its mandate in public engagement, lifelong learning, and knowledge transfer. The operational guidelines are articulated into four main types of action:

#### ***Public dissemination and community engagement activities***

Targeting public institutions, businesses, scientific communities, and schools, these activities aim to strengthen the dialogue between research and society and to promote a culture of open and inclusive innovation. The activation process involves: submission of a proposal by the interested party; co-design with the Spoke 5 task force; technical and organizational feasibility assessment; planning and implementation of the initiative.

#### ***Collaboration on lifelong learning and orientation projects***

The spoke supports the co-design of training programs for various target groups (students, professionals, public administrations, companies), in face-to-face, online, or blended formats. The process includes submission of the request; definition of the training target; needs analysis and joint planning; development of the program and selection of certification modalities (e.g., CFU, Open Badges, certificates).

#### ***Joint initiatives for knowledge transfer and social impact***

These actions aim to produce tangible social effects through the active involvement of both internal and external stakeholders. Activation entails: submission of the initiative and identification of the target audience; shared planning with support from the task force; verification of strategic alignment with the spoke's objectives; implementation and monitoring of the expected impact.

#### ***Request for endorsement and use of the project's visual identity***

Formal collaboration pathways may also be activated through the authorized use of the Rome Technopole logo and visual identity, following a request, review, and approval process in collaboration with the project's General Directorate. All proposals are managed through direct interaction with the Spoke 5 task force and follow standardized operational models designed to ensure transparency, methodological consistency, and recognition of partner contributions. Validated activities are integrated into the spoke's digital platform, contributing to traceability and the analysis of the ecosystem's overall impact.

<i>Type of Activity</i>	<i>Phase 1 – Initiation</i>	<i>Phase 2 – Co-Design</i>	<i>Phase 3 – Evaluation</i>	<i>Phase 4 – Implementation</i>
Public dissemination and engagement	Submission of proposal and objective description	Definition of operational plan with Spoke 5	Assessment of available resources and timing	Logistical management and implementation
Lifelong learning and orientation	Request with target group and intended goals	Identification of beneficiaries and training needs	Co-design of content and delivery methods	Program development and certification
Knowledge transfer and social impact	Initiative presentation	Planning of activities and stakeholder involvement	Assessment of sustainability and strategic consistency	Coordination and impact monitoring
Endorsement and visual identity request	Submission of formal request	Completion of form and required attachments	Internal review and approval	Authorization for use of visual identity

**Table 2:** Operational Procedures for Activation and Collaboration by Spoke 5.

### The Active Role of Spoke 5 in Generating Social Impact and Promoting Inter-Stakeholder Cooperation

Within the Rome Technopole framework, Spoke 5 acts as a cross-cutting, proactive agent responsible for initiating and coordinating structured activities in public engagement, lifelong learning, and knowledge transfer, all of which are recognized as genuine Key Performance Indicators (KPIs) within the project’s implementation plan. Its mission extends beyond passive support to the design of impactful, measurable initiatives that integrate the social dimension into innovation processes, contributing directly to the NRRP’s strategic goals. The spoke’s effectiveness depends on its ability to foster horizontal cooperation among thematic spokes and flagship projects, promoting shared responsibility in public value creation. As Garcés-Ayerbe et al. (2019) emphasize, the success of complex strategies hinges on combining communication and cooperation: while the former reduces asymmetries and gathers input, the latter enables co-design and joint implementation. Following this logic, stakeholder engagement evolves from simple information exchange to active co-authorship of impact (Plaza-Úbeda et al., 2010). Spoke 5 therefore operates based on a generative approach, anticipating ecosystem needs and activating targeted initiatives—such as training programs or outreach campaigns—that align with identified gaps or emerging demands. This requires a specific investment in relational and design capacities, capable of mediating across academic, industrial, and institutional cultures and launching initiatives with high visibility and organizational relevance.

The digital platform developed with INFN is central to this model, enabling real-time tracking, classification, and strategic analysis of public engagement activities (Baffo et al., 2025). Through continuous data monitoring and contextual assessment, the platform allows for the identification of operational gaps, seasonal trends, and thematic imbalances. Based on these insights, Spoke 5 independently develops high-impact project proposals, using formalized “call for proposal” procedures that ensure transparency, inclusiveness, and strategic alignment. Calls include objectives, target stakeholders, implementation formats, and participation criteria, and are disseminated through institutional networks with follow-ups and active facilitation. This operational mechanism mobilizes internal stakeholders not as passive recipients but as co-designers of cross-sectoral initiatives, reinforcing cooperation, performance tracking, and organizational learning. In this way, Spoke 5 translates engagement principles into structured practices, fostering ecosystem-wide integration and long-term institutional transformation.

#### **Case Studies: Proactive Activation of High Social Impact Internal Calls**

Spoke 5’s strategy has been operationalized, during the initial implementation phases of the project, through a coherent set of independently designed initiatives launched across the ecosystem via public calls addressed to internal partners. These calls not only align with objectives of public engagement and knowledge transfer, but also serve as internal governance instruments, enabling the iden-

tification of underrepresented project areas and the activation of inter-organizational collaborations. The four calls described in the following table represent the case studies with the highest levels of social impact promoted thus far. They address key priorities of the Rome Technopole—ranging from lifelong learning and employment inclusion to the valorization of STEM education and the promotion of female entrepreneurship—and are characterized by their ability to integrate participation, innovation, and systemic outcomes.

<b>Call Title</b>	<b>Brief Description</b>	<b>Thematic Area</b>
New Lifelong Learning Activities within the Rome Technopole	<ul style="list-style-type: none"> <li>• Training proposals targeting students, professionals, and citizens</li> <li>• Integration into the ecosystem's lifelong learning offer</li> <li>• Focus on advanced skills and inclusive growth</li> </ul>	Lifelong learning, continuing education, responsible innovation
Career Boost	<ul style="list-style-type: none"> <li>• Placement event for graduates and doctoral students</li> <li>• Meetings with HR representatives from partner companies</li> <li>• Workshops, mentoring, and mock interviews</li> </ul>	University-to-work transition, job placement, academia-industry dialogue
Hackathon Flash	<ul style="list-style-type: none"> <li>• Intensive format targeting teachers, especially women</li> <li>• STEM teaching design with companies</li> <li>• Networking and work-life balance support</li> </ul>	Schools, STEM culture, gender equity, innovative teaching
Promoting Female Academic Entrepreneurship	<ul style="list-style-type: none"> <li>• Mapping of female-led university startups and spin-offs</li> <li>• Training and networking opportunities for female students</li> <li>• Breaking gender stereotypes in innovation</li> </ul>	Female entrepreneurship, university empowerment, gender stereotype mitigation

**Table 3:** High Social Impact Calls Promoted by Spoke 5.

### **Challenges of Internal Cooperation in a Multi-Stakeholder Ecosystem**

The networked architecture of Rome Technopole, structured around a hub-and-spoke model and involving universities, public research centers, industrial enterprises, and institutional actors, introduces significant managerial complexity in the dynamics of internal stakeholder cooperation. The diversity of organizational fields involved generates notable challenges in terms of operational integration, goal alignment, and organizational cohesion (Perkmann et al., 2013). Universities operate under academic logics, with timelines governed by academic calendars and priorities focused on research and teaching. Research centers, while more flexible in project management, are oriented toward long-term missions with strong disciplinary specialization. Industrial enterprises, by contrast, function according to market logics, emphasizing competitiveness, quick response times, and goal-oriented strategies. These differences often give rise to operational misunderstandings and misaligned expectations that hinder effective collaboration (Klerkx & Aarts, 2013). A second challenge concerns time management and prioritization. While universities plan their activities on annual cycles, industrial partners function on much shorter time horizons, requiring rapid responses and concrete outputs. This temporal asymmetry can undermine project coherence unless addressed through adaptive coordination tools.

Another critical issue involves the recognition of the strategic value of transversal activities, such as lifelong learning, public engagement, and social impact initiatives. In highly technological or applied research-oriented contexts, these components may be perceived as marginal or ancillary to the main development lines. However, a growing body of research emphasizes their fundamental role in securing social legitimacy, sustainability, and institutional evolution within complex partnerships (George et al., 2016). Spoke 5 plays a strategic mediating role in this context, acting as a cultural and organizational interface among disciplinary, institutional, and industrial domains. Its work focuses on designing initiatives that combine scientific rigor, operational feasibility, and social relevance—thereby helping to construct a shared space of convergence among actors with diverse orientations. Ultimately, overcoming tensions among stakeholders requires the development of shared digital tools, structured dialogue environments, and ongoing investment in fostering a culture of engagement as a collective responsibility. Only through such multilayered integration can latent synergies be activated, transforming stakeholder diversity into a genuine asset for territorial innovation (Gioia et al., 2013).

## Conclusions

The Rome Technopole represents an advanced laboratory for observing the organizational and relational dynamics that characterize the innovation ecosystems promoted under the Italian National Recovery and Resilience Plan (NRRP). Its hub-and-spoke configuration, the multidimensionality of the actors involved, and the cross-cutting nature of the missions assigned to the spokes make it a particularly emblematic case for investigating the internal functioning of complex partnerships and the cooperation modalities among public and private stakeholders. This contribution has highlighted the strategic role of Spoke 5, not merely as a unit responsible for dissemination and training, but as a generative agent of social impact—capable of identifying operational gaps and proactively designing interventions to activate the latent potential within the ecosystem. The analysis of operational mechanisms and the promoted calls confirms the existence of an engagement model oriented not only toward service provision but toward the construction of an adaptive and participatory space. At the same time, the internal coordination challenges have become evident, particularly in relation to the coexistence of differing organizational logics—academic, industrial, and institutional—which do not always integrate seamlessly. The ability to harmonize timelines, goals, and languages represents a persistent challenge for those engaged in ecosystem governance.

In this perspective, the experience of the authors, developed within the framework of Spoke 5's activities, underscores the need to continue developing and implementing methods, tools, and practices for the systematic and structured engagement of internal stakeholders. Only through dialogical governance—based on stable relationships and effective cooperation mechanisms—can the sustainability and transformative capacity of territorial ecosystems be ensured beyond the timeframe of extraordinary funding.

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