Research, Development and Innovation Projects for Territorial Cohesion in Inland Marginal Areas: Economic Analysis of Social and Cultural Benefits

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Abstract. To counteract the phenomena of demographic decline and marginalisation of inland areas, there is an urgent need for strategies and policy interventions to prevent the loss of a vast historical and cultural heritage and to trigger development and territorial cohesion processes. Various programmes and intervention strategies introduced by European and non-European governments show that investing in Research, Development, and Innovation (RDI) can be a crucial line of action for the economic valorisation of marginalised urban contexts. However, there is a lack of an operational framework that can support analysts in selecting effective intervention strategies. RDI projects are in fact complex interventions that, first, involve a multiplicity of actors and target groups. In addition, they are initiatives that generate a series of socio-cultural and environmental externalities that need to be adequately considered in the evaluations in order to make a correct judgement on the social profitability of the investments under analysis.

The aim of this study is to define a decision support model for RDI projects promoted within innovation ecosystems, which in turn must be included in a programmatic design of an ecoregion or macro-region. By means of such an economic analysis model, we intend to address the analyst in the: (a) estimation of social costs and benefits deriving from a RDI infrastructure; (b) evaluation of the social return on investment; (c) assessment of the investment risk variables and critical issues to be addressed to define strategic guidelines for the establishment and management of innovation ecosystems.

The conducted research is a starting point for application to real case studies that will allow the defined model to be tested.

(*) The paper is attributed equally to all authors.

Keywords: Internal Marginalized Areas · Ecoregions · RDI Projects · Economic Analysis

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1 Introduction

In recent decades, the increasing migration from inland to urban areas is exacerbating the already marked imbalance between metropolises and small municipalities worldwide. On the one hand, cities and urban areas are growing very rapidly. According to the United Nations [1], the urban population now accounts for more than 55% of the global population and is expected to grow steadily to 68% by 2050. This translates into the presence – again according to United Nations estimates [2] – of 43 megacities by 2030, where megacity means an urban complex with at least ten million inhabitants. On the other hand, there is a relentless depopulation of small towns, mainly due to new housing and employment needs that lead citizens to prefer metropolises to rural areas. Added to this are the few or no job opportunities, the considerable distance from large service centres and the inadequacy of infrastructure and transport [3].

It is evident that these migratory dynamics are leading to a stark contrast between: (i) urban areas, which cover only 0.4–0.9 per cent of the global surface area, but are home to more than half the world's population and are responsible for about three quarters of the world's final energy use [4]; (ii) small towns, which are increasingly isolated economically, socially and culturally, and where the main risks concern productive impoverishment and the degradation of the existing building stock [5].

According to the latest data from the European Commission (2018), inland areas cover 83% of the territory of the European Union, hosting around 30% of its population. They are places with a higher percentage of citizens at risk of poverty and social exclusion than cities. This is in fact 22.4% for inland areas, while it is around 21.3% and 19.2% for large cities and medium-sized towns respectively [6]. If the marginality they suffer has caused, on the one hand, cultural, social and economic isolation; on the other, it has allowed them to preserve intact a vast material and immaterial heritage «in an autonomy that, although not devoid of contemporaneity, represents an object of great interest not only in terms of memory conservation, but also in terms of its potential to compose qualitative social and settlement models». [7] (p. 15). Awareness of the potential of these realities has been growing in recent decades and began with the crisis of the metropolis: the rapid process of urbanization has in fact led to an exponential growth in the use of resources, making it increasingly difficult to guarantee the principles of sustainability within urban systems [8]. It is exactly this crisis, therefore, that is increasingly leading to marginal realities being considered as a possible solution to mend the city-countryside relationship [9].

For all the above reasons, enhancing and protecting inland and marginal areas becomes an opportunity for the sustainable development of nations. It is therefore fundamental to proceed with a well-structured programme of interventions that is coherent and compatible with the culture of the local population and that is in step with the dynamics of the global economy and the technological revolution [10]. Starting from the analysis of problems and resources, in an integrated planning perspective it is necessary to define strategies that aim not only at building reuse, but also at environmental and landscape protection, infrastructural redevelopment and especially at social cohesion [11]. This territorial cohesion can be pursued if one invests in knowledge and applied knowledge, the latter representing a winning strategy to curb depopulation in the active and youth age [12–16].

On the basis of these premises, the aim of the paper is to demonstrate that within the framework of strategies and actions aimed at fostering the revitalisation of inland areas, a crucial role can be played by programmes and projects that contribute to defining 'innovation ecosystems'. In fact, promoting systems in which different actors - institutions, associations, universities, individual entrepreneurs and society – work together to generate, test and develop innovative solutions means investing in «knowledge of knowledge» and, as a consequence, supporting sustainable and effective development plans for the benefit of communities.

To address this issue, it becomes essential to first investigate the multiple socio-cultural, environmental, and economic repercussions that can result from the establishment of Ecosystems of Innovation (EI), and then to define operational tools useful for selecting effective intervention strategies [17]. Therefore, this research aims to characterise a decision-support model in processes aimed at the establishment of EI, with the objective of promoting social and environmental regeneration in inner and marginalised urban contexts.

The paper is divided into the following sections. Section 2 analyses the main strategies promoted by governments for the enhancement of marginal inland areas, with a focus on those based on the promotion of innovation. Section 3 first clarifies the meaning of innovation ecosystem, then defines characteristics and target groups of RDI infrastructures, then characterises the economic evaluation model. Section 4 returns conclusive remarks and research perspectives.

2 Innovation-Based Strategies for the Enhancement of Marginal Inland Areas

The growing institutional interest in inland areas, induced by the awareness of their great potential, is evident in the actions and strategies that governments are introducing to counter depopulation.

These include the Long-term Vision for the EU's rural areas (2021), which identifies actions to be taken to ensure more connected, prosperous, and resilient rural areas and communities. Specifically, 'flagship initiatives' are envisaged that aim to: (i) create new opportunities for the emergence of innovative businesses and, consequently, new jobs; (ii) strengthen territorial cohesion; (iii) improve the infrastructure and service system; (iv) promote the dissemination of diversified economic activities and sustainable agricultural practices [6].

Among the first European countries to undertake actions to counter the phenomenon of depopulation of inland areas is Spain, which already in 1984 established the *Programa Experimental de Recuperaciòn y Utilizaciòn Educativa de Pueblos Abandonados*, with the aim of revitalising small towns through cultural and educational projects [18].

France in 2015 adopted the Town-Country Reciprocity Agreements to promote inter-municipal partnerships between large, small and medium-sized towns, villages and rural areas in order to reduce economic and social gaps between the different parties and strengthen the most disadvantaged ones [19].

In Ireland, the Rural Regeneration and Development Fund (RRDF) offers an unprecedented opportunity for the revitalisation of small rural towns. It is a EUR 1 billion commitment by the government to invest in rural Ireland from 2019 to 2027, as the strengthening of rural economies and communities is one of the national strategic outcomes of the Ireland 2040 project [20].

Through the Bioenergy Villages strategy, Germany has chosen to invest in renewable energy production for the enhancement of small municipalities: currently in 120 small towns farmers and local cooperatives produce and distribute sustainable energy [21].

With the aim of countering the demographic decline and promoting the development of smaller centres, the *Strategia Nazionale per le Aree Interne* (SNAI) was launched in Italy in 2013, financed by the ordinary funds of the Stability Law. This strategy adopted a perimeter and prioritisation of inland areas according to their degree of 'peripherality' with respect to the poles, understood as centres of delivery of essential services, such as education, health, and mobility [10]. In addition to providing the perimeter of the inland areas, the SNAI has identified priority areas of intervention throughout the national territory where pilot projects of territorial enhancement are currently underway [22, 23].

Recently, more and more intervention programmes are demonstrating that investing in Research, Development and Innovation (RDI) can be a winning strategy to counter depopulation and the exodus of young people from inland areas to large urban centres. This is because, in addition to fostering a deeper awareness of the resources and problems of marginalised areas, RDI projects allow for the creation of new jobs and generate a set of social benefits for the community resulting from the production and dissemination of new knowledge.

According to Hosseini et al. [24], it is becoming increasingly important to look at intermediate and sparsely populated regions as arenas for digital innovation. In other terms, sparsely populated areas need technological innovation to address a complex set of local challenges related to specific geographical, economic, social and ecological conditions. Similarly, Provenzano et al. [25] also emphasise the fundamental importance of linking the innovation process with rural areas if the sustainable growth of peripheral areas is to be promoted.

The possibility of fostering the revitalisation of inland areas through innovation is also evidenced by the 'Smart Villages' strategy promoted by the European Network for Rural Development, which disseminates models and programmes for the regeneration of rural areas, sharing experiences and information. Specifically, this strategy aims at transforming 'marginal' cities into active and participative places, where the use of technology plays a decisive role in outlining new development paths [9]. In the literature, there are several authors who study the advantages of the Smart Village model, also analysing virtuous and successful experiences [26–28].

Again, the Organisation for Economic Cooperation and Development (OECD) in its recent report 'Unlocking Rural Innovation' [29] points out that innovation must be at the heart of the challenges facing rural regions. This is because innovation in rural regions can take very different forms than in cities. Just think that the main innovation systems are typically found in larger cities, with universities and companies large enough to have a formal R&D function. Whereas in rural areas, while it is true that science-based activities can be very successful, the uptake and implementation of these innovations

requires: (i) connections to the places where the idea was developed; (ii) the resources to acquire and introduce the new technology.

Therefore, in less densely populated areas – where access to labour, capital, markets and public services is hindered by the lack of physical and digital infrastructure – only the realisation of networks and partnerships between institutions, universities, companies, associations and society can make the diffusion of innovation possible, so as to generate positive spill-over effects for the territory [30–32].

Within this framework is the Italian government's initiative «Ecosystems for Innovation in the South in Marginalised Urban Contexts» financed by the Supplementary Fund to the National Recovery and Resilience Plan (PNRR) with EUR 350 million. The aim of the investment is to promote the social and environmental regeneration of the most degraded urban areas in Southern Italy, characterised by depopulation and abandonment of inland areas. The objective is the creation of Innovation Hubs to offer highly qualified training, encourage multidisciplinary research and the birth of innovative economic activities [33].

3 Research Method

The paper intends to address the issue of the enhancement of inland areas through the creation of innovation ecosystems. While the literature and the actions implemented so far by governments demonstrate the importance of innovation as a driver of opportunities for marginalised areas, there is a lack of a systematic frame of reference that can support analysts in selecting effective intervention strategies. These are complex interventions involving a multiplicity of actors and target groups. In addition, such initiatives generate a series of socio-cultural and environmental externalities that need to be adequately considered in evaluations in order to be able to make a correct judgement on the social profitability of investments.

Therefore, the aim of this paper is to define a decision support model for processes aimed at setting up EI. To this end, we first clarify the meaning of an innovation ecosystem. Then, the characteristics of RDI projects and the effects they generate on the community are analysed. Finally, we define the logical-operational steps of the model.

3.1 What is an Innovation Ecosystem?

The concept of 'ecosystem' is rapidly gaining ground in the literature on innovation, strategy, and entrepreneurship [34]. In an increasingly specialised world, a single company generally lacks internal resources for the development of innovation. Therefore, to build a value proposition, it is increasingly necessary for individual organisations to rely on the contributions of various stakeholders, both internal and external to the institution [35, 36].

The term ecosystem was first used in a context different from its original scope, i.e. biological systems, in 1993 by Moore to describe a collection of producers and users that contribute to the performance of an organisation [37]. Subsequently, this concept has been employed in the field of innovation management, where an ecosystem is defined

as a network of organisations interconnected or operating around an organisation or a technology platform with the aim of producing valuable goods and services [38–40].

Gomes et al. [34] for the first time clarify the differences between business ecosystems and innovation ecosystems, formerly used with the same meaning. In fact, it is possible to speak of an innovation ecosystem when «the value creation predominates over value capture. Also, in these cases, the relationships among actors are unstable and unclear, co-evolving in unforeseen ways, which may be changing from cooperation to competition» [34] (p.46).

In this sense, the innovation ecosystem allows us to work collectively to enable the flow of knowledge and support technological development with the aim of generating innovation [41]. According to Su et al., an innovation ecosystem must be composed of different stakeholders, including government, associations, practitioners, and others who inhabit the same scenario and appropriate new values through innovation [42].

According to Dias Sant'Ana et al., the main classifications regarding the structure of an innovation ecosystem relate to: (i) life cycle; (ii) level; (iii) layered structure [36]. With reference to lifecycle (i), innovation ecosystems are structured in four stages: emergence, expansion, leadership and self-renewal. Regarding level (ii), ecosystems can be distinguished into: macroscopic (national or international), medium (regional) or microscopic (organisational). At the macro or national level, the creation of innovation ecosystems requires the establishment of new governmental institutions, new policies, and regulations to promote interactions and the capacity for diffusion [43]. At the micro level, the ecosystem consists of: (i) social entrepreneurship organisations and technology platforms, whose purpose is to disseminate expertise; (ii) external organisations that provide access to additional resources [38]. Finally, regarding the layered structure, we identify: (a) the core-periphery structure, which consists of a 'core' company and peripheral actors; (b) the triple-layer structure, which holds a central layer, platform layer, and development and application layer; (c) the core-periphery triple-layer structure, which brings together the two models described [36].

Therefore, in the light of the above, by Ecosystem of Innovation (EI) we mean a network of universities, research organisations, territorial public bodies, and highly qualified public and private entities that promote and implement Research, Development and Innovation (RDI) infrastructures. This is to facilitate technology transfer and accelerate the digital transformation of companies' production processes with a view to economic and environmental sustainability and social impact on the territory. Such processes can be fostered by innovation ecosystems, more effectively if they are embedded in a programmatic design of an Ecoregion, i.e. a more or less large portion of ecologically homogeneous territory, or in a Macro-Region context, i.e. an area characterised by common problems and which can be conceived as an application of multi-level governance. In this case, policy implementation takes place on several levels, through (loyal) cooperation between EU institutions, states and local levels and thus as an instrument to ensure greater policy coordination between actors [44].

3.2 RDI Projects: Social Benefits and Target Groups

To understand how RDI projects can foster social cohesion in marginalised urban contexts, it is first necessary to investigate the social benefits and the relevant user-target groups.

Building RDI infrastructures in inland areas by making them areas of technological specialisation means:

- attracting resources to the area from outside (scholars, researchers and specialised professionals);
- activate in the short- and medium-term cross-fertilisation processes between businesses, between public administrations, between public administrations themselves, both local and non-local;
- facilitate the professional growth of operators;
- enable the increase and dissemination of know-how, also through the involvement of banks and venture capital;
- encourage the circulation of knowledge, also among the community [45, 46].

It follows that the model of the innovation ecosystem promoting RDI infrastructures represents a strategic network capable of fostering the circulation of knowledge and determining a series of spill-over effects on a multiplicity of user-target groups. These target groups are specifically represented by:

1. companies and laboratories that are part of the innovation ecosystem;
2. other enterprises and laboratories, already existing but outside the network, that benefit from the positive externalities generated by the research infrastructure, in terms of production and dissemination of new knowledge, and in more general terms of effects deriving from learning-by-doing processes;
3. new enterprises, i.e. start-ups and technology spin-offs, which are created as a result of the activities carried out by the RDI infrastructure. These enterprises can enjoy benefits in terms of reduced business mortality rate, cost savings and/or development of innovative products and processes;
4. researchers involved in the design, development and use of innovative machinery and technologies, as well as academics benefiting from scientific production. Specifically, the potential benefits for academic researchers are publications and citations in academic journals and the registration of patents;
5. young professional researchers working in companies. In this case, the expected benefit is expressed in terms of an increase in human capital, as well as social capital represented by the development of networks among colleagues and the establishment of new research groups;
6. students, usually post-graduates or doctoral students, but also graduates, who by attending higher education courses can certainly contribute to the increase in social and human capital;
7. population residing in the areas targeted for intervention and technological experimentation. The implementation of applied research activities enables the population to benefit from the reduction in mortality and accident rates associated with these risky events;

8. the public and the community at large. Those interested in the themes of the innovative technologies experimented in the area benefit from the possibility of access to the infrastructure, to participate directly in the training activities and local workshops promoted by the promoters of the ecosystem, to benefit from all the activities conveyed through the media and social networks or through awareness campaigns [45, 46].

3.3 Methodology

This research intends to characterise a decision-support model for innovative projects promoted in the context of EI that can guide the analyst in: (a) estimating the social costs and benefits deriving from a RDI infrastructure; (b) assessing the social return on investment; (c) analysing the investment's risky variables and the critical issues to be addressed in order to define strategic guidelines for setting up and managing EI.

The logical-operational steps on which the model is based are detailed below.

1. *Definition of project goals and evaluation parameters*
2. Having clarified the goals to be achieved with the investment in research, development, and innovation, it is necessary to define: the time horizon of the evaluation; the social discount rate; and the pricing system [47–49].
3. *Cost analysis of the RDI infrastructure.* The second step translates into the estimation of: investment costs, which are incurred during the design and construction phases; operation and maintenance costs, which concern the operational phase of the RDI infrastructure; end-of-life costs, which relate to the decommissioning phase and residual value of the works at the end of the analysis period. Being an economic analysis, the investment cost is net of VAT, while the operating, maintenance and decommissioning costs are multiplied by appropriate conversion coefficients [40].
4. *Identification of target groups and analysis of social benefits.* As highlighted in the previous section, there are eight groups of social agents whose welfare is potentially affected by the services offered by a RDI infrastructure. Once the beneficiaries have been identified, one or more benefits can be associated with each group. Although the estimation of benefits may vary considerably depending on specific project characteristics, a set of benefits resulting from the implementation of RSI infrastructures can be identified. Specifically, these are:
   A. Development of new/improved products, services and technologies;
   B. New patents;
   C. Increased birth rate and longevity of start-ups and spin-offs;
   D. Knowledge spillovers (not protected by patents);
   E. Learning-by-doing benefits;
   F. Human capital formation;
   G. Knowledge outcomes and their impact;
   H. Social benefits of RDI services for target groups;
   I. Recreational benefits for the general public [45, 46].

A. The development of new/improved products, services and technologies is a direct benefit of the project. The social value of these assets can be obtained by estimating the

incremental shadow profits expected from their sale. In formula:

$$\mathrm{E(Z)} = \sum_{\mathrm{i=1}}^{I} \sum_{\mathrm{t=0}}^{\tau} s_t \cdot E(\Pi_{\mathrm{it}})$$

In which: E(Z) is the expected present value of new (or improved) products, services and technologies; *i* is the number of innovations over time *t*; $\mathrm{E}(\Pi_{\mathrm{it}})$ represents the incremental profit directly attributable to innovation; $\mathrm{s_t}$ is the discount factor.

B. The benefit generated by new patents produced and registered by the RDI infrastructure can be estimated in terms of incremental social value. Let I be the number of patents over time τ; $\mathrm{VSM}(\mathrm{pv_{it}},\mathrm{ex_{it}})$ the Marginal Social Value of the i-*th* patent, which takes into account both the private value ($\mathrm{pv_{it}}$) and the externality ($\mathrm{ex_{it}}$) in terms of knowledge spillover; $\mathrm{s_t}$ the discount factor. Then the expected present value E(P) of the patent can be expressed as:

$$\mathrm{E(P)} = \sum_{\mathrm{i=1}}^{I} \sum_{\mathrm{t=0}}^{\tau} s_t \cdot \mathrm{E}(\mathrm{VSM}_{\mathrm{pv}_{it,},\mathrm{ex_{it}}}) \tag{1}$$

If: 'use' is the average utilisation rate of granted patents; 'ref' is the average number of references included in granted patents in the technology sector under consideration; $\mathrm{pv_{it}}$ is the private value of granted patents in the specific technology sector; then in the formula (1), $\mathrm{E}(\mathrm{ex_{it}})$ is:

$$\mathrm{E}(\mathrm{ex_{it}}) = \sum_{\mathrm{i=1}}^{I} \sum_{\mathrm{t=0}}^{\tau} \mathrm{use} \cdot \frac{\mathrm{E}(\mathrm{pv_{it}})}{\mathrm{ref}} \tag{2}$$

C. Since the RDI infrastructure contributes to an increase in the birth and survival rate of start-ups and spin-offs, this benefit can be evaluated as the incremental profit expected and obtained by the firms, since they are able to live longer than in the counterfactual scenario. In a marginal area, it is reasonable to assume that the main contribution of the RDI project is to increase the number of start-ups in the area where the investment has fallen. Therefore, the analysis can be conducted by estimating the overall profit generated by the largest number of start-ups during their life cycle. It follows that the *ex-ante* evaluation of spin-off and start-up profits requires the determination of the following parameters:

- annual number of spin-offs/start-ups expected to be created as a result of the RDI investment;
- expected value of annual profits of spin-offs/start-ups in the country and in the reference sector;
- average duration of spin-offs/start-ups in the country and in the reference sector.

D. Research projects also generate knowledge spillovers (industry databases or software) for companies not directly benefiting from the project. The value of this benefit is estimated by assuming that the software and databases are not currently available on the market and that the cost of the individual product is estimated as a function of the time spent by the researchers on its realisation.

E. The approach in point D can also be applied to estimate the benefits of the learning-by-doing processes enjoyed by the high-tech providers involved in the design, development, or operation of the technological innovation infrastructure. Companies that can access the innovations produced by the research centre can in turn use them to produce further innovations. Again, the benefit is assessed through the shadow profit of non-user companies attributable to the RDI project or through the estimated avoided costs.

F. The benefit in terms of human capital formation is mainly enjoyed by young researchers and graduates involved in the RDI Centre's activities. These human resources, having the opportunity to work in the RDI infrastructure, acquire an advantage in terms of professional experience and career prospects, compared to a situation of non-participation in the project. This advantage is expressed in terms of incremental salary accumulated over a working life compared to the scenario without the project.

The expected present value of the benefits inherent in the accumulation of human capital E(H) equals the sum of the expected increasing earnings $E(E_{it})$ for each i-*th* student and commonly indexed from the moment φ when they leave the research centre:

$$\mathrm{E(H)} = \sum_{\mathrm{i}=1}^{I} \sum_{\mathrm{t}=\varphi}^{\tau} s_t \cdot \mathrm{E}(E_{it}) \tag{3}$$

The estimation of incremental remuneration can be conducted through: the benefit transfer approach; surveys and opinions of experts working in the relevant field; the willingness-to-pay (WTP) approach of young researchers and students for a period of study and training at the Centre, in anticipation of the salary increases they expect to realise once they enter the labour market.

G. For researchers and academics, one of the main benefits of working in the Research Centre is the opportunity to access experimental data, to contribute to the production of technological innovation, and to disseminate knowledge results through scientific publications.

The marginal value of publication is estimated through the marginal scientific cost of production approach. This marginal scientific cost is representative of the time spent by scientists to conduct research activities and produce the related output at appropriate shadow wages. Obviously, if one wants to consider that not all scientific production has the same impact on the community, one has to multiply the expected value of the scientific publication E(O) by an impact index, which summarises the level of influence of that knowledge on the academic community. In formula:

$$\mathrm{E(O)} = \sum_{\mathrm{t}=0}^{\tau} (s_t \cdot \mathrm{E}(Y_t) \cdot \mathrm{E(m)}) \tag{4}$$

where: $E(Y_t)$ is the expected social cost of scientific production at time t; s_t is the discount factor; E(m) is the impact index (or multiplier).

Specifically:

$$\mathrm{E}(Y_t) = \text{number of academics} \times \text{average annual productivity} \times \text{unit production cost per paper} \tag{5}$$

The unit cost of production per knowledge output (paper) can be estimated using the ratio between the author's gross salary and the number of scientific outputs produced per year, considering only the amount of salary related to the time dedicated to research within the RDI Centre. Finally, the use of bibliometric techniques (e.g. by predicting the median number of citations per scientific publication) makes it possible to estimate the impact multiplier E(m), expressed by the ratio between the number of citations and the number of bibliographic references for each article.

H. RDI infrastructures use new knowledge to provide innovative services and products needed, for instance, to tackle climate change, find new ways to ensure energy security and efficiency, mitigate the risk of natural disasters, improve health.

The methods for evaluating the overall benefits resulting from the application of a research result depend on the type of innovative service or product made available by the infrastructure. However, these methods are generally based on willingness to pay or avoided costs. Given the innovative nature of the service/product provided, the challenge is to predict the probability of success and the different levels of effectiveness associated with the innovation implemented.

I. Finally, the involvement of the community in educational and scientific activities, the organisation of awareness campaigns and the promotion of the area will generate recreational benefits for all visitors to the infrastructure. In this case, the marginal social value of the benefit is expressed through the visitors' implicit willingness to pay. The most common approach to assessing WTP is the travel cost method. The catchment area is then defined and the number of visitors over the time horizon of the project is estimated. From a theoretical point of view, WTP corresponds to the sum of the following contributions: the cost of the return ticket, in the case of travel by train, coach or plane, or the cost of fuel, tolls and other operating costs in the case of travel by car; the value of the time spent travelling; the cost of hotel accommodation and food, for visitors coming from more than 150 km.

Table 1 summarises the main expected benefits of the RDI infrastructure, its users and possible methodological approaches to be implemented for evaluations.

4. *Assessment of social profitability.* Once the expected benefits of the project have been estimated, the economic viability and hence the social profitability of the investment can be assessed in terms of Net Present Value (NPV), which expresses the positive or negative difference, or equality, between the discounted sum of the benefits and the discounted sum of the costs of the project; Internal Rate of Return (IRR), which represents the return of the project within the structural, economic and financial system in which the investment is placed; Benefit-Cost Ratio (B/C), which indicates the amount of euros gained or lost for every euro spent on the intervention.
5. *Analysis of critical variables and investment risk assessment.* The complexity inherent in the implementation of RDI infrastructure requires the assessment of project-related risks. This assessment, whose objective is to manage the inherent riskiness and uncertainty in the data and assumptions underlying the ex-ante investment appraisal, requires: sensitivity analysis; qualitative risk analysis; probabilistic risk analysis; possible definition of risk mitigation and containment measures [50].

Figure 1 summarises the steps of the model.

Table 1. Expected benefits of RDI infrastructure [45, 46].

Benefit	Marginal social value	Evaluation approach	Target group
A. Development of new/improved products, services and technologies	Incremental shadow profits	Enterprise surveys; Statistical inference from enterprise data	(1), (2), (3)
B. New patents	Marginal social value of the patent	Inventor surveys; Statistical inference from data on the decision to renew patents or the economic terms of patent transactions	(1), (2), (3), (4)
C. Increased birth rate and longevity of start-ups and spin-offs	Incremental shadow profits	Start-up and spin-off surveys; Statistical inference from start-up and spin-off data; Transfer of benefits	(1), (2), (3)
D. Knowledge spillovers (not protected by patents)	Increased shadow profits; Avoided costs; Willingness to pay for time savings	Enterprise surveys; Avoided cost of producing or purchasing a technology; Cost avoided through the exploitation of a new technology; Benefit transfer	(1), (2), (3), (8)
E. Learning-by-doing benefits	Increased shadow profits; Avoided costs	Enterprise surveys; Statistical inference from enterprise data; Benefit transfer	(1), (2), (3)
F. Human capital formation	Incremental salary over working life	Survey of alumni; Benefit transfer	(5), (6)
G. Knowledge outcomes and their impact	Marginal cost of production	Gross salary of scientists; Value of time; Value of scientific publications	(4), (5)
H. Social benefits of RDI services for target groups	Willingness to pay avoided costs	Costs-damages avoided due to risk reduction	(7), (8)
I. Recreational benefits for the general public	Willingness to pay for time savings	Travel cost method; Contingent valuation; Benefit transfer	(8)

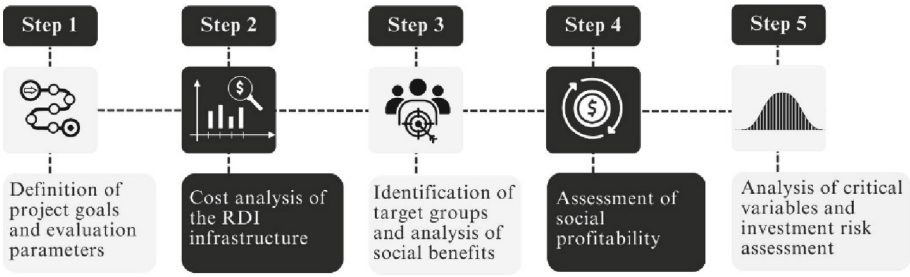


Fig. 1. Steps of the model.

4 Concluding Remarks and Research Perspectives

The crisis of the metropolitan city model and the accentuation of environmental degradation phenomena lead to the need to enhance and protect inland and marginal areas. There is therefore an urgent need for well-structured intervention programmes aimed not only at building reuse, but also at environmental and landscape protection, infrastructure redevelopment and social cohesion. The actions and programmes implemented so far by governments show that investing in research, development and innovation can be a crucial course of action to foster territorial cohesion in marginalised areas. However, there is a lack of a systematic frame of reference that can support analysts in selecting effective intervention strategies.

In line with the above, this paper aims to define a Cost-Benefit Analysis model for RDI projects promoted within innovation ecosystems, which, it has been said, in order to function must themselves be included in a programmatic design of an ecoregion or macro-region. The RSI projects generate social and cultural impacts involving a multiplicity of actors and target groups and represent one of the main items of cost-benefit testing. However, these externalities are often difficult to estimate and are therefore not always adequately taken into account in economic evaluations.

The proposed economic model consists of the following four steps: (i) definition of project objectives and evaluation benchmarks; (ii) analysis of RDI infrastructure costs; (iii) identification of target groups and analysis of social benefits; (iv) analysis of critical variables and investment risk assessment.

From the characterisation of the model, it emerges that crucial steps to be able to make a correct judgement on the social profitability of the investments under analysis concern first of all the identification of the categories of potential beneficiaries of the project. Then, by means of specific estimation approaches, the evaluation of social externalities, which for RDI projects concern: the development of new/improved products, services and technologies; the filing of new patents; the increase in the birth rate and longevity of start-ups and spin-offs; the spillover of knowledge (not protected by patents); learning-by-doing benefits; the training of human capital; the results of knowledge and its impact; social benefits of RDI services deriving from the dissemination of new knowledge; recreational benefits for the community related to scientific promotion activities. Finally, the assessment of project-related risks is a further crucial step to be able to consider the complexity inherent in the implementation of the RDI infrastructure.

In a research perspective, the application to case studies will allow both to validate the defined model and to demonstrate how investment in 'knowledge and applied knowledge' can become a concrete driver of opportunities for marginalised urban contexts, fostering their long-term productivity and growth.

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