

UNIVERSITY, INNOVATION ECOSYSTEMS AND NRRP FOR SUSTAINABLE DEVELOPMENT. THE CASE STUDY “ROME TECHNOPOLE”¹

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Abstract

Sustainable development, a global imperative, can be pursued through innovation ecosystems. The Innovation Ecosystems are networks that promote collaboration between universities, research bodies, public institutions, and private entities in areas aligned with regional specializations. They aim to enhance research results, technology transfer, and digital transformation while addressing the triple helix model of university-industry-government collaboration. These ecosystems, driven by collaborative efforts between universities and diverse stakeholders, catalyze sustainable progress. The National Recovery and Resilience Plan (NRRP) encourages sustainable development goals in Italy. This study proposes leveraging innovation ecosystems to achieve sustainable development. It invests in networks that foster collaboration between universities, industries, and governments. The focus is on Rome Technopole, an innovation hub addressing energy transition, digital transformation, and health through seven flagship projects. Using a "Hub&Spoke" governance structure and aligning with the Quintuple Helix Model, Rome Technopole encourages public engagement, entrepreneurship, and innovation, especially among students, contributing to regional development. The research emphasizes universities' pivotal role in these ecosystems, promoting research, technology transfer, and education aligned with sustainability goals. It introduces a model integrating Quality Instruction (SDG4) into a quintuple helix framework. Acknowledging the study's limitation in its early stages, future work involves monitoring the collaborative relationships, roles, and actions proposed and led by the universities.

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Keywords

hub&spoke; *innovation ecosystems*; *NRRP*; *sustainable development*; *partnership*; *university third mission*.

Introduction

The introduction of the leading role of the National Recovery and Resilience Plan (NRRP) for sustainable development and innovation represents a fundamental step for the future of Italy (Pilati, 2021). The NRRP stands as a crucial pillar on the road to addressing the global challenges of the 21st century, including the climate crisis, digitalization, and the need to ensure a fair and inclusive future for all citizens (Di Bartolomeo & D'Imperio, 2022).

The NRRP is not simply a bureaucratic document but rather an ambitious declaration of intent and a milestone in transforming Italy into a nation at the forefront of sustainable development and innovation. Its leading role is anchored in promoting policies and projects that stimulate the post-pandemic economic recovery, but with a look far beyond the present, aiming to build a greener, more resilient, and innovation-oriented future (Ales, 2022).

One of the keys to the success of the NPRR lies in promoting the five-helix model, a collaborative approach involving government, businesses, scientific institutions, citizens, and the third sector, as highlighted by Wahdiniwaty et al. (2022) and Saepuloh et al. (2022). This model represents a unique opportunity to mobilize resources, skills, and creativity from different sources (Carayannis et al., 2012), thus allowing Italy to address the most pressing challenges with a holistic vision. The five helixes - innovation, ecological transition, social cohesion, competitiveness, and culture - constitute the pillars on which the NPRR is based. Innovation will drive the digital and technological transformation of the country, while the ecological transition will lead us towards a greener and more sustainable economy (Pilati, 2021). Social cohesion will ensure no one is left behind in this process, promoting equity and inclusion. Competitiveness will make us more resilient in an ever-changing world, while culture will strengthen Italy's identity and heritage (Buti & Messori, 2020).

In summary, the NRRP represents a courageous commitment for Italy, a guide towards a better future that requires the collaboration of all players in society. By implementing innovative policies, concrete projects, and an integrated approach, Italy can emerge more robust, sustainable, and resilient from this challenge, positioning itself at the center of global innovation and promoting sustainable development (Ales, 2022).

In line with the consideration drawn, the study focuses on exploring the essential role of collaboration between the different systems in the innovation process; thus, the Case of the Technopole of Rome, an innovation ecosystem, is presented and analyzed. The research is structured in four sections: first, a brief literature review regarding the evolution of the collaboration concept from the partnership/network to innovation ecosystems, and second, the methodology section highlights the approach used and presents the NRRP as a promoter of innovation ecosystems. The third section is the case study analysis of Rome Technopole, and finally, the research concludes with some points for reflection and perspectives.

Literature review

Due to globalization and technological advances, contemporary society is more interdependent and plural, making it a polycentric, multi-nodal, multisectoral, multi-level, and multi-actor economy (Eriksson et al., 2020). According to Cristofoli et al. (2017), in this context of networked and connected organizations, the current economic and social crises have further strengthened the importance of involving public/private actors to manage processes cooperatively. This has emphasized networks as the most appropriate organizational arrangement to address contemporary issues (Wang et al., 2018). To confirm this, Meneguzzo et al. (2010) state that the emergence of these new problems, alongside the awareness that public administration is less and less able to govern them directly according to a rational and dirigiste approach, has led scholars to focus attention on networks. For instance, public-private partnerships (as institutional cooperation agreements between the public and private sectors) have received considerable attention over the last 40 years because they may be able to address complex challenges, such as policies, projects, and public service issues (Wang et al., 2018).

A network comprises nodes or actors and links or relationships connecting nodes. Nodes can be individuals, groups, organizations, regions, and even countries, and bonds can take different forms of relationships, such as interactions and similarities (Borgatti et al., 2018; Kapucu & Hu., 2021). Unlike the hierarchical control and command coordination structure, networks rely more on interdependent relationships to function and have a more flexible and horizontal coordination structure (Kapucu & Hu, 2020). Specifically, in public administration, networks are institutional and management solutions born from the interdependence of several companies, public or private. They effectively address complex problems such as environmental pollution, international terrorism, and adequate infrastructure for global developments or reform welfare systems (Meneguzzo et al., 2010). These networks, therefore, take shape around political problems and/or political programs and are formed, reproduced, and modified by an ecology of the games between the actors involved (Kickert et al., 1997; Cepiku et al., 2021).

In their investigation, Eriksson et al. (2020) emphasize the importance of coordinating function and support structures to facilitate collaboration and develop a joint and coordinated value proposal. Precisely in this direction is the Quintuple Helix Model oriented. The model, developed from the studies of Dzisah and Etzkowitz (2008), Carayannis & Campbell (2009, 2010), and Carayannis, Bath, and Campbell (2012), analyses the relationship that binds the actors in the system (PA, for-profit and non-profit sector, civil society, education and research system), proposing a collaborative model oriented towards sustainable development that generates value for society, taking into account their contribution potential and interests (Kholiavko et al., 2021). This model allows for analyzing the changes in the roles played by the different sectors of society in its transition to sustainability. The essential building block of the model - beyond the active human agents - is the knowledge resource (Figure 1), which, through its circulation between social subsystems, brings about changes in innovation and know-how in society and the economy (Carayannis et al., 2012).

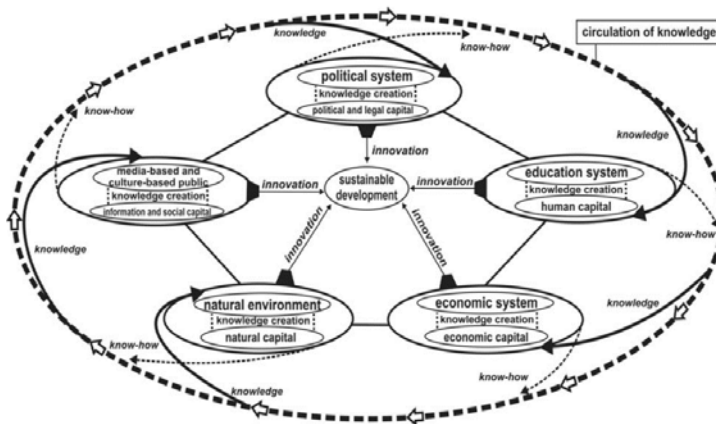


Figure 1. The Quintuple helix model: systems and functions (Carayannis et al., 2012)

Specifically, the Quintuple Helix model has shown how an investment in knowledge and the promotion of its production determines crucial new impulses for innovation, know-how, and societal progress (Carayannis & Campbell, 2010). Thus, Carayannis and Campbell (2009) suggest that knowledge systems and information architectures compete and co-evolve in innovation systems. Hage et al. (2013) propose that the connectedness among organizations could indicate its prospects for success.

Indeed, topics such as the collaboration between organizations and the creation of value by actors have garnered growing interest from practitioners and scholars (e.g., Adner, 2006; Adner & Kapoor, 2010; Cusumano & Gawer, 2002). In line with these remarks, the concept of an 'ecosystem' is increasingly used in management and business to describe collectives of heterogeneous yet complementary organizations that jointly create some kind of system-level output, analogous to an 'ecosystem service' delivered by natural ecosystems and one that extends beyond the outputs and activities of any individual participant of the ecosystem (Thomas & Autio, 2020). According to Miller (1975), an ecosystem implies that everything is connected to everything and feeds back through the ecosystem itself, so the interconnectedness preserves the overall system. Due to its attractiveness and elasticity, the ecosystem concept has been applied to a wide range of phenomena by a variety of scholarly perspectives and under varying monikers such as 'innovation ecosystems,' 'business ecosystems,' 'technology ecosystems,' 'platform ecosystems,' 'entrepreneurial ecosystems,' and 'knowledge ecosystems' (Dedehayir et al., 2018). In this context, the term 'innovation ecosystems' has become popular in industry, academia, and government (Oh et al., 2016).

The studies of Carayannis and Campbell (2010) show that knowledge and technology, critical elements of innovation ecosystems, evolve through interactions among players. Innovation ecosystems refer to heterogeneous constellations of organizations, which co-evolve capabilities in the co-creation of value (Moore, 1993; Adner & Kapoor, 2010; Autio & Thomas, 2014). Producers, suppliers, distributors, financial and research institutions, makers of complementary technologies, and regulatory bodies are just

some of the organizations that constitute the innovation ecosystem (e.g., Mäkinen & Dedehayir, 2014; Dedehayir et al., 2018). A synthesis of the study of Granstrand and Holgersson (2020) shows that actors, artifacts², and activities are all elements in an innovation ecosystem linked together through relations, including complement and substitute relations. Indeed, the roles and relationships between the innovation ecosystem stakeholders (including university, industry, and government partners) are ultimately concerned with forming innovation ecosystems to enhance economic welfare and co-create value/innovation (Dedehayir et al., 2018). According to Oh et al. (2016), characteristics³ and success factors⁴ distinguish the innovation ecosystem from the earlier concept of collaboration/network, which allows innovation production.

Methodology

The Innovation Ecosystems, financed by the Ministry of University and Research as part of Mission 4 Component 2 of the NRRP, with a total investment of 1.3 billion euros, are networks of Universities, Public Research Bodies (EPR), Territorial Public Bodies, and other highly qualified and internationally recognized public and private entities, organized in a Hub type governance model (with management and coordination activities) & Spoke (aimed at research). By intervening in areas of technological specialization consistent with the industrial and research vocations of the reference area, these Ecosystems promote and strengthen the collaboration between the research system, the production system and local institutions, with a view to economic and environmental sustainability and social impact on the territory in line with the triple helix model, which focuses precisely on the virtuous relations between university-industry-government and which, emphasizing the importance of education and research for innovation, is compatible with the model of the economy of knowledge (Etzkowitz, 2008; Etzkowitz & Leydesdorff, 1995; Etzkowitz, 1993).(Figure2).

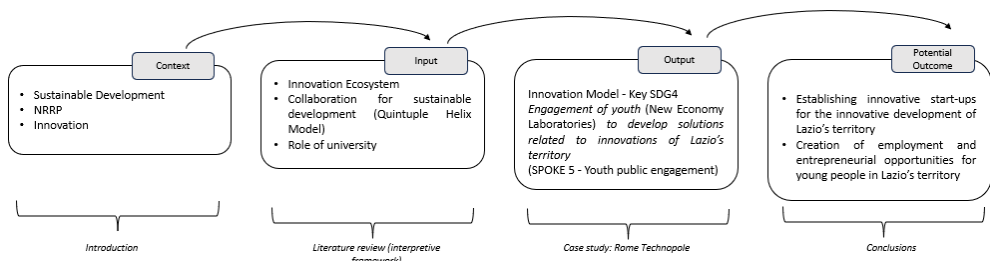


Figure 2. Logic Flow of the Research
(Source: Authors' own research results)

² Artifacts include products and services, tangible and intangible resources, technological and non-technological resources, and other system inputs and outputs, including innovations.

³ Emphasis that innovation diffuses through a social system; the central role of ICT in connecting the innovation actors; open innovation that allows ideas from diverse sources to be combined; public relations value differentiated roles of actors and the importance of market forces.

⁴ Talent; density of researchers, entrepreneurs, and facilitating institutions; entrepreneurial culture, access to capital, and a supportive regulatory environment.

The objective of the Innovation Ecosystems, in close connection with the Third Mission logic of the Universities (Sanchez & Elena, 2006; Laredo, 2007; Spaapen et al., 2011; Molas-Gallart et al., 2002.), is to enhance the results of research, facilitate technology transfer, accelerate the digital transformation of business production processes; the activities include applied research, training to reduce the misalignment between the skills required by companies and those offered by universities, the valorization of research results with their transfer to the company, support for the creation and development of start-ups and research spin-offs, promoting incubation and venture capital fund activities and services.

Results and discussion: *The case study "Rome Technopole"*

On the Italian national territory, 11 innovation ecosystems have been financed, in which 222 organizations are involved, including 60 universities, AFAM institutions, high schools, 29 public bodies and EPRs, and 133 companies.

Among these Ecosystems, we find the "Rome Technopole," which represents the first multi-technological pole for teaching, research, and technology transfer in the sectors of energy transition, digital transformation, and health and bio-pharmaceuticals, aimed at achieving three macro-priority objectives for the Lazio Region. The "Rome Technopole" activity is organized along seven flagships as part of these macro-objectives. The Main objectives of Rome Technopole are:

1. Favour a process of repositioning regional industrial and production realities towards segments and markets with higher added value through adapting know-how and technologies of excellence.
2. Make the Lazio Region (Italy) a "large European innovation region" with an international dimension.
3. Lead the industrial sector of Lazio along internationalization paths toward markets of strategic interest.

The mission of the Rome Technopole project is to establish a center of aggregation and integration of skills in the "Key Enabling Technologies" (KET) field. The objective is to coordinate the existing skills and excellence already present on the regional territory and recognized in Italy and abroad, creating a new European pole of the so-called knowledge economy, also pooling the excellent potential for international recognition of the city of Rome, able to stand out as a productive-technological pole with high attractiveness for large companies, at the forefront in the fields of energy, energy sustainability, digital and life sciences. Creating the Technopolo innovation ecosystem is organized with a "Hub&Spoke" type governance structure. 7 Universities are involved (Sapienza, Tor Vergata, Roma Tre, Cassino and Southern Lazio, Tuscia, Luiss, Campus Bio-Medico), 4 EPR Public Research Bodies (CNR, INFN, ISS, ENEA), Lazio Region, Roma Capitale, Chamber of Commerce of Rome, Chamber of Commerce of Frosinone and Latina, Unindustria, INAIL, multiple industries and companies (Acea, Aeroporti di Roma, Airbus Italia, Almagora, BV Tech, Capgemini Italia; Catalent Anagni, Coima REM, Confindustria Dispositivi Medici, ENI, GALA; Lazio Innova, Leonardo, Lventure Group, Maire Tecnimont, MBDA Italia, Takis, Thales Alenia Space Italia, Unicredit, Unidata, Wsense, Westpole), organized in a Hub (Participation Foundation established on 8 June 2022) and 6 Spokes (Figure 3).

HUB ROME TECHNOPOLE	SPOKE 1	Applied research, technology development and innovation
	SPOKE 2	Technology transfer, new entrepreneurship, business incubation and acceleration
	SPOKE 3	University education, industrial PhD courses, internationalization
	SPOKE 4	Professional undergraduate education in technology
	SPOKE 5	Out-reach, public engagement, lifelong learning
	SPOKE 6	Open Research Infrastructures, joint labs, higher education with industrial collaboration
specific and transversal area: S1 - Energy transition (EnT); S2 -Digital transition (DgT); S3- Health and bio-pharma.		

Figure 3. Rome Technopole Structure -HUB&Spoke
(Source: Authors' own research results)

To accomplish its mission and goals, Rome Technopole implements the research supply chain – technology transfer – business acceleration and incubation – high education – outreach and public engagement – joint labs and open labs, as sketched in the figure. According to this methodology, the Hub& Spoke structure of the Rome Technopole project is organized into six thematic functional spokes, widening the full range of activities of the innovation ecosystem and representing the building blocks of the innovation ecosystem (Figure 4).

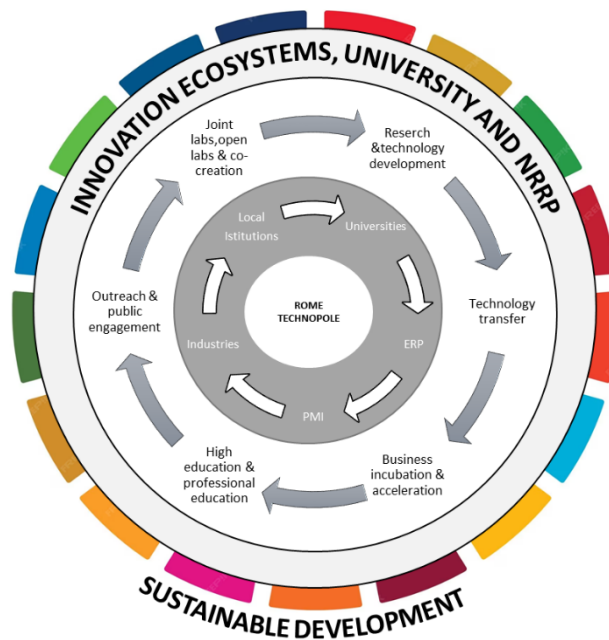


Figure 4 The Innovation Ecosystems Rome Technopole
(Source: Authors' own research results)

Spoke Five is particularly important, as it aims, through public engagement activities, to create a bridge with civil society, citizens, and young people, embracing the Quintuple Helix Model for sustainable development. In the "Quadruple Helix" model, the territorial context and civil society (Fourth Helix) are seen as key drivers in a democratic approach to innovation in which the government, businesses, the academic

world, and civil society work together to co-creating the future, according to the Open Society model: from the knowledge economy to the knowledge society and democracy (Ranga & Etzkowitz 2013); while the Quintuple Helix Model, adding the perspective of the natural environment, is based on a win-win situation for all (win-win approach), between ecology, knowledge and innovation, creating profitable synergies between economy, society and democracy (the so-called "project sociological transition") (CE, 2009).

In this perspective, the activities of Spoke 5 include the New Economy Laboratories "Preparing for the Future" - Planning and innovating from a sustainable perspective, an extra-educational activity launched by the Faculty of Economics of the University of Rome "Tor Vergata" in AY 14/15, whose objective is to stimulate self-entrepreneurship and social innovation through the development of sustainable projects in response to local needs.

In their 9th edition, the Laboratories have so far involved 966 students, leading to the development of 209 entrepreneurial idea projects, many of which have been winners of prizes and competitions at the national level, such as Start Cup Lazio, whose link with the Laboratories is today it has been strengthened by the "Rome Technopole," in which both projects have converged, respectively in SPOKE 2 and SPOKE 5; the Laboratories have also led to the launch of innovative and sustainable startups such as Orto 2.0 and, starting from the 20/21 academic year, they have closed with a Hackathon.

By encouraging collaboration between local entrepreneurs, citizens, and young creatives, the animation of incubators and common workplaces, and the creation of startups, the Laboratories are indeed a best practice capable of contributing to outlining and implementing a governance model of sustainable development of the territory capable of putting Education (SDG 4 Agenda 2030) and future generations at the center, effectively replicating and scaling the "O.S.A.! Young" model at a regional level, experimented with the Metropolitan City of Rome Capital in process of declination of the National and Regional Strategies for Sustainable Development in the Metropolitan Strategic Plan and the Metropolitan Agenda for sustainable development. The link between the New Economy Laboratories has today been strengthened by the birth of the PNRR – Innovation Ecosystems "Rome Technopole" project in which the two projects have merged. In Fact, from this year (a.y. 2023/2024), the laboratories have been included within the PNRR project - "Rome Technopole" innovation ecosystems, as a public engagement activity (SPOKE 5) aimed at involving young people on issues related to social innovation, to environmental, economic and social sustainability. However, the laboratories also have potential connections with SPOKE 2 (start-ups were born from the Labs for the reasons above) and with SPOKE 5 (this is an extra-educational activity) (Figure 5).

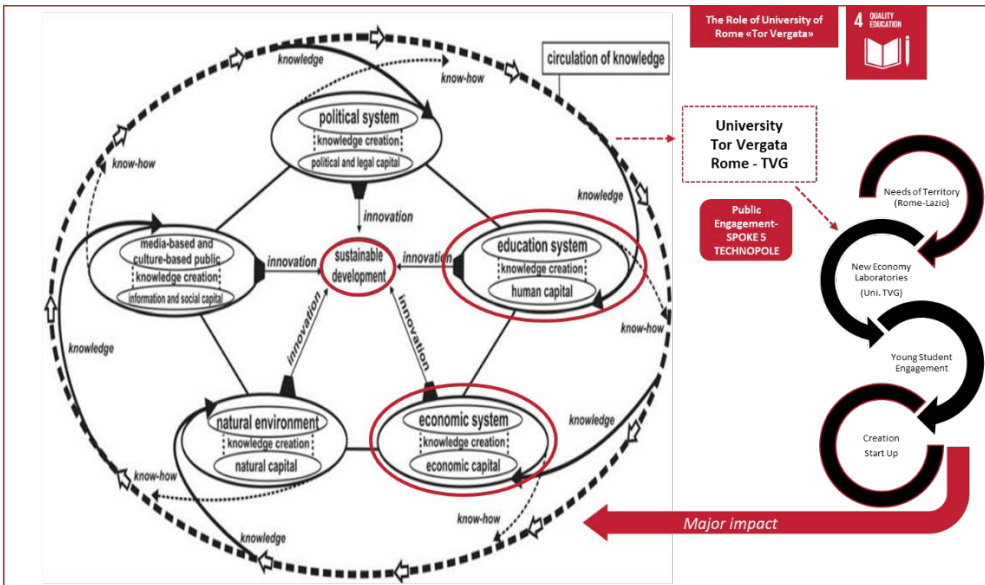


Figure 5. Innovation Model - Key SDG4
(Source: Authors' own research results)

The model shown in Figure 5 represents the significant impact of the laboratories on the Quintuple helix model (Carayannis et al., 2012). The creation of laboratories that encourage young people in the area to create start-ups that aim to "solve" a local problem flows into the quintuple helix model, creating sustainable development, mainly inventing the economic system (creation of a start-up but also the support of the Knowledge technology hub) and the university system (education, know-how).

Conclusions

Innovation is crucial in enabling sustainable solutions to global challenges, facilitating progress towards sustainable development goals (Wang et al., 2022). Therefore, it becomes natural to refer to collaboration (SDG 17- Partnership for the Goals) as a focal tool for achieving goals in this area.

As highlighted, Rome Technopole aims to be a multi-technology pole of international reference for advanced education, research, and technology transfer to respond to the territory's needs. They were first improving the attractiveness of the regional training, research, innovation, technology transfer, and industrial productivity system in the three critical strategic sectors (Energy Transition, Digital Transition, Health, and Bio-Pharma) at national and international levels, and second, establishing an outstanding public-private collaboration model to foster stable partnerships between research and businesses in Rome and the Lazio region. These two factors allow the Rome Technopole to provide a significant focal point in Rome for major corporations engaged in crucial technological sectors of particular importance within the regional context. The third key point is, as highlighted earlier in the discussion, the possibility of structuring the co-design of the university and long-life learning pathways valid for the construction of projects and skills necessary to respond to the territory's needs. Thus, the inclusion of universities in innovation ecosystems allows, through the guidance of

the third mission, the creation and coordination of networks and sustainable connections with local actors (public and private, profit and non-profit, and civil society) capable of stimulating social innovation through research intervention and training-action activities. As in this model, the entire ecosystem operates in a complementary synergetic logic with significant educational and scientific research centers.

The research aims to enrich knowledge on collaboration for sustainable and innovative development, stimulating debate on the university's role in the ecosystem. The limitation of the work is due to the initial stage of the proposed case. It will, therefore, be followed by monitoring the phenomenon and analyzing the evolution of the collaborative relationships/roles and the actions proposed and led by the universities.

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