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Research Article

Multicriteria Spatial Decision Analysis for the Development of the Italian Minor Airport System

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The infrastructures supporting air transport throughout the world in the civil sector are classified as primary-level (large numbers of passengers and goods on both commercial and charter long- and medium-haul flights) and secondary-level (few passengers and goods on general aviation private, short-haul flights). In parallel with primary-level air traffic general growth all over the world and in Italy, the popularity of "individual" nonscheduled general aviation traffic increased in many countries since 1990s. The latter aviation has proved to be a valid alternative to rail and road transport for short-medium distance journeys (100-500 km) for classes of business and tourist passengers. In keeping with the national and international airport system development scenarios, the paper illustrates the results of in-depth analyses aiming to construct an integrated GIS-based Multicriteria Decision Analysis evaluation methodology. It gears towards formulating strategies for the development and streamlining of some existing (51) Italian minor airports and for the right locations for the new hubs required to construct an efficient second-level air transport network (the "highway in the sky"). Different levels of evaluation verify the suitability of airport services and infrastructure (status quo) and the attractiveness of airport hubs given the territorial facilities found in their catchment areas.

1. Introduction

The infrastructure supporting air transport throughout the world is classified in the civil sector [1] depending on the quantity of passengers and/or goods handled and on the type of activities (aviation and/or nonaviation) carried out. Primary-level civil aviation infrastructure (airports belonging to the main network of each country) is earmarked for transporting large numbers of passengers and goods travelling on both commercial and charter long-haul and medium-haul flights. Secondary-level aviation infrastructure (general aviation, regional airports belonging to the secondary or minor network of each country) serves small numbers of passengers and goods travelling on private, short-haul flights.

An analysis of air transport traffic in the main airports of the civil aviation sector reveals the following.

(i) Global air traffic, in the world [2], measured in Revenue Passenger Kilometres (RPK) from 1970 to 2015, doubles every 15 years. Furthermore, Revenue Passenger Kilometres (RPKs) grew 6.3% in 2016, as compared to 2015, and for the next 20 years Airbus forecasts a 4.4% annual growth in global air traffic.

(ii) Global air traffic, in Europe [3, 4], has seen continuous growth since November 2015; it particularly increased by 4.5% in September 2017 compared to September 2016. The number of air journeys expected in 2050 in Europe has also significantly increased (more than 25.000 Instruments Flight Rules Movements).

(iii) Global air traffic, in Italy, has grown in recent years; a 4.9% increase in the number of passengers was particularly recorded in the first quarter of 2017, compared to the same period the year before, as well as a 12.3% increase in the quantity of goods transported [5].

Twelve countries have added over 50 daily flights to Spain, the UK, and Germany [3]. The increase in flights has caused congestion in European airports, which has led to considerable delays among both arrivals and departures. In fact, according to Air Traffic Flow Management (ATFM) indicators, total ATFM delays in European airports belonging to the main network of each state increased by 68.9% in September 2017 compared to September 2016. En-route ATFM delays increased by 83.3% mainly due to capacity and weather (excessive demand in relation to supply for take-off and landing spaces in airports and unfavorable weather conditions); airport ATFM delays increased by 49.6% [3].

As regards the general growth of air traffic in airports belonging to the main network of each country, since the 1990s we have seen the growing popularity of "individual" [6], or private, noncommercial, nonscheduled "point to point" flights all over the world and in Italy, using general aviation aircraft [7, 8] operating out of the secondary airport network. They have proved to be a valid alternative to rail and road transport for short and medium distance journeys (100-500 km) for a number of different classes of users, including business and tourist passengers. This phenomenon is the result of the introduction of the latest aircraft, advanced ultralight aircraft and very light jets, on the general civil aviation market, particularly in Europe and in the United States. These differ from traditional general aviation aircraft due to their dynamic performance features (greater ease in take-off and landing, not requiring handling operations or even a control tower in many cases, ease in movement due to their smaller size, etc.) and extremely low fuel consumption vehicles. Their growing popularity has become particularly noticeable in the United States [9] since the early 2000s and in many European countries as well, such as the United Kingdom, France, and Germany [8, 10].

In the air transport infrastructure sector, a survey on the current state of the Italian airport system highlights that only certain types of airports are important strategic hubs in the transport system, from the international to the national and local level, becoming an integral part of the general national intermodal system [11]. A territorial analysis of the infrastructural system of national transport networks, consisting of linear and spatial distributional components, as well as what is known as intermodal exchange hubs, allows us to identify various levels of development in transport systems (on rail, road, via sea and air), particularly in urban systems featuring a high level of infrastructural development. Such levels of development are defined by subsequent levels of integration with local and national production and distribution systems and are inextricably linked to demographic issues and problems to do with the competition for land use [12]. The degree of interaction between transport infrastructure networks and the socioeconomic and urban context can be affected by the strategic role of networks within multiregional and international competitive structures [13]. To this end, the Italian national airport plan (or PNA) [11] states that the main airport system network in Italy consists of 42 airports of national importance (grouped in two categories: main airports and service airports, depending on the characteristics indicated in the 2012 PNA) that can meet the demand for collective commercial traffic with differing levels of connectivity on a continental and international medium- and long-haul level. Some of these 42 airports (33) are included in the Trans-European Transport Network (TEN-T) and are classified according to various levels of importance based on what has been established by the European Union in its Single European Sky 2 initiative [14–16]. As mentioned earlier, airports of local importance (minor or general aviation airports) that mainly handle private as opposed to commercial flights are not included in the network defined by the 2012 PNA but they do constitute a secondary, or second-level network. Though it provides a service for the manufacturing areas and businesses in surrounding territories, Italy's network of minor airports has not been particularly developed and is poorly connected to intermodal transport systems [10]. If it were to be properly enhanced and expanded, the network of minor airports could take on strategic importance in the national infrastructural system, playing a role that could support primary airport networks. The factors in favor of the development of the Italian minor airport system can be summarized into the following possibilities [11]: (a) absorbing air traffic, encouraging the streamlining of operations in main airports, and ensuring that the traffic demand from specific sectors is met; (b) meeting the demand for individual, business, and air-taxi service flights and redirecting part of that work to traditional transport networks, such as road and rail; (c) meeting the demand for activities that run parallel to passenger and goods transport, i.e., (i) nonaviation activities, which include a wide range of commercial and tourist services designed to satisfy different types of users, (ii) aviation activities, such as working flights, civil defence, reconnaissance activities, patrols, training, education and support provided to civil protection forces, air rescue, and the monitoring and protection of large swathes of territory and emergency services, not only when natural disasters occur but above all when fighting forest fires, which are increasingly frequent occurrences in this country, and more generally all forms of territorial surveillance that are designed to verify and avoid damaging alterations and attacks.

It is in just such a framework of development that the possibility of turning minor (existing or planned) Italian airports into hubs that can attract economic development in marginalised areas where urban and territorial services are scarce or entirely absent has come to light.

In keeping with the national and international airport system development scenarios mentioned earlier, this paper illustrates the results of in-depth analyses carried out as part of ongoing research, divided up into different steps. This research aims to construct an integrated GIS-based Multicriteria Decision Analysis evaluation methodology [12, 17–19]. This methodology is geared towards formulating strategies for the development and streamlining of the existing Italian minor airport network and the identification of the right locations for the new hubs that could be required to construct an efficient second-level air transport network (the "highway in the sky"). To this end, it is necessary to identify which of the 51 existing minor airport hubs should be used as the basis for the construction of a second-level network that could meet the growing demand for commercial and general aviation traffic and cover any "exposed" locations, i.e., places that are not currently served by minor airports. The second-level network will need to be formulated in a way that will ensure that its hubs are evenly distributed across the country and connected with other modes of transport, taking into account aspects regarding the following: (i) infrastructural characteristics that are intrinsic to airports (tracks, taxiways, and aprons); (ii) infrastructural characteristics that are extrinsic to airports: airport services (airport services, air traffic support services, services to passengers, and intermodal connectivity); (iii) facilities for manufacturing (companies and the labour market), tourism (the number of state museum institutes and related visitors), and the transport network infrastructure (boasting road, rail, and public transport infrastructure) in the areas served by each minor airport; (iv) current urban and territorial redevelopment processes (town planning forecasts and implementation from a vast level to a local scale) so as to ensure the integration and overlapping of systems (urban, environmental, and transport systems); (v) economic and financial aspects (cost/benefit ratio for the completion, upgrading, and/or conversion of airport hubs).

As regards each of the existing 51 minor airports (alternatives, *A.n*) (Figure 1), the in-depth analysis involved in the implementation of the evaluation methodology proposed in this paper addresses points (i), (ii), and (iii) as listed above and is aimed at assessing the following:

(1) The suitability of airport services and infrastructure (status quo)

(2) The attractiveness of airport hubs given the territorial facilities found in their catchment areas.

The aspects that should be taken into consideration when constructing and implementing an evaluation methodology are of a multicriterial and spatial nature; thus such a methodology attempts to build a data processing interface that will produce georeferenced analysis data for example to develop an assessment process that integrates multicriterial analysis (MCDA) and georeferencing and geoprocessing (GIS) tools. This allows us to solve decision-making problems that deal with a different number of aspects and objectives that sometimes clash with each other [20], including the spatial aspects of the data considered right from the start.

If we examine the field literature concerning MCDA and GIS integration, what emerges is that it is possible to obtain three levels of integration [18, 21]: (i) loose coupling, where each of these two tools can use the information originating from the processing operations of the other as input data (their database and interface remain separate); (ii) tight coupling, where the MCDA uses a separate database despite being an integral part of the GIS (the two systems share the GIS data interface); (iii) full integration, where the MCDA and GIS share both the database and the interface (the set of commands found in GIS packages support particular data processing routines typical of both tools using the generic language of programming).

The methodological approach proposed in the previous phases of research development, aimed at assessing the suitability of airport service and infrastructure facilities (status quo), was of the tight coupling kind [21, 22]. In this study, we illustrate an upgrade of the evaluation methodology to the full integration type (see Section 2) which permits assessment and further analysis for evaluating the status quo of Italian minor airports and evaluating (from scratch) the attractiveness of airport hubs in view of the territorial facilities of their catchment areas. The upgrade was carried out with the aim of implementing and managing a greater quantity of spatial/territorial data in an integrated and automated way, data that characterizes the decision-making problem analyzed here. Such an upgrade will also prove an essential basis for the development of further research phases.

2. Materials and Methods

2.1. Research Design. As mentioned earlier, this paper illustrates an integrated evaluation methodology designed to judge airport hubs both individually and taken together as far as the following aspects are concerned:

(1) The suitability (status quo) of their infrastructure and service facilities (paragraph 1, point 1):

   (1.1) The identification of characteristics: A: intrinsic infrastructural characteristics (criteria, *Cj.A*; subcriteria, *Sj.A*; indicators, *Ij.A*); B: extrinsic characteristics: airport services (criteria, *Cj.B*; subcriteria, *Sj.B*; indicators, *Ij.B*)

   (1.2) Data collection (specific resource parameters *iIj.A*, *Ij.B*)

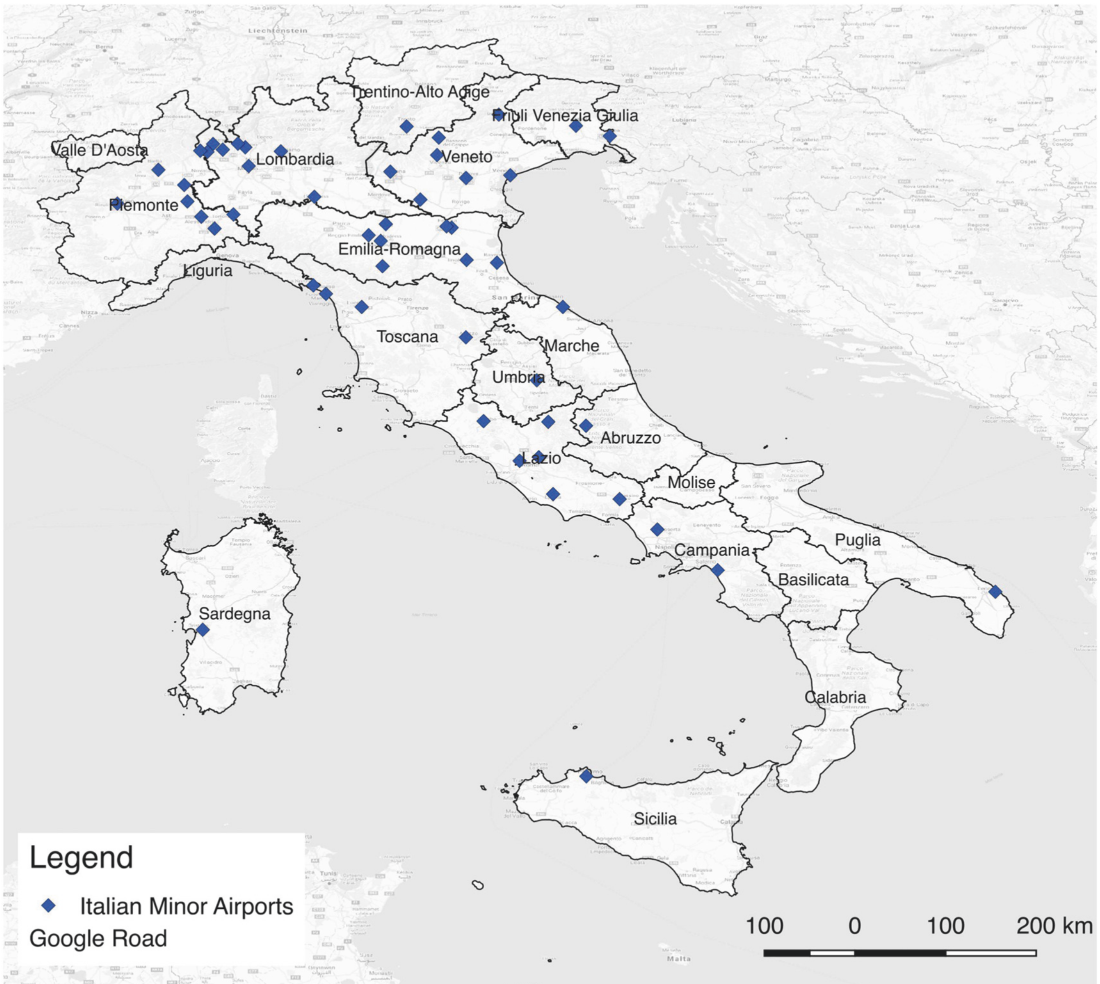
   (1.3) The structuring and organization of the data collected (point 1.1 and 1.2) in order to obtain Judgment Levels (JL) for a "structural classification" (JLA) involving *A.n* classification on the basis of the amount of intrinsic infrastructural resources, a "services classification" (JLB) involving *A.n* classification on the basis of the extrinsic characteristics such as airport services available and an "overall classification of resources" (JLC) that combines the JLA and JLB levels

(2) Their attractiveness given the territorial facilities of their catchment areas (paragraph 1, point 2):

   (2.1) The identification of parameters designed to define the D profiles of manufacturing, tourism, and infrastructure in a particular territory (criteria, *Cj.D*; subcriteria, *Sj.D*; indicators, *Ij.D*)

   (2.2) Data collection (specific resource parameters *iIj.D*)

   (2.3) The structuring and organization of the data collected (points 2.1 and 2.2) in order to obtain Judgment Levels (JL) for a "territorial attractiveness classification" (JLD) involving *A.n* classification on the basis of the presence of extrinsic



NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport
North-West (ITC)	Piemonte	1	*Alessandria*
		2	*Biella Cerrione*
		3	*Casale Monferrato*
		4	*Novi Ligure*
		5	*Torino Aeritalia*
		6	*Vercelli*
	Lombardia	7	*Alzate Brianza*
		8	*Como Idroscalo*
		9	*Calcinate del Pesce*
		10	*Cremona Migliaro*
		11	*Milano Bresso*
		12	*Valbrembo*
		13	*Varese Venegono*
		14	*Vergiate*
		15	*Voghera*
	Liguria	16	*Sarzana Luni*
	Val D'Aosta		Region without minor airports
North-East (ITD)	Trentino	17	*Trento Mattarello*
	Veneto	18	*Asiago*
		19	*Belluno*
		20	*Legnago*
		21	*Padova*
		22	*Thiene*
		23	*Venezia*
		24	*Verona Boscomantico*
	Emilia	25	*Carpi Budrione*
		26	*Ferrara Aguscello*
		27	*Ferrara*
		28	*Modena*
		29	*Pavullo nel Frignano*
		30	*Lugo di Romagna*
		31	*Ravenna*
		32	*Reggio Emilia*
	Friuli V Giulia	33	*Gorizia*
		34	*Udine Campoformido*
Centre (ITE)	Toscana	35	*Arezzo*
		36	*Lucca Tassignano*
		37	*Massa Cinquale*
	Umbria	38	*Foligno*
	Marche	39	*Fano*
	Lazio	40	*Aquino*
		41	*Guidonia*
		42	*Latina*
		43	*Rieti*
		44	*Roma Urbe*
		45	*Viterbo*
South (ITF)	Abruzzo	46	*L'Aquila Preturo*
	Molise		Region without minor airports
	Campania	47	*Capua*
		48	*Salerno*
	Puglia	49	*Lecce Lepore*
	Basilicata		Region without minor airports
	Calabria		Region without minor airports
Islands	Sicilia	50	*Palermo*
	Sardegna	51	*Oristano Fenosu*

Figure 1: Italy's minor airports.

infrastructural resources over a large area; "airport potential classification" (JLE) that classifies the 51 airports based on a combination of the previous evaluation phases.

A synthetic overview (Figure 2) shows the ensemble of Judgment Levels in relation to the considered aspects and with the type of obtainable classification (a complete list of abbreviations is shown in Abbreviations).

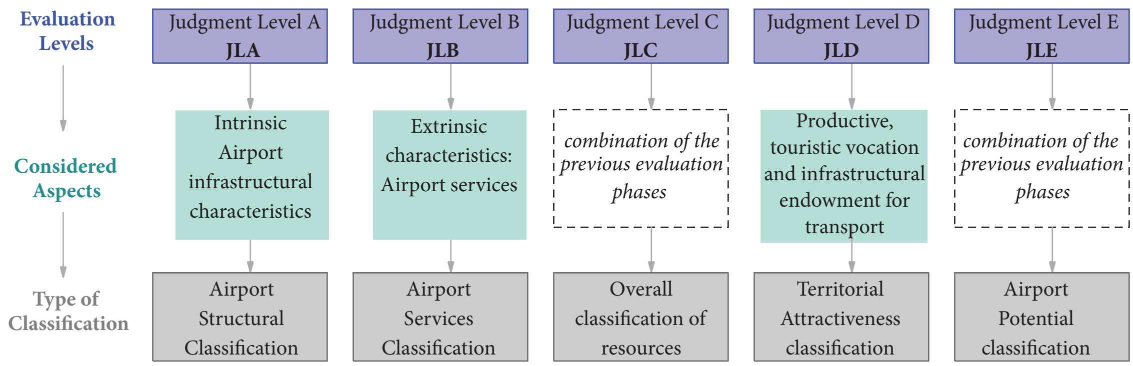


Figure 2: Judgment Levels overview.

The results obtained by implementing these Judgment Levels will be useful for singling out the parts of the country that are "covered" by minor airports and those that are "exposed" in order to identify new areas (among those judged to be exposed) where the system of minor airports could achieve national coverage.

This paper is structured as follows: definition of the framework of the evaluation methodology (Section 2.2), evaluation elements and selection, organization, and spatial data processing for JLA, JLB, JLC, JLD, and JLE (Section 2.3), interrogation of spatial data based on a multicriteria analysis (MCSDA) (Section 2.4), evaluation and discussion of results for JLA, JLB, JLC, JLD, and JLE levels according to the MCSDA approach (Section 3), and conclusions (Section 4).

2.2. The Framework of Evaluation Methodology. As mentioned earlier, the structure of the evaluation methodology we propose is based on a full integration between Multicriteria Decision Analysis (MCDA), which allows us to consider a multicriterial data set, and Spatial Decision Support Systems (SDSS) that implement the spatial/territorial analysis [12, 17–19, 21, 23–25]. The evaluation methodology proposed can be defined as a type of Multicriteria Spatial Decision Analysis (MCSDA) due to its ability to (i) contribute to the construction of databases with a suitable amount of information, exploiting the potential of Geographical Information Sciences (GISciences) [26], databases that can be consulted and easily updated, linked to the national infrastructure system (these systems have been developed since the 1990s [27–31] and have expanded enormously in the past 20 years [12, 32–34] thanks also to their integration with World Wide Web (WWW) technologies [35]); (ii) participate in the formation of TIS territorial information systems regarding the network of minor airports, such as those for the organization and consultation of data supporting decisions; (iii) combine geographic data (map criteria) with assessment indicators (decision-makers' preference and uncertainties) in order to collect information that will prove suitable and useful when making decisions [36].

Given the enormous range of data of all kinds that requires inclusion in the evaluation and the spatial nature and/or the strong spatial aspect of most of this data, the multicriterial spatial evaluation model (MCSDA) proposed is based on the creation of a Gis-based database [37]. Thanks to the use of computer software, it is possible to create, manage, and search data that helps us in making an assessment by constructing a database arranged in fields and columns. Using the database as a basis, the evaluation model is implemented using the management and processing of the data (of a multicriterial nature) using tools (computer software) for georeferencing and spatial analysis. Such instruments process and search the database using topographic overlay functions, spatial queries, network analysis, isochrones, and heatmaps. A number of different software packages, including open-source software (the most popular one is currently ESRI ArcGIS proprietary software and open-source QuantumGIS), allow us to create MCSDA models thanks also to the graphic interface that supports the input and management of data increasingly intuitively in recent releases. In order to complete this paper, we chose to use open-source QuantumGIS software to make implementation possible without having to resort to purchasing a licence. The MCSDA on each airport (evaluation alternatives) have been implemented in subsequent methodological steps as follows (Figure 3):

(1) Consider (from the data used in previous research development phases) or define (ex novo) a set of evaluation elements made up of alternatives (*An*), criteria (*Cj.n*), subcriteria (*Sj.n*), indicators (*Ij.n*), specific resource parameters *i*(*Ij.n*) for JLA "structural classification", JLB "services classification", JLC "overall classification of resources", JLD "territorial attractiveness classification", and JLE "airport potential classification" Judgment Levels.

(2) Organize and spatially process the specific resource parameters, related to each alternative, through the database for JLA, JLB, JLC, JLD, and JLE Judgment Levels.

(3) Interrogate spatial data based on a multicriteria type evaluation procedure (MCSDA).

(4) Provide a specific classification for each JLA, JLB, JLC, JLD, and JLE Judgment Level.

(5) Extract the evaluation results for each JLA, JLB, JLC, JLD, and JLE Judgment Level.

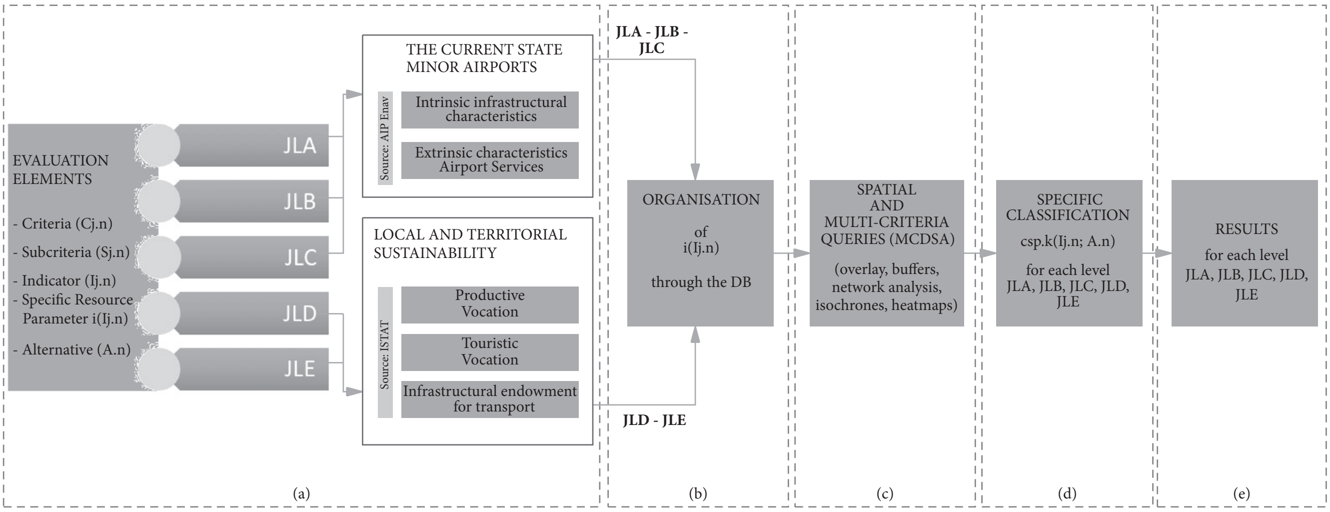


Figure 3: Framework of the model.

2.3. Evaluation Elements, Organization, and Spatial Elaboration of Data through the DB for Judgment Levels JLA, JLB, JLC, JLD, and JLE. Italy's 51 minor airports (*A.n* alternatives) were georeferenced in the 1984 World Geodetic System (WGS84) of geographic coordinates (georeferenced spatial data is data that refers to a physical location on the Earth's surface using coordinates in a geographic reference system. Geodesy, based on satellite positioning, uses geodetic geocentric data, where the origin of the Cartesian triad coincides with the centre of the Earth's mass, i.e., of a global type, unlike traditional geodesy [38]), in accordance with the information provided by the Ente Nazionale Aviazione Civile (ENAC) (Figure 1). The WGS84 is a global geocentric system created using spatial observations and consisting of a right-handed Cartesian triad whose point of origin coincides with the centre of the Earth's mass [39].

A shape-file was created for each minor airport, which allows us to archive vector data that can contain a range of information (e.g., location, form, attributes). In the case study proposed here, each minor airport is represented with a georeferenced point on the maps.

Sets of elements for evaluation were considered or defined for each Judgment Level (Tables 1 and 2) [22] (Table 3), consisting of multiple *Cj.n, Sj.n,* and *Ij.n* associated with data and the abovementioned *i(Ij.n)* parameters of specific facilities, linked to intrinsic and extrinsic characteristics and territorial profiles that should be considered for each alternative *A.n* that has been geographically specified.

The specific resource parameter i(Ij.n) identified for each A.n was arranged in a Microsoft Excel spreadsheet (which included the one created during previous phases of the research), sorted into fields and columns. The spreadsheet was laid out with A.n placed in rows and Cj.n and Sj.n in columns, while the i(Ij.n) was placed at the point where they cross. Saving the Excel file in a comma separated value format (.csv) allowed us to link the Excel spreadsheet to the Quantum GIS (QGIS) software chosen from among the open-source software packages available due to its intuitive graphic interface and the ease with which it can be combined with other IT tools. The tables that follow describe the ways and methods used to construct the set of evaluation elements for each level (through the database). The evaluation elements for the JLC and JLE summarizing levels consist of the results of previous Judgment Levels.

The JLA "structural classification" (see paragraph 2.4) was implemented using the set of Cj.A, Sj.A, Ij.A, and i(Ij.A) designed to describe the intrinsic infrastructural characteristics of A.n (Table 1) [22].

The JLB "services classification" was implemented (see paragraph 2.4) using the set of Cj.B, Sj.B, Ij.B, and i(Ij.B) (Table 2) [22] and the potential resource parameters (ppd.n) designed to describe the airport services available for each alternative A.n (Table 2). The JLB level refers to data used in previous phases of research development [22], combined with the addition of new Cj.B, Sj.B, Ij.B, and i(Ij.B) (Table 2) concerning the proximity of (i) hubs (or medium- or long-haul main airports), (ii) interports, (iii) ports, and (iv) railway stations (underline part in Table 2). The elements for evaluation used at this Judgment Level were built up on the basis of the following:

(I) *The geographic area of analysis:* The geographic areas taken into account for assessments (JLB) (Figure 4) carried out on alternative A.ns were identified by considering the territories closest to minor airports found in the 50 km buffer area (a spatial search in SQL Buffer: the process of creating a polygon that covers the area within a particular distance from objects that could comprise one or more points).

(II) Consultation and inclusion of the data retrieved (2017) from the Aeronautical Information Publication (AIP) [36] helps convey the level of airport services at each analyzed alternative.

(III) Consultation and inclusion of Italian Istituto Nazionale di Statistica (ISTAT) statistical data helps

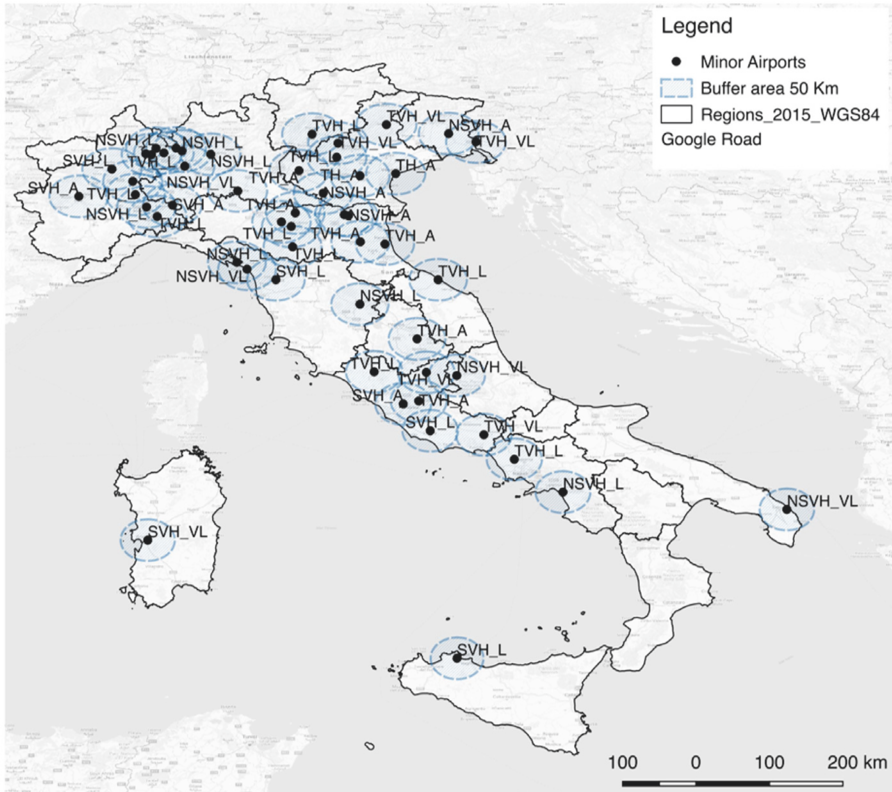


Figure 4: The geographic area of analysis for the JLB: "services classification".

convey the level of services linked to intermodal connectivity (indicators from IB.16 to IB.19).

The JLC "overall classification of resources" was implemented (see paragraph 2.4) by considering the results obtained from the JLA and JLB Judgment Levels using the methods described at paragraphs 3.1 and 4.

The JLD "territorial attractiveness classification" was implemented using the set of Cj.D, Sj.D, Ij.D, i(Ij.D), and potential resource parameters (ppd.n) for the alternative A.n (Table 3) used to describe the facilities found in the territory surrounding each airport. The assessment elements used at this level were built up on the basis of the following:

(I) *The definition of geographical areas of analysis:* The geographical areas used for JLD assessments carried out on alternative *A.n* (Figure 5) were identified by taking into account the territories closest to minor airports and the average time it takes to cross them by road, measured at two levels: (i) 15 minutes; (ii) 30 minutes. These geographical areas consist of a territory where towns are usually found for each minor airport hub, as well as the main council and provincial services.

(II) *The consultation and inclusion of ISTAT statistical data* helps build up an area's profile as regards (i) manufacturing, (ii) tourism, and (iii) infrastructure in the territories surrounding minor airports.

The JLE "airport potential classification" was implemented (see paragraph 2.4) by considering the results obtained from the JLC and JLD Judgment Levels using the methods described at paragraphs 3.3 and 4.

2.4. The Definition of Spatial Queries for Each Judgment Level. For each Judgment Level, the procedure was implemented by defining spatial queries on the database as described in paragraph 2.3. Queries in Structure query language (Sql) have been defined for each Judgment Level according to the methodology outlined below.

For the JLA "structural classification", specific classification function *f(csp.n)* was constructed to obtain a specific classification *csp.n(A.n)* for each indicator *I.A.n* and for each alternative *A.n*. The set of *csp.n (A.n)* has been aggregated into two sublevels (JLA1 and JLA2) through the concise classification functions *f(csnt.n)* in order to obtain a concise classification *csnt.n (An)* for each alternative *A.n* (Table 4) [22].

For the JLB "services classification", threshold satisfaction (ssd.n) has been defined and considered in the construction of the value classification function f(cdm.n) in order to obtain a value classification and related score cdm.n(A.n) referred to each indicator I.B.n for each alternative A.n. Each cdm.n(A.n) has been implemented by the weighting and standardization of the value classification function f(cdm.n) in order to obtain a service requisites classification

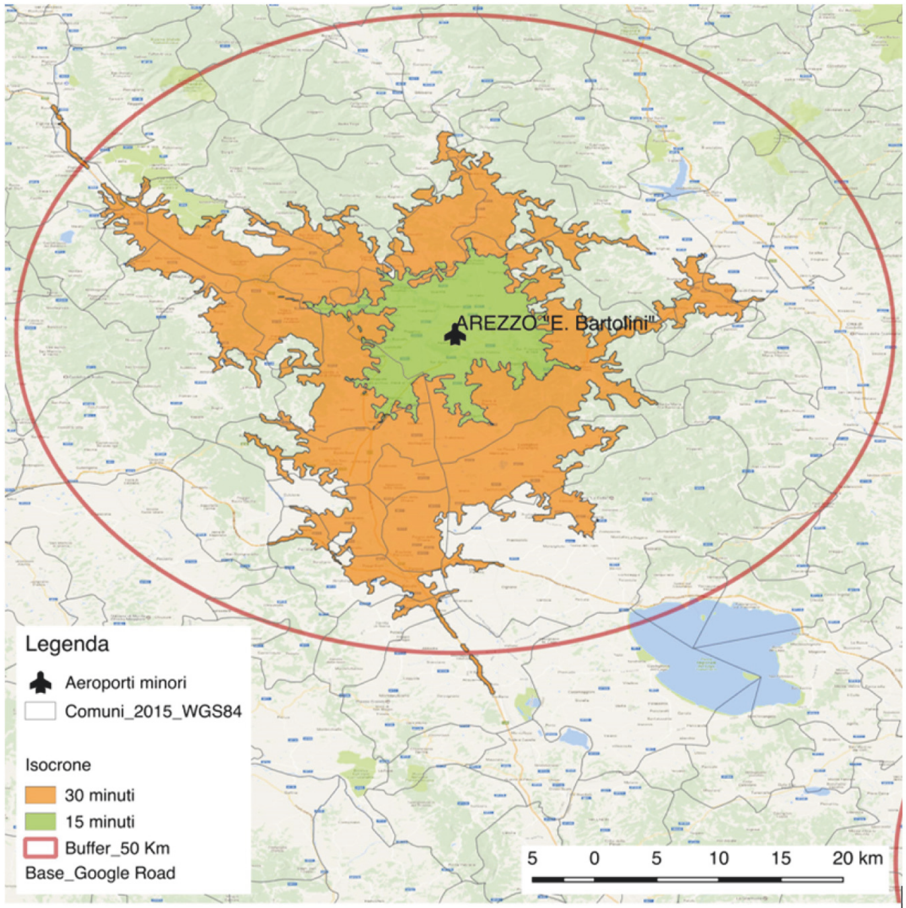


Figure 5: The geographical areas of analysis for the JLD: "territorial attractiveness classification" example for Arezzo airport "E. Bartolini".

Table 1: Evaluation Elements for JLA "structural classification".

Criteria (*CA.n*)	**Sub-criteria (*SA.n*)**	**Indicators (*IA.n*)**		**Unit of measure**	**Specific resource parameter *i(IA.n* for alternative (*A.n*)**	**Specific classification indicator *(pcsp.n)***	
Structural requisites (JLA)	*SA.1* Tracks	IA.1	Length	(meter)	*i(IA.1;A.n)*	*pcsp.a(IA.1)* *pcsp.b(IA.1)* *pcsp.c(IA.1)*	*>900* *800≤IA.1≤900* *<800*
		IA.2	Width	(meter)	*i(IA.2;A.n)*	*pcsp.a(IA.2)* *pcsp.b(IA.2)* *pcsp.c(IA.2)*	*>18* *15≤IA2≤18* *<18*
		IA.3	Accessibility	(corner obstacle)	*i(IA.3;A.n)*	*pcsp.a(IA.3)* *pcsp.b(IA.3)* *pcsp.c(IA.3)*	*α* *β* *γ*
		IA.4	Paving	(material type)	*i(IA.4;A.n)*	*pcsp.a(IA.4)* *pcsp.b(IA.4)*	*asphalt/tarmac* *grass*
Structural requisites (JLA)	*SA.2* Taxiways	*IA.5*	Width	(meter)	*i(IA.5;A.n)*	*pcsp.a(IA.5)* *pcsp.b(IA.5)*	*>10.5* *≤10.5*
		IA.6	Paving	(material type)	*i(IA.6;A.n)*	*pcsp.a(IA.6)* *pcsp.b(IA.6)*	*asphalt/tarmac* *grass*
Structural requisites (JLA)	*SA.3* Aprons	*IA.7*	Paving	(material type)	*i(IA.7;A.n)*	*pcsp.a(IA.7)* *pcsp.a(IA.7)*	*asphalt/tarmac* *grass*

Source: Guarini M.R., Battisti F., Buccarini C., Chiovitti A., 2015: A Model of Multicriteria Analysis to Develop Italy's Minor Airport System.

Table 2: Evaluation elements for JLB "services classification".

Criteria (*CB.n*)	Sub-criteria (*SB.n*)		Indicators (*IB.n*)		Specific resource parameter *i(IB.n)* for alternative (*A.n*)	Potential resource parameter (*ppd.n*)	
Services requisites (JLB)	*SB.1*	Airport services	*IB.1*	VDS "advanced" (access)	*i(IB.1;An)*	*ppd.a(IB.1;An)* *ppd.b(IB.1;An)*	*open* *closed*
			IB.2	Fire services (ICAO category)	*i(IB.2;An)*	*ppd.a(IB.2;An)* *ppd.b(IB.2;An)* *ppd.c(IB.2;An)* *ppd.d(IB.2;An)*	*1* *2* *3* *4*
			IB.3	ATS (time slot activities)	*i(IB.3;An)*	*ppd.a(IB.3;An)* *ppd.b(IB.3;An)* *ppd.c(IB.3;An)* *ppd.d(IB.3;An)*	*0* *8* *12* *24*
			IB.4	Refuelling (time slot activities)	*i(IB.4;An)*	*ppd.a(IB.4;An)* *ppd.b(IB.4;An)* *ppd.c(IB.4;An)* *ppd.d(IB.4;An)*	*0* *8* *12* *24*
			IB.5	Handling (time slots activities)	*i(IB.5;An)*	*ppd.a(IB.5;An)* *ppd.b(IB.5;An)* *ppd.c(IB.5;An)* *ppd.d(IB.5;An)*	*0* *8* *12* *24*
			IB.6	Lighting signs for RWY and TWY (presence)	*i(IB.6;An)*	*ppd.a(IB.6;An)* *ppd.b(IB.6;An)*	*yes* *no*
Services requisites (JLB)	*SB.2*	Air traffic support services	*IB.7*	Hangar for aircraft in transit (availability)	*i(IB.7;An)*	*ppd.a(IB.7;An)* *ppd.b(IB.7;An)*	*yes* *no*
			IB.8	Service repairs (availability)	*i(IB.8;An)*	*ppd.a(IB.8;An)* *ppd.b(IB.8;An)*	*yes* *no*
Services requisites (JLB)	*SB.3*	Services to passenger	*IB.9*	Dining (facilities presence)	*i(IB.9;An)*	*ppd.a(IB.9;An)* *ppd.b(IB.9;An)*	*yes* *no*
			IB.10	Hotel (km from airport)	*i(IB.10;An)*	*ppd.a(IB.10;An)* *ppd.b(IB.10;An)* *ppd.c(IB.10;An)*	<1 $1\leq IA.10\leq 5$ >5

Table 2: Continued.

Criteria (*CB.n*)		Sub-criteria (*SB.n*)	Indicators (*IB.n*)		Specific resource parameter *i(IB.n)* for alternative (*A.n*)	Potential resource parameter (*ppd.n*)	
Services requisites (JLB)	*SB.4*	Intermodal connectivity	*IB.11*	City (minutes from airport by car)	*i(IB.11;An)*	*ppd.a(IB.11;An)* *ppd.b(IB.11;An)* *ppd.c(IB.11;An)*	*<10* *10≤IA.11≤20* *<20*
			IB.12	Chief town (minutes from airport by car)	*i(IB.12;An)*	*ppd.a(IB.12;An)* *ppd.b(IB.12;An)* *ppd.c(IB.12;An)*	*<20* *20≤IA.11≤40* *<40*
			IB.14	Taxy (facilities presence)	*i(IB.14;An)*	*ppd.a(IB.14;An)* *ppd.b(IB.14;An)*	*yes* *no*
			IB.15	Car rental (facilities presence)	*i(IB.15;An)*	*ppd.a(IB.15;An)* *ppd.b(IB.15;An)*	*yes* *no*
			IB.16	Hub in buffer 50 km from minor airport	*i(IB.16;An)*	*ppd.a(IB.16;An)* *ppd.b(IB.16;An)*	*yes* *no*
			IB.17	Harbour in buffer 50 km from minor airport	*i(IB.17;An)*	*ppd.a(IB.17;An)* *ppd.b(IB.17;An)*	*yes* *no*
			IB.18	Inter-port in buffer 50 km from minor airport	*i(IB.18;An)*	*ppd.a(IB.18;An)* *ppd.b(IB.18;An)*	*yes* *no*
			IB.19	Railway stations (Km from airport)	*i(IB.19;An)*	*ppd.a(IB.19;An)* *ppd.b(IB.19;An)*	*<6* *>6*

Source: elaboration from Guarini M.R., Battisti F., Buccarini C., Chiovitti A., 2015: A Model of Multicriteria Analysis to Develop Italy's Minor Airport System.

Table 3: Evaluation Elements for JLD "territorial attractiveness classification".

Criteria (CD.n)	Sub-criteria (SD.n)		Indicators (*ID.n*)		Specific resource parameter i(ID.n) for alternative (A.n)	Potential resource parameter (ppd.n)	Sources
Territorial Services (JLD)	*SD.1*	Tourist Vocation	*ID.1.1*	Number of visitors (Demand) in state antiquity and art museum institutes (by province)	*i(ID.1.1;An)*	*ppd.n(ID.1.1;A.n)*	*ISTAT, Territorial Indicators for Development Policies, Cultural Heritage, indicators n. 076_P, census 2015:* http://www.istat.it/it/archivio/16777
			ID.1.2	Number of institutes (Supply) belonging to state antiquity and art museum institutes (by province)	*i(ID.1.2;An)*	*ppd.n(ID.1.2;A.n)*	*ISTAT, Territorial Indicators for Development Policies, Cultural Heritage, indicator n. 077_P, census 2015:* http://www.istat.it/it/archivio/16777
			ID.1.3	Amount of touristic accommodation (Supply) (hotels and similar establishments holiday accommodation and other short-stay accommodation, camping areas and equipped areas for motorhomes and caravans) in Isochrone area 15 minutes	*i(ID.1.3;An)*	*ppd.n(ID.1.3;A.n)*	*Elaboration in Structure Query Language from data ISTAT, Tourism Ateco 2007, Indicator: total collective accommodation establishments, 2015:* http://dati.istat.it/?lang=it&SubSessionId =39dcb0ba-24c5-4a0e-b637-2b85f16a9f52 &themetreeid=-200
			ID.1.4	Number of touristic accommodations (Supply) (hotels and similar establishments, holiday accommodation and other short-stay accommodation, camping areas and equipped areas for motorhomes and caravans) in Isochrone area 30 minutes	*i(ID.1.4;An)*	*ppd.n(ID.1.4;A.n)*	*Elaboration in Structure Query Language from data ISTAT, Tourism Ateco 2007, Indicator: total collective accommodation establishments, 2015:* http://dati.istat.it/?lang=it&SubSessionId =39dcb0ba-24c5-4a0e-b637-2b85f16a9f52 &themetreeid=-200

Table 3: Continued.

Criteria (CD.n)	Sub-criteria (SD.n)		Indicators (*ID.n*)		Specific resource parameter i(ID.n) for alternative (A.n)	Potential resource parameter (ppd.n)	Sources
Territorial Services (JLD)	*SD.2*	Infrastructural endowment for transport	*ID.2.1*	Area served by road infrastructures: Space Interrogation in Structure Query Language - Isochrone area 15 minutes	*i(ID.2.1;An)*	*ppd.n(ID.4;A.n)*	*Elaboration in Structure Query Language from data ISTAT, Territorial bases and censorship variables, publication 2011:* http://www.istat.it/it/archivio/104317
			ID.2.2	Area served by road infrastructures: Space Interrogation in Structure Query Language - Isochrone area 30 minutes	*i(ID.2.2;An)*	*ppd.n(ID.5;A.n)*	*Elaboration in Structure Query Language from data ISTAT, Territorial bases and censorship variables, publication 2011:* http://www.istat.it/it/archivio/104317
			ID.2.3	Number of passengers (Demand) using public transport in the provincial capitals	*i(ID.2.3;An)*	*ppd.n(ID.6;A.n)*	*ISTAT, Territorial Indicators for Development Policies, City, data n. 650_C, census 2015:* http://www.istat.it/it/archivio/16777
			ID.2.4	Urban public transport networks in the provincial capitals	*i(ID.2.4;An)*	*ppd.n(ID.2.4;A.n)*	*ISTAT, Territorial Indicators for Development Policies, City, indicator n.138_C, census 2013:* http://www.istat.it/it/archivio/16777
Territorial Services (JLD)	*SD.3*	Productive Vocation	*ID.3.1*	Number of companies (in municipal areas)	*i(ID.3.1;An)*	*ppd.n(ID.3.1;A.n)*	*ISTAT and Infocamere Movimprese, Territorial Indicators for Development Policies, Demografia d'impresa data n. 138_P, census 2016:* http://www.istat.it/it/archivio/16777
			ID.3.2	Participation of population in the labour market (in municipal areas)	*i(ID.3.2;An)*	*ppd.n(ID.3.2;A.n)*	*ISTAT and Infocamere Movimprese, Territorial Indicators for Development Policies, Work indicator n. 108_P, census 2015:* http://www.istat.it/it/archivio/16777

Table 4: MCSDA-JLA "structural classification" procedure.

Criteria (*CA.n*)	Sub-criteria (*SA.n*)	Indicators (*IA.n*)	Specific resource parameter *i(IA.n)* for alternative (*A.n*)	Specific classification function *[f(csp.n)]*	Specific classification *[csp.n(A.n)]*	Sub-Level	Concise classification function *[f(csnt.n)]*	Concise classification *(csnt.n)*	Value classification and related score *(cdm.n)*
Structural requisites (JLA)	*SA.1* Tracks	*IA.1* Length	*i(IA.1;A.n)*	*if i(IA.1;A.n)>pcsp.a(IA.1)* *if pcsp.a(IA.1)≤i(IA.1;A.n)≤pcsp.b(IA.1)* *if i(IA.1;A.n)<pcsp.c(IA.1)*	*csp.a(IA.1;A.n) = S* *csp.b(IA.1;A.n) = A* *csp.c(IA.1;A.n) = NS*	JLA1	*if cspc.a(IA.1; IA.2; IA.3; IA.4)*	*= csnt.a(JLA1) (S)*	cdm.a(IA.1;A.n) S=1
		IA.2 Width	*i(IA.2;A.n)*	*if i(IA.2;A.n)>pcsp.a(IA.2)* *if pcsp.a(IA.2)≤i(IA.2;A.n)≤pcsp.b(IA.2)* *if i(IA.2;A.n)<pcsp.c(IA.2)*	*csp.a(IA.2;A.n) = S* *csp.b(IA.2;A.n) = A* *csp.c(IA.2;A.n) = NS*		*if cspc.b(IA.1); cspc.b(IA.2); cspc.b(IA.3); cspc.b(IA.4)*	*= csnt.b(JLA1) (T)*	cdm.a(IA.1;A.n) T=0.5
		IA.3 Accessibility	*i(IA.3;A.n)*	*if i(IA.3;A.n)>pcsp.a(IA.3)* *if pcsp.a(IA.3)≤i(IA.3;A.n)≤pcsp.b(IA.3)* *if i(IA.3;A.n)<pcsp.c(IA.3)*	*csp.a(IA.3;A.n) = S* *csp.b(IA.3;A.n) = A* *csp.c(IA.3;A.n) = NS*		*if cspc.c(IA.1); cspc.c(IA.2); cspc.c(IA.3)=NS*	*= csnt.c(JLA1) (NS)*	cdm.a(IA.1;A.n) NS=0
		IA.4 Paving	*i(IA.4;A.n)*	*if i(IA.4;A.n)=pcsp.a(IA.4)* *if i(IA.4;A.n)=pcsp.b(IA.4)*	*csp.a(IA.4;A.n) = S* *csp.b(IA.4;A.n) = A*				
	SA.2 Taxiways	*IA.5* Width	*i(IA.5;A.n)*	*if i(IA.5;A.n)>pcsp.a(IA.5)* *if i(IA.5;A.n)<pcsp.b(IA.5)*	*csp.a(IA.5;A.n) = S* *csp.b(IA.5;A.n) = A*	JLA2	*if cspc.a(IA.5; IA.6; IA.7)*	*= csnt.a(JLA2) (S)*	cdm.a(IA.1;A.n) S=1
		IA.6 Paving	*i(IA.6;A.n)*	*if i(IA.6;A.n)=pcsp.a(IA.6)* *if i(IA.6;A.n)=pcsp.b(IA.6)*	*csp.a(IA.6;A.n) = S* *csp.b(IA.6;A.n) = A*		*if cspc.b(IA.5); cspc.b(IA.6); cspc.b(IA.7)*	*= csnt.b(JLA2) (T)*	cdm.a(IA.1;A.n) T=0.5
	SA.3 Aprons	*IA.7* Paving	*i(IA.7;A.n)*	*if i(IA.7;A.n)=pcsp.a(IA.7)* *if i(IA.7;A.n)=pcsp.b(IA.7)*	*csp.a(IA.7;A.n) = S* *csp.b(IA.7;A.n) = A*				

				S = suitable; A= adaptable; NS = not suitable.			**JLA structural requisites classification**
							if (JLA1) and (JLA2)=S⟶ JLA=S
							if (JLA1) = T and (JLA2)=S⟶ JLA=T
							if (JLA1) = NS and (JLA2)=S or (JLA2)=T⟶ JLA=NS		

Source: elaboration from Guarini M.R., Battisti F., Buccarini C., Chiovitti A., 2015: A Model of Multicriteria Analysis to Develop Italy's Minor Airport System.

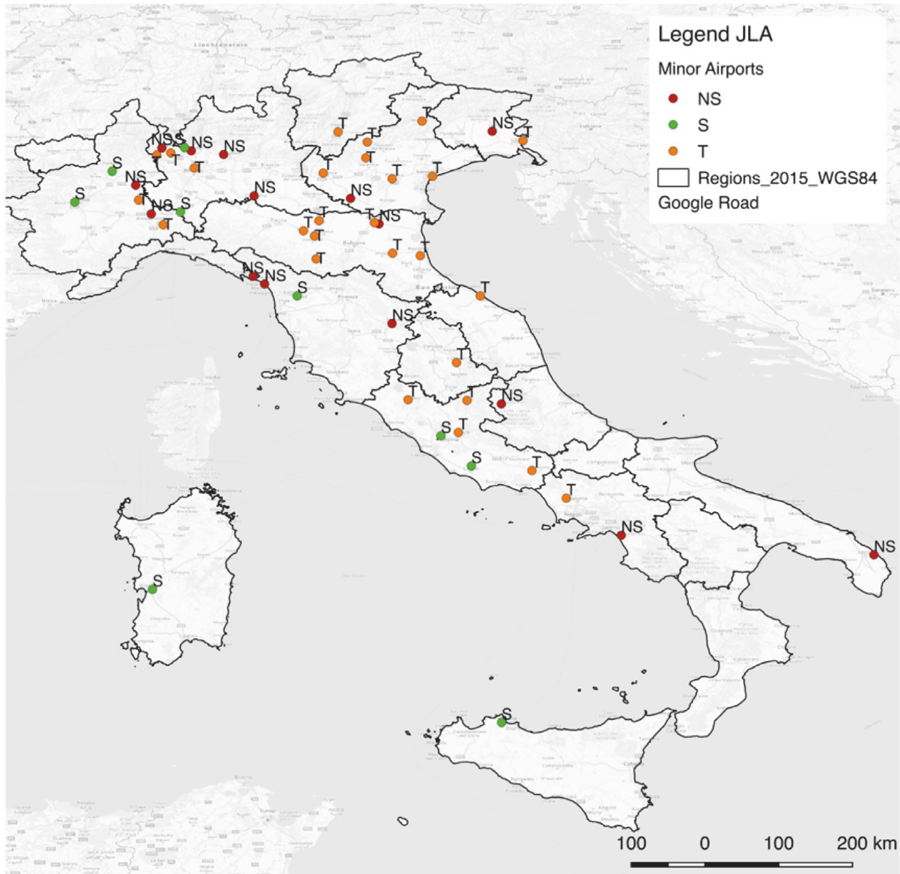


Figure 6: MCSDA implementation for JLA: spatial mapping.

(weighted and standardized) cdm.n(A.n) for each alternative A.n (Table 5) [22].

For the JLC "overall classification of resources", the procedure was defined as follows. Assigning a weight of 2 to the Value Classification Score of the JLA level (multiplying each Value Classification Score by 2), representing the importance of the structural requisites (JLA) with respect to the service requisites (JLB), which is assigned a weight of 1, a Weighted Structural Classification JLAw and a Weighted Services Classification JLBw are obtained. By adding the values obtained in JLAw and in JLBw for each alternative *A.n* a Weighted General Equipment Classification JLCw can be obtained.

For subsequent procedural steps (JLCw, JLD, and JLE), univariate data analysis (UDA) [37] has been used; it allows defining, for a given range of numerical variables, the percentiles (*Stn*) included between 0 and 1, in order to define categorical variables (break values) which are significant compared to the range of numerical variables analyzed considering that "categorical variables can come from numeric variables by aggregating values" [37]. Starting from the qualification of the JLCw, JLD, and JLE outputs, a number of categorical variables considered as attractiveness thresholds (ssd.n) for the qualification of the Italian minor airports (alternative An) can be turned into different levels of evaluation.

In detail for each level of evaluation mentioned above the procedure is defined as follows: for the classification of outputs obtained in JLCw, through the UDA 4 percentiles can be defined (St.1 = 1; St.2 = 0.6; St.3 = 0.3; St.4 = 0.0), in order to define 3 intervals of attraction in the JLCw for the evaluation of alternatives (*A.n*). These percentile values were assumed as Thresholds of Attractiveness *(ssd.n)* and these were considered in the construction of the value classification function *f (cdm.n)* in order to obtain the Classes *Cl.n(A.n)* for the JLCw level.

For the JLD "territorial attractiveness classification", Thresholds of Attractiveness *(ssd.n)* were defined through the UDA considering 6 percentiles (St.1 = 1; St.2 = 0.8; St.3 = 0.6; St.4 = 0.4; St.5 = 0.2; St.6 = 0.0) for each range of specific resource parameters *i(ID.n)* for each indicator *ID.n* in order to define 5 intervals of attraction for the evaluation of specific resource parameter *i(ID.n)* for alternatives (*A.n*). These *ssd.n* for each indicator *ID.n.* were considered in the construction of the value classification function *f(cdm.n)* in order to obtain the value classification and related score *cdm.n(A.n)* for each *A.n.* Each *cdm.n(A.n)* was analyzed by concise classification function *f(csnt.n)* in order to obtain a territorial

Table 5: MCSDA-JLB "services classification" procedure.

Criteria (*CB.n*)	Sub-criteria (*SB.n*)	Indicators (*IB.n*)	Specific resource parameter *i(IB.n)* for alternative (*A.n*)	Potential resource parameter *(ppd.n)*	Thresholds satisfaction *(ssd.n)*	Value classification function *[f(cdm.n)]*	Value classification and related score *(cdm.n)*	Weighting and standardisation of value classification function *[fnl(cdm.n)]*	JLB Services requisites (Weighted and standardised value) classification *(cdmn.n)*
					ssd(IB.1;St.n)VH	if *ppd.a(IB.1;A.n)>ssd(IB.1;St.n)VH*	= *cdm.a(IB.1;A.n)VH=1*	*fnl[cdm.a(IB.1;A.n)VH∗p(IB.1;St.n)]*	*cdmn.a(IB.1;A.n) or*
					ssd(IB.1;St.n)H	if *ssd(IB.1;St.n)VH>ppd.a(IB.1;A.n)>ssd(IB.1;St.n)H*	= *cdm.a(IB.1;A.n)H=0.75*	*fnl[cdm.a(IB.1;A.n)H∗p(IB.1;St.n)]*	
				ppd.a(IB.1;A.n)	*ssd(IB.1;St.n)A*	if *ssd(IB.1;St.n)H>ppd.a(IB.1;A.n)>ssd(IB.1;St.n)A*	= *cdm.a(IB.1;A.n)A=0.5*	*fnl[cdm.a(IB.1;A.n)A∗p(IB.1;St.n)]*	
					ssd(IB.1;St.n)L	if *ssd(IB.1;St.n)A>ppd.a(IB.1;A.n)>ssd(IB.1;St.n)L*	= *cdm.a(IB.1;A.n)L=0.25*	*fnl[cdm.a(IB.1;A.n)L∗p(IB.1;St.n)]*	
					ssd(IB.1;St.n)VL	if *ppd.a(IB.1;A.n)<ssd(IB.1;St.n)VL*	= *cdm.a(IB.1;A.n)VL=0*	*fnl[cdm.a(IB.1;A.n)VL∗p(IB.1;St.n)]*	
Service requisites (JLB)	*SB.1*	*IB.1*	*i(IB.1; An)*						
					ssd(IB.1;St.n)VH	if *ppd.n(IB.1;A.n)>ssd(IB.1;St.n)VH*	= *cdm.n(IB.1;A.n)VH=1*	*fnl[cdm.n(IB.1;A.n)VH∗p(IB.1;St.n)]*	*cdmn.n(IB.1;A.n) or*
					ssd(IB.1;St.n)H	if *ssd(IB.1;St.n)VH>ppd.n(IB.1;A.n)>ssd(IB.1;St.n)H*	= *cdm.n(IB.1;A.n)H=0.75*	*fnl[cdm.n(IB.1;A.n)H∗p(IB.1;St.n)]*	
				ppd.b(IB.1;A.n)	*ssd(IB.1;St.n)A*	if *ssd(IB.1;St.n)H>ppd.n(IB.1;A.n)>ssd(IB.1;St.n)A*	= *cdm.n(IB.1;A.n)A=0.5*	*fnl[cdm.n(IB.1;A.n)A∗p(IB.1;St.n)]*	
					ssd(IB.1;St.n)L	if *ssd(IB.1;St.n)A>ppd.n(IB.1;A.n)>ssd(IB.1;St.n)L*	= *cdm.n(IB.1;A.n)L=0.25*	*fnl[cdm.n(IB.1;A.n)L∗p(IB.1;St.n)]*	
					ssd(IB.1;St.n)VL	if *ppd.n(IB.1;A.n)<ssd(IB.1;St.n)VL*	= *cdm.n(IB.1;A.n)VL=0*	*fnl[cdm.n(IB.1;A.n)VL∗p(IB.1;St.n)]*	
Service requisites (JLB)	...	...	...	...	...	... ...	...	...	...
					ssd(IB.n;St.n)VH	if *ppd.n(IB.n;A.n)>ssd(IB.n;St.n)VH*	= *cdm.n(IB.n;A.n)VH=1*	*fnl[cdm.n(IB.n;A.n)VH∗p(IB.1;St.n)]*	*cdmn.n(IB.n;A.n)*
					ssd(IB.n;St.n)H	if *ssd(IB.n;St.n)VH>ppd.n(IB.n;A.n)>ssd(IB.n;St.n)H*	= *cdm.n(IB.n;A.n)H=0.75*	*fnl[cdm.n(IB.n;A.n)H∗p(IB.1;St.n)]*	
Service requisites (JLB)	*SB.n*	*IB.n*		*ppd.n(IB.n;A.n)*	*ssd(IB.n;St.n)A*	if *ssd(IB.n;St.n)H>ppd.n(IB.n;A.n)>ssd(IB.n;St.n)A*	= *cdm.n(IB.n;A.n)A=0.5*	*fnl[cdm.n(IB.n;A.n)A∗p(IB.1;St.n)]*	
					ssd(IB.n;St.n)L	if *ssd(IB.n;St.n)A>ppd.n(IB.1;A.n)>ssd(IB.n;St.n)L*	= *cdm.n(IB.n;A.n)L=0.25*	*fnl[cdm.n(IB.n;A.n)L∗p(IB.1;St.n)]*	
					ssd(IB.n;St.n)VL	if *ppd.n(IB.n;A.n)<ssd(IB.n;St.n)VL*	= *cdm.n(IB.n;A.n)VL=0*	*fnl[cdm.n(IB.n;A.n)VL∗p(IB.1;St.n)]*	

VH= very high; H= high; A=average; L=low; VL=very low.

Source: elaboration from Guarini M.R., Battisti F., Buccarini C., Chiovitti A., 2015: A model of Multicriteria Analysis to Develop Italy's Minor Airport System.

Table 6: MCSDA-JLD "territorial attractiveness classification" procedure.

Criteria (CD.n)	Sub-criteria (SD.n)	Indicators (*ID.n*)	Specific resource parameter i(ID.n) for alternative (A.n)	Potential resource parameter (ppd.n)	Attractiveness Thresholds (*ssd.n*)	Value classification function *[f(cdm.n)]*	Value classification and related score *(cdm.n)*	Concise classification function *[f(csnt.n)]*	JLD Territorial Services classification *(csnt.n)*
					ssd St.1(ID.1.1)	if *ssd(ID.1.1;St.6)<ppd.n(ID.1.1;A.n)≤ssd(ID.1.1;St.5)*	*= cdm.n(ID.1.1;A.n)=0.2*		
					ssd St.2(ID.1.1)	if *ssd(ID.1.1;St.5)<ppd.n(ID.1.1;A.n)≤ssd(ID.1.1;St.4)*	*= cdm.n(ID.1.1;A.n)=0.4*		
	SD.1	*ID.1.1*	*i(ID.1.1;An)*	*ppd.n(ID.1.1;A.n)*	*ssd St.3(ID.1.1)*	if *ssd(ID.1.1;St.4)<ppd.n(ID.1.1;A.n)≤ssd(ID.1.1;St.3)*	*= cdm.n(ID.1.1;A.n)=0.6*		
					ssd St.4(ID.1.1)	if *ssd(ID.1.1;St.3)<ppd.n(ID.1.1;A.n)≤ssd(ID.1.1;St.2)*	*= cdm.n(ID.1.1;A.n)=0.8*		
					ssd St.5(ID.1.1)	if *ssd(ID.1.1;St.2)<ppd.n(ID.1.1;A.n)≤ssd(ID.1.1;St.1)*	*= cdm.n(ID.1;A.n)=1*		
		...	...	...	...	... ...	...	If 0.00 < M[fnl(cdm.n)]≤ 0.20;	csnt.n= **VL**
					ssd St.1(ID.2.1)	if *ssd(ID.2.1;St.6)<ppd.n(ID.2.1;A.n)≤ssd(ID.2.1;St.5)*	*= cdm.n(ID.2.1;A.n)=0.2*	If 0.20 < M[fnl(cdm.n)]≤ 0.40;	csnt.n= **L**
					ssd St.2(ID.2.1)	if *ssd(ID.2.1;St.5)<ppd.n(ID.2.1;A.n)≤ssd(ID.2.1;St.4)*	*= cdm.n(ID.2.1;A.n)=0.4*	If 0.40 < M[fnl(cdm.n)]≤ 0.60;	csnt.n= **A**
Territorial Services (JLD)	*SD.2*	*ID.2.1*	*i(ID.2.1;An)*	*ppd.n(ID.2.1;A.n)*	*ssd St.3(ID.2.1)*	if *ssd(ID.2.1;St.4)<ppd.n(ID.2.1;A.n)≤ssd(ID.2.1;St.3)*	*= cdm.n(ID.2.1;A.n)=0.6*	If 0.60 < M[fnl(cdm.n)]≤ 0.80;	csnt.n= **H**
					ssd St.4(ID.2.1)	if *ssd(ID.2.1;St.3)<ppd.n(ID.2.1;A.n)≤ssd(ID.2.1;St.2)*	*= cdm.n(ID.2.1;A.n)=0.8*	If 0.80 < M[fnl(cdm.n)]≤ 1.00;	csnt.n= **VH**
					ssd St.5(ID.2.1)	if *ssd(ID.2.1;St.2)<ppd.n(ID.2.1;A.n)≤ssd(ID.2.1;St.1)*	*= cdm.n(ID.2.1;A.n)=1*		
		...	...		...	... ...	...		
					ssd St.1(ID.3.1)	if *ssd(ID.3.1;St.6)<ppd.n(ID.3.1;A.n)≤ssd(ID.3.1;St.5)*	*= cdm.n(ID.3.1;A.n)=0.2*		
					ssd St.2(ID.3.1)	if *ssd(ID.3.1;St.5)<ppd.n(ID.3.1;A.n)≤ssd(ID.3.1;St.4)*	*= cdm.n(ID.3.1;A.n)=0.4*		
	SD.3	*ID.3.1*	*i(ID.3.1;An)*	*ppd.n(ID.3.1;A.n)*	*ssd St.3(ID.3.1)*	if *ssd(ID.3.1;St.4)<ppd.n(ID.3.1;A.n)≤ssd(ID.3.1;St.3)*	*= cdm.n(ID.3.1;A.n)=0.6*		
					ssd St.4(ID.3.1)	if *ssd(ID.3.1;St.3)<ppd.n(ID.3.1;A.n)≤ssd(ID.3.1;St.2)*	*= cdm.n(ID.3.1;A.n)=0.8*		
					ssd St.5(ID.3.1)	if *ssd(ID.3.1;St.2)<ppd.n(ID.3.1;A.n)≤ssd(ID.3.1;St.1)*	*= cdm.n(ID.3.1;A.n)=1*		
		...	...		...	... ...	...		

VL=very low; L=low; A=average; H= high; VH= very high.
M= arithmetic mean.

Table 7: MCSDA implementation for JLC: definition of the Weighted General Classification Equipment JLCw.

	JLA				JLB				JLC		JLD		JLE	
Minor airport (A.n)	Value Classification (cdm.n)	Value Classification Scores	Weight	Weighted Structural Classification JLAw	Value Classification (cdm.n)	Value Classification Scores	Weight	Weighted Services Classification JLBw	Weighted General Equipment Classification JLCw	Classes *Cl.n(A.n)*	Territorial Service Classification (csnt.n)	Value Classification Scores	Final Classification Scores	Classes *Cl.n(A.n)*
Alessandria	NS	0.00	2	0	VL	0.00	1.00	0.00	0.00	1.00	H	0.75	0.75	0.00
Alzate Brianza	NS	0.00	2	0	VL	0.00	1.00	0.00	0.00	1.00	H	0.75	0.75	0.00
Aquino	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	A	0.50	1.50	0.50
Arezzo	NS	0.00	2	0	A	0.50	1.00	0.50	0.50	0.00	A	0.50	1.00	0.00
Asiago	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	L	0.25	1.25	0.00
Belluno	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	L	0.25	1.25	0.00
Biella Cerrione	S	1.00	2	2	H	0.75	1.00	0.75	2.75	1.00	L	0.25	3.00	1.00
Calcinate del Pesce	NS	0.00	2	0	L	0.25	1.00	0.25	0.25	0.00	H	0.75	1.00	0.00
Capua	T	0.50	2	1	A	0.50	1.00	0.50	1.50	1.00	H	0.75	2.25	1.00
Carpi Budrione	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	A	0.50	1.50	0.50
Casale Monferrato	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	H	0.75	1.75	0.50
Como Idroscalo	S	1.00	2	2	VL	0.00	1.00	0.00	2.00	1.00	H	0.75	2.75	1.00
Cremona Migliaro	NS	0.00	2	0	VL	0.00	1.00	0.00	0.00	1.00	A	0.50	0.50	1.00
Fano	T	0.50	2	1	A	0.50	1.00	0.50	1.50	1.00	A	0.50	2.00	0.50
Ferrara	T	0.50	2	1	A	0.50	1.00	0.50	1.50	1.00	H	0.75	2.25	1.00
Ferrara Aguscello	NS	0.00	2	0	L	0.25	1.00	0.25	0.25	0.00	H	0.75	1.00	0.00
Foligno	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	H	0.75	2.00	0.50
Gorizia	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	L	0.25	1.25	0.00
Guidonia	T	0.50	2	1	H	0.75	1.00	0.75	1.75	1.00	H	0.75	2.50	1.00
L'Aquila Preturo	NS	0.00	2	0	VH	1.00	1.00	1.00	1.00	0.00	L	0.25	1.25	0.00
Latina	S	1.00	2	2	H	0.75	1.00	0.75	2.75	1.00	A	0.50	3.25	1.00
Lecce Lepore	NS	0.00	2	0	A	0.50	1.00	0.50	0.50	0.00	A	0.50	1.00	0.00
Legnago	NS	0.00	2	0	VL	0.00	1.00	0.00	0.00	1.00	H	0.75	0.75	0.00
Lucca Tassignano	S	1.00	2	2	L	0.25	1.00	0.25	2.25	1.00	A	0.50	2.75	1.00
Lugo di Romagna	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	A	0.50	1.50	0.50
Massa Cinquale	NS	0.00	2	0	A	0.50	1.00	0.50	0.50	0.00	L	0.25	0.75	0.00

Table 7: Continued.

Minor airport (A.n)	JLA				JLB				JLC		JLD		JLE	
	Value Classification (cdm.n)	Value Classification Scores	Weight	Weighted Structural Classification JLAw	Value Classification (cdm.n)	Value Classification Scores	Weight	Weighted Services Classification JLBw	Weighted General Equipment Classification JLCw	Classes *Cl.n(A.n)*	Territorial Service Classification (csnt.n)	Value Classification Scores	Final Classification Scores	Classes *Cl.n(A.n)*
Milano Bresso	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	VH	1.00	2.00	0.50
Modena	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	H	0.75	1.75	0.50
Novi Ligure	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	H	0.75	2.00	0.50
Oristano Fenosu	S	1.00	2	2	H	0.75	1.00	0.75	2.75	1.00	A	0.50	3.25	1.00
Padova	T	0.50	2	1	VH	1.00	1.00	1.00	2.00	1.00	VH	1.00	3.00	1.00
Palermo Boccadifalco	S	1.00	2	2	A	0.50	1.00	0.50	2.50	1.00	H	0.75	3.25	1.00
Pavullo nel Frignano	T	0.50	2	1	H	0.75	1.00	0.75	1.75	1.00	A	0.50	2.25	1.00
Ravenna	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	H	0.75	2.00	0.50
Reggio Emilia	T	0.50	2	1	A	0.50	1.00	0.50	1.50	1.00	H	0.75	2.25	1.00
Rieti	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	L	0.25	1.50	0.50
Roma Urbe	S	1.00	2	2	H	0.75	1.00	0.75	2.75	1.00	H	0.75	3.50	1.00
Salerno Pontecagnano	NS	0.00	2	0	VH	1.00	1.00	1.00	1.00	0.00	H	0.75	1.75	0.50
Sarzana Luni	NS	0.00	2	0	VH	1.00	1.00	1.00	1.00	0.00	A	0.50	1.50	0.50
Thiene	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	A	0.50	1.75	0.50
Torino Aeritalia	S	1.00	2	2	A	0.50	1.00	0.50	2.50	1.00	H	0.75	3.25	1.00
Trento Mattarello	T	0.50	2	1	H	0.75	1.00	0.75	1.75	1.00	A	0.50	2.25	1.00
Udine Campoformido	NS	0.00	2	0	L	0.25	1.00	0.25	0.25	0.00	H	0.75	1.00	0.00
Valbrembo	NS	0.00	2	0	L	0.25	1.00	0.25	0.25	0.00	H	0.75	1.00	0.00
Varese Venegono	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	A	0.50	1.50	0.50
Venezia	T	0.50	2	1	VH	1.00	1.00	1.00	2.00	1.00	H	0.75	2.75	1.00
Vercelli	NS	0.00	2	0	L	0.25	1.00	0.25	0.25	0.00	A	0.50	0.75	0.00
Vergiate	T	0.50	2	1	L	0.25	1.00	0.25	1.25	0.50	H	0.75	2.00	0.50
Verona Boscomantico	T	0.50	2	1	A	0.50	1.00	0.50	1.50	1.00	H	0.75	2.25	1.00
Viterbo	T	0.50	2	1	VL	0.00	1.00	0.00	1.00	0.00	A	0.50	1.50	0.50
Voghera Rivanazzano	S	1.00	2	2	VH	1.00	1.00	1.00	3.00	1.00	H	0.75	3.75	1.00

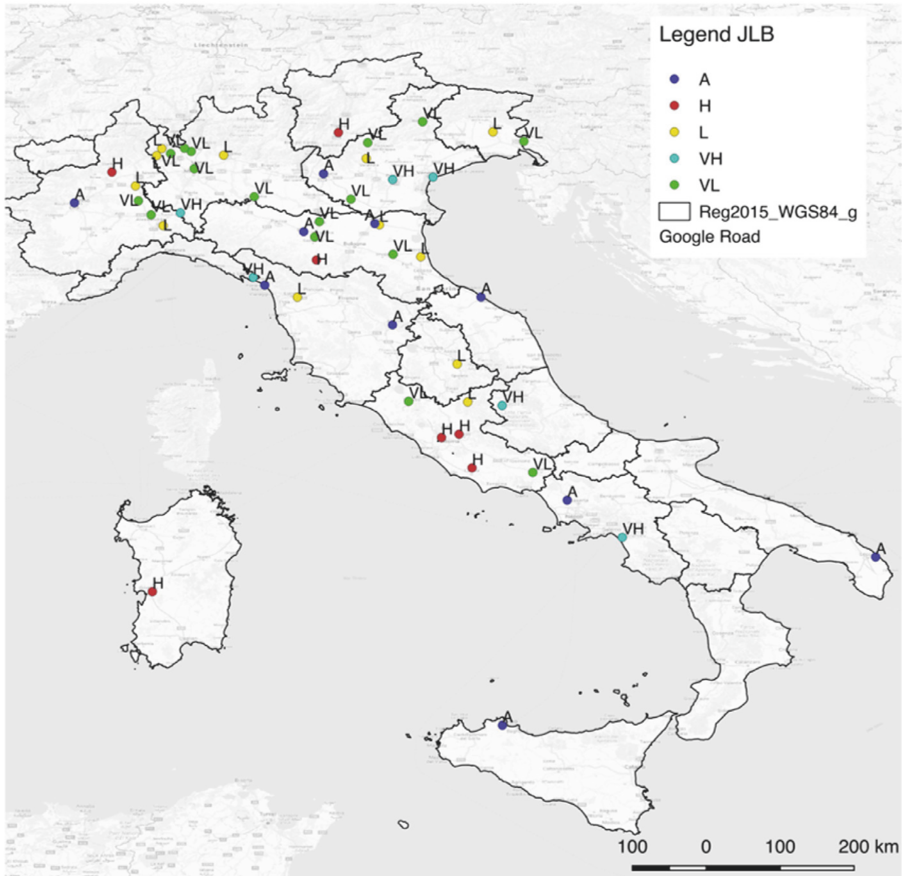


Figure 7: MCSDA implementation for JLB: spatial mapping.

Table 8: MCSDA implementation for JLC: statistical analysis (a) and Thresholds of Attractiveness definition (b).

(a) Statistical analysis

Percentile functions		Values
St.4	percentile (0.0)	0.00
St.3	percentile (0.3)	1.00
St.2	percentile (0.6)	1.25
St.1	percentile (1)	3.00

(b) Attractiveness Thresholds (ssd.n)

Classes Cl.n(A.n)	JLCw Thresholds (ssd.n)
Cl.n(A.n) = 0	0.00>JLCw≥1.00
Cl.n(A.n) = 0.5	1.00>JLCw≥1.25
Cl.n(A.n) = 1	1.25>JLCw≥3.00

services classification *csnt.n(A.n)* for each alternative *A.n* (Table 6).

By adding the Weighted General Equipment classification JLCw values and the territorial attractiveness classification *csnt.n(A.n)* the range of numerical variables for the JLE "airport potential classification" is obtained. From the numerical variables (scores) obtained for JLE, Thresholds of Attractiveness *(ssd.n)* were defined through the UDA [40]. For this purpose, the 4 percentile values *(*St.1 = 1; St.2 = 0.6; St.3 = 0.3; St.4 = 0.0*)* in order to define 3 intervals of attraction (Classes *Cl.n*) for the evaluation of the alternatives (*A.n)* in JLE are defined. These percentile values were assumed as Thresholds of Attractiveness *(ssd.n)* and these were considered in building the value classification function *f(cdm.n)* in order to obtain Classes *Cl.n(A.n)* for the JLE level.

3. Results and Discussion

3.1. JLA "Structural Classification", JLB "Services Classification", and JLC "Overall Classification of Resources". Below, maps illustrate the results of the implementation for each level of data evaluation, in accordance with the MCSDA methodology described in previous paragraphs. Regarding the evaluation of the suitability of an airport's infrastructure and services (status quo) (Tables 1 and 2), the implementation of this evaluation methodology led to results that were the same as those obtained in previous phases of evaluation in regard to the JLA (Figure 6) but that differed when it came to JLB (Figure 7) and JLC (Figure 8) levels [21, 22]. Next, we describe the methods used to define (i) Weighted General Classification Equipment JLCw (Table 7); (ii) the Statistical

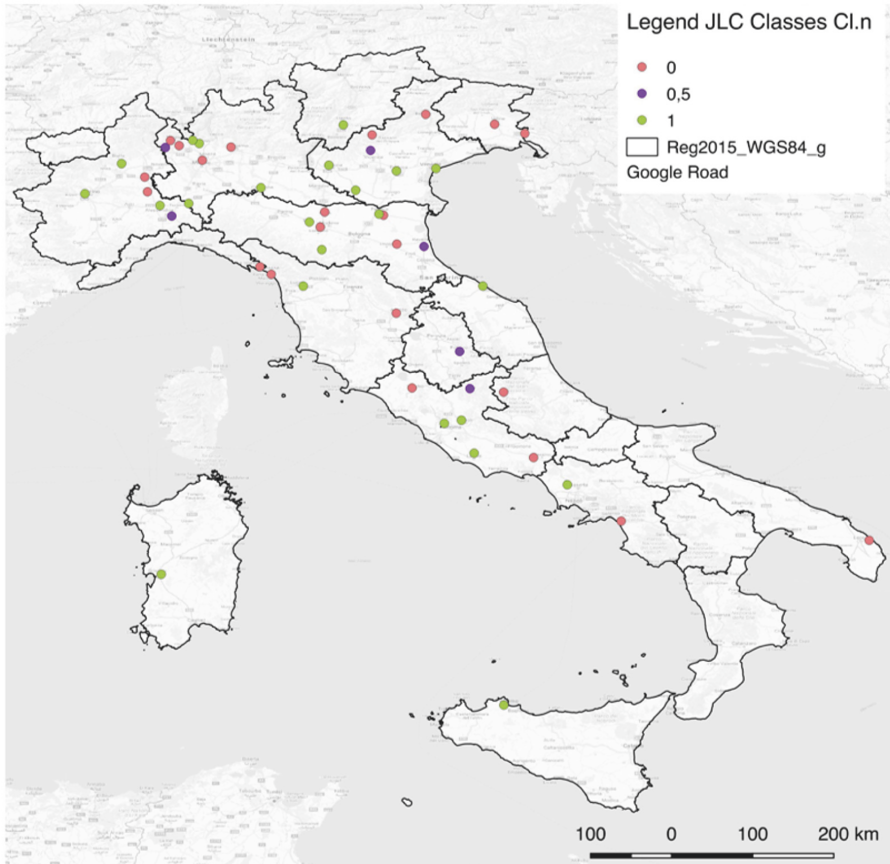


Figure 8: MCSDA implementation for JLC: assigning of Classes Cl.n(A.n), spatial mapping.

Analysis for the definition of Thresholds of Attractiveness (ssd.n) (Table 8(a)); (iii) the way we formulated Thresholds of Attractiveness for each quantity obtained in JLCw (Table 8(b)).

3.2. JLD "Territorial Attractiveness Classification". As regards the assessment of the attractiveness of airport hubs given the facilities available in their catchment areas (level JLD), the following are listed: the specific resource parameters *i(ID.n)* for each alternative *A.n* (Table 9); the Statistical Analysis for the definition of Thresholds of Attractiveness (Table 10(a)); the building up of Thresholds of Attractiveness for each *ID.n* indicator (Table 10(b)); the results of the implementation, i.e., the concise classification for the JLD level (Table 11) and their spatial representation in maps (Figure 9).

3.3. JLE "Airport Potential Classification". The implementation of the MCSDA for JLE provides us with an airport potential Classification Score for each alternative *A.n* (Table 12). Next, the following are listed: the Statistical Analysis for the definition of Thresholds of Attractiveness *(ssd.n)* (Table 13(a)); the building up of Thresholds of Attractiveness for each score obtained in the JLE level (Table 13(b)); the results of the implementation (the attribution of *Cl.n(A.n)* classes for the JLE level) represented using maps (Figure 10).

3.4. Summary and Discussion. The analysis of the output obtained (Figure 11) allows us to identify the number and percentage of minor airports compared to the total that fall within each class of assessment (*Cl.n)* for each Judgment Level:

(i) In JLC "overall classification of resources", the summarizing level for assessing the suitability (status quo) of an airport's services and infrastructure (paragraph 1, point 1) pertains to classes the three Classes *Cl.C.1, Cl.C.2,* and *Cl.C.3*, related to Judgment Level C, representing the level of facilities (from lowest to highest) of overall resources: 22 (43%), 6 (12%), and 23 (45%), respectively, of second-level hubs.

(ii) In JLE "airport potential classification", the summarizing level for assessing the attractiveness of airport hubs compared to the facilities found in their catchment areas (paragraph 1, point 2) pertains to the Classes *Cl.E.1, Cl.E.2,* and *Cl.E.3*, related to Judgment Level E, representing the levels (from lowest to highest) of scores obtained in previous Judgment Levels: 15 (30%), 17 (33%), and 19 (37%), respectively.

Such data describes the status quo and the potential for developing the existing infrastructural assets of our minor airports through upgrading and/or expansion work for the

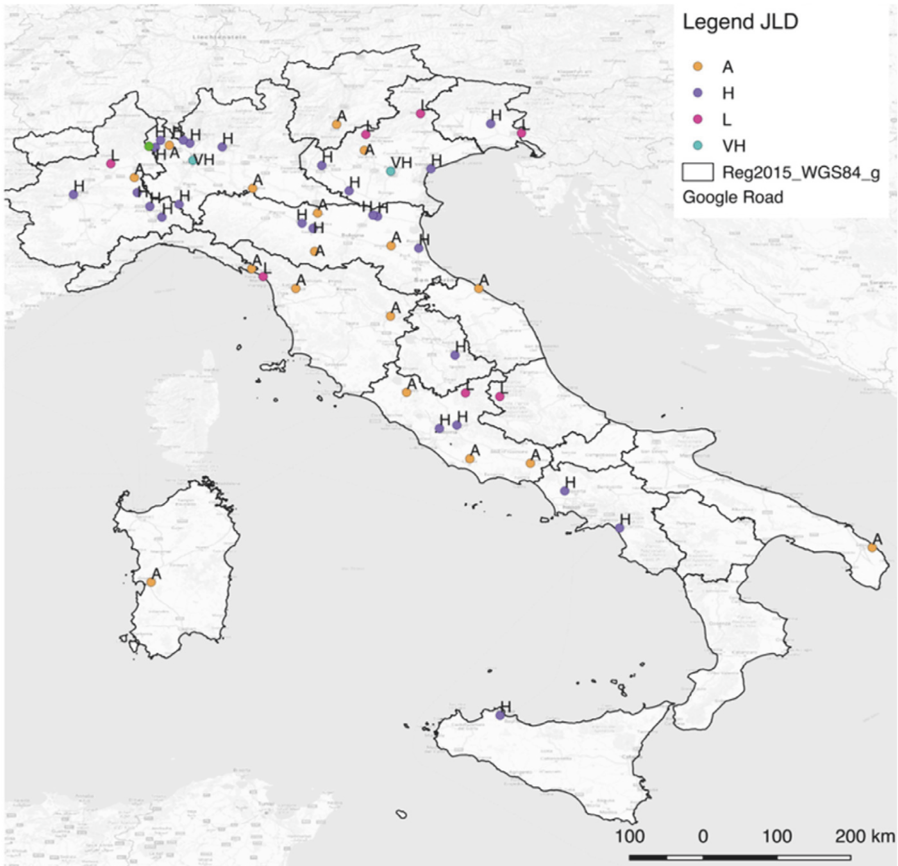


Figure 9: MCSDA implementation for JLD: spatial mapping.

choice of hubs worth including in the "highway in the sky" network. Further integrated analysis, such as Fuzzy Analysis, Strategic Planning Tools (SPT), Participation Techniques (PT), and Financial and Economic Analysis [41–47], could be useful for achieving the aim of the development of the Italian Network. At this stage of the research, such work can be defined as follows: (i) of greater scope for *A.n* falling within the *Cl.1* classes both for the JLC level and for the JLE level; (ii) of average scope for *A.n* falling within the *Cl.2* classes both for the JLC level and for the JLE level; (iii) of minor scope or nil for *A.n* that fall within *Cl.3* classes both for the JLC and for JLE levels.

The heatmap of minor airports on national territory (Figure 12) was built up using the Qgis software (by the space query heatmap) considering each alternative *A.n* according to JLE "airport potential classification" three classes obtained as *Cl.E.1, Cl.E.2,* and *Cl.E.3* related to Judgment Level E "airport potential classification". The three classes (*Cl.E.1, Cl.E.2,* and *Cl.E.3)* show the coverage of the areas on national territory by minor airports in three levels: (i) max coverage: (ii) medium coverage; (iv) low coverage or no coverage. It is remarkable that minor airports offer the maximum coverage of northern areas of Italy while they offer a low coverage (or no coverage) of areas in the Adriatic Coast, in the Southern areas, and in the island. In the northern areas the maximum coverage is characterized by the presence of minor airports pertaining to the Classes *Cl.E.1, Cl.E.2,* and *Cl.E.3.* This is to be considered in successive assessments phases that could allow understanding which *A.n* could be added in the network (called "highway in the sky") and which ones have to be excluded. In the Adriatic Coast and in the southern areas in particular the low coverage of the areas is characterized by minor airports pertaining to *Cl.E.1* and *Cl.E.2* representing the lowest classes in JLE final classification. The map in Figure 13 shows the overlap degree for maximum covered northern areas highlighting the necessity to better explore the issue of the alternative choice among minor airports.

4. Conclusions

The evaluation methodology proposed for subsequent levels of analysis helps define the overall performance of Italy's infrastructural system of minor airports as regards the suitability of intrinsic infrastructural facilities, services (status quo), and the attractiveness of airport hubs given the territorial facilities present in their catchment areas.

The figures and graphics obtained and illustrated here serve as the basis for future phases of analysis also through the use of Multicriteria Decision Analysis (MCDA) integrated with other evaluation tools or techniques (Fuzzy Analysis,

Table 9: MCSDA implementation for JLD: specific resource parameter i(ID.n).

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	*Specific resource parameter i(ID.n) for alternative (A.n)*									
					SD.1 Tourist Vocation ID.1				*SD.2* Infrastructural endowment for transport				*SD.3* Productive Vocation	
					ID.1.1	*ID.1.2*	*ID.1.3*	*ID.1.4*	*ID.2.1*	*ID.2.2*	*ID.2.3*	*ID.2.4*	*ID.3.1*	*ID.3.2*
North-West (ITC)	**Piemonte**	**1**	**Alessandria**	AL	10,517	2	13	25	14.72	56.56	1.392	214.4	2,125.00	71.4
		2	**Biella Cerrione**	BL	0	0	8	17	9.24	47.31	1.028	90.4	803.00	71.3
		3	**Casale Monferrato**	AL	10,517	2	12	20	16.47	62.17	1.392	214.4	2,125.00	71.4
		4	**Novi Ligure**	AL	10,517	2	1	59	11.02	51.19	1.392	214.4	2,125.00	71.4
		5	**Torino Aeritalia**	TO	1,784,722	12	15	70	8.92	49.51	229.000	596.1	13,383.00	71.4
		6	**Vercelli**	VC	0	0	7	12	13.22	53.97	0.651	51.4	884.00	70.3
North-West (ITC)	**Lombardia**	**7**	**Alzate Brianza**	CO	0	0	21	36	7.29	54.55	10.404	221.7	2,680.00	70.2
		8	**Como Idroscalo**	CO	0	0	30	30	7.46	52.76	10.404	221.7	2,680.00	70.2
		9	**Calcinate del Pesce**	VA	16,821	2	31	32	10.22	53.31	5.254	157.2	4,103.00	70.1
		10	**Cremona Migliaro**	CR	2,416	1	6	6	7.91	52.30	1.328	173.2	1,549.00	70.0
		11	**Milano Bresso**	MI	790,141	3	72	246	28.78	75.89	613.210	461.0	23,583.00	73.4
		12	**Valbrembo**	BG	0	0	20	60	23.20	51.57	17.987	158.9	5,195.00	66.6
		13	**Varese Venegono**	VA	16,821	2	22	28	7.97	45.31	5.254	157.2	4,103.00	70.1
		14	**Vergiate**	VA	16,821	2	12	51	9.01	54.36	5.254	157.2	4,103.00	70.1
		15	**Voghera Rivanazzano**	PV	37,420	3	12	16	16.62	53.70	6.872	158.7	2,731.00	71.1
North-West (ITC)	**Liguria**	**16**	**Sarzana Luni**	SP	16,307	3	19	19	4.10	8.09	13.250	303.3	1,325.00	70.3
North-West (ITC)	**Val D'Aosta**				Region without minor airports									
North-East (ITD)	**Trentino Alto-Adige**	**17**	**Trento Mattarello**	TN	0	0	24	72	6.70	33.60	21.179	113.5	2,488.00	71.0
North-East (ITD)	**Veneto**	**18**	**Asiago**	VI	0	0	4	14	2.10	8.70	6.630	211.0	3,972.00	67.8
		19	**Belluno**	BL	8,069	1	5	9	2.14	8.09	2.376	55.3	708.00	72.7
		20	**Legnago**	VR	1,216	1	1	22	33.20	57.37	38.550	103.3	4,968.00	68.7
		21	**Padova**	PD	21,497	1	38	73	17.67	60.83	27.824	215.9	5,220.00	68.2
		22	**Thiene**	VI	0	0	6	53	2.90	52.12	6.630	211.0	3,972.00	67.8
		23	**Venezia**	VE	923,115	9	0	12	15.57	62.47	185.109	95.9	4,369.00	67.4
		24	**Verona Boscomantico**	VR	1,216	1	28	56	14.78	42.17	38.550	103.3	4,968.00	68.7

Table 9: Continued.

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	Specific resource parameter i(ID.n) for alternative (A.n) — *SD.1* Tourist Vocation ID.1				*SD.2* Infrastructural endowment for transport				*SD.3* Productive Vocation	
					ID.1.1	*ID.1.2*	*ID.1.3*	*ID.1.4*	*ID.2.1*	*ID.2.2*	*ID.2.3*	*ID.2.4*	*ID.3.1*	*ID.3.2*
North-East (ITD)	Emilia Romagna	**25**	**Carpi Budrione**	MO	83,100	3	4	7	10.70	37.60	15.318	122.7	4,044.00	71.4
		26	**Ferrara Aguscello**	FE	129,319	5	23	26	12.74	35.65	8.901	29.1	1,690.00	74.6
		27	**Ferrara**	FE	129,319	5	25	26	15.73	34.53	8.901	29.1	1,690.00	74.6
		28	**Modena**	MO	83,100	3	17	19	9.78	36.23	15.318	122.7	4,044.00	71.4
		29	**Pavullo nel Frignano**	MO	83,100	3	0	1	3.14	7.39	15.318	122.7	4,044.00	71.4
		30	**Lugo di Romagna**	RA	354,265	8	0	0	4.29	10.69	6.729	38.4	1,906.00	73.1
		31	**Ravenna**	RA	354,265	8	16	34	17.75	55.83	6.729	38.4	1,906.00	73.1
		32	**Reggio Emilia**	RE	13,792	1	17	21	14.67	58.73	11.562	71.7	3,105.00	70.2
North-East (ITD)	Friuli V Giulia	**33**	**Gorizia**	GO	0	0	13	24	8.70	29.65	0.836	119.2	505.00	68.4
		34	**Udine Campoformido**	UD	155,279	4	16	22	16.74	61.34	11.805	282.8	2,171.00	68.1
Centre (ITE)	Toscana	**35**	**Arezzo**	AR	145,031	8	18	19	5.70	34.60	3.861	79.3	1,870.00	71.4
		36	**Lucca Tassignano**	LU	19,294	2	37	81	7.70	31.60	1.659	78.0	2,421.00	69.4
		37	**Massa Cinquale**	MS	0	0	20	34	2.10	7.09	0.910	213.1	1,310.00	68.8
Centre (ITE)	Umbria	**38**	**Foligno**	PG	194,061	10	30	91	7.54	48.23	24.700	83.9	3,301.00	71.4
Centre (ITE)	Marche	**39**	**Fano**	PU	397,365	3	4	23	13.73	32.43	2.673	153.7	1,882.00	67.9
Centre (ITE)	Lazio	**40**	**Aquino**	FR	1,146,403	5	5	6	2.50	8.04	0.853	202.8	1,690.00	74.6
		41	**Guidonia**	RM	18,156,284	55	9	169	11.53	36.38	1199.402	190.1	30,238.00	68.9
		42	**Latina**	LT	124,023	5	3	9	14.50	42.38	0.887	76.7	3,493.00	61.3
		43	**Rieti**	RI	0	0	2	5	4.80	6.09	2.665	104.1	770.00	61.6
		44	**Roma Urbe**	RM	18,156,284	55	2	278	2.80	6.87	1199.402	190.1	30,238.00	68.9
		45	**Viterbo**	VT	502,457	19	6	11	10.54	32.68	2.022	46.5	1,703.00	65.3
South (ITF)	Abruzzo	**46**	**L'Aquila Preturo**	AQ	92,335	9	5	7	3.80	7.76	3.451	56.3	1,476.00	63.3
	Molise				Region without minor airports									
	Campania	**47**	**Capua**	CE	563,676	10	6	17	14.75	50.33	1.500	284.8	5,641.00	45.5
		48	**Salerno Pontecagnano**	SA	435,790	8	10	22	15.55	35.98	5.450	325.8	7,150.00	54.2
	Puglia	**49**	**Lecce Lepore**	LE	9,145	1	9	27	3.50	8.74	1.400	80.1	4,897.00	55.3
	Basilicata				Region without minor airports									
	Calabria				Region without minor airports									
Islands (ITG)	Sicilia	**50**	**Palermo Boccadifalco**	PA	494,006	17	8	39	12.35	33.58	24.500	212.3	5,339.00	50.2
	Sardegna	**51**	**Oristano Fenosu**	OR	123,575	3	10	13	4.30	7.09	0.150	121.8	512.00	63.2

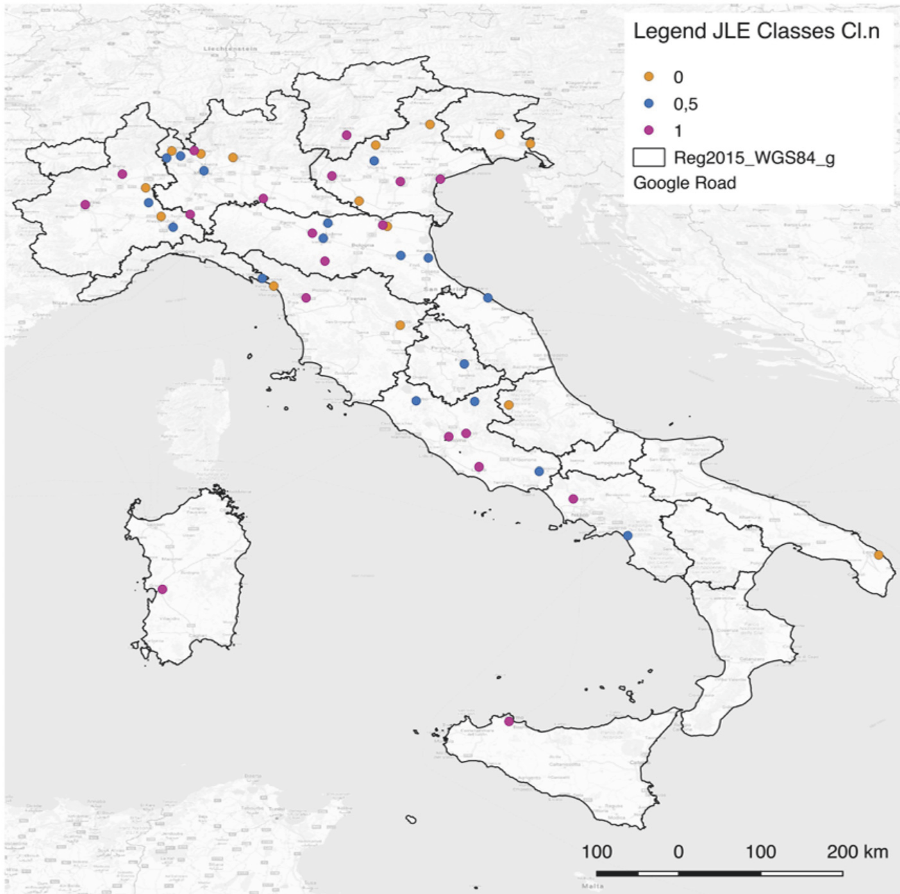


Figure 10: MCSDA implementation for JLE: spatial mapping.

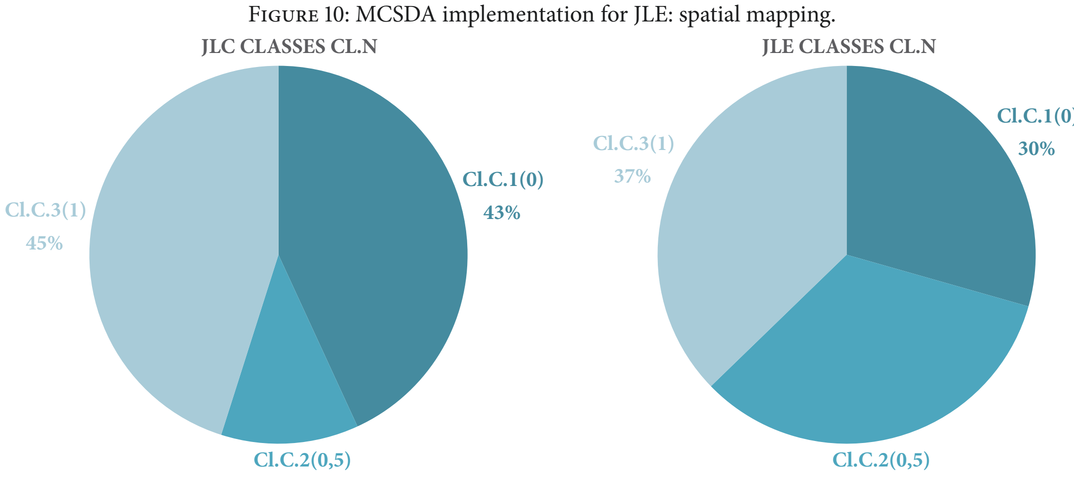


Figure 11: Analysis of output of evaluation for alternatives A.n for JLC, "overall classification of resources", and JLE, "airport potential classification".

Strategic Planning Tools, Participation Techniques, Financial and Economic Analysis) built up to evaluate (i) the value of money for constructing a second-level airport network "highway in the sky" following the quantification of the amount of investment necessary and the socioeconomic, financial, and environmental repercussions associated with identifying/constructing each airport hub in the geographic area concerned (following the redevelopment/upgrading of existing infrastructure and/or the planning of new infrastructure); (ii) the inclusion of second-level network hubs within the processes of territorial and urban transformation underway (planning forecasts and implementation programmes from the macro-area level to the local one) so as to guarantee the integration and overlapping of systems (urban, environmental, and transport systems); (iii) the sustainability of upgrading/expansion work and/or relocation (on the basis of the exposed areas identified) and therefore the structure of the network on the basis of the investment time necessary to guarantee that it becomes fully operational.

Table 10: MCSDA implementation for JLD: statistical analysis for the definition of Thresholds of Attractiveness (a) and definition of the Thresholds of Attractiveness for each Indicator (b).

(a) Statistical analysis for the definition of Thresholds of Attractiveness (ssd.n)

		SD.1 **Tourist Vocation ID.1**				***SD.2*** **Infrastructural endowment for transport**				***SD.3*** **Productive Vocation**	
		ID.1.1	**ID.1.2**	**ID.1.3**	**ID.1.4**	**ID.2.1**	**ID.2.2**	**ID.2.3**	**ID.2.4**	**ID.3.1**	**ID.3.2**
St.6	percentile (0.0)	0.00	0.00	0.00	0.00	2.10	6.09	0.15	29.12	505.00	45.46
St.5	percentile (0.2)	0.00	0.00	4.00	12.00	4.29	8.74	1.39	78.04	1690.00	67.44
St.4	percentile (0.4)	16615.40	2.00	8.00	19.60	7.95	35.23	5.25	116.94	2152.60	68.86
St.3	percentile (0.6)	117327.00	3.00	15.80	27.80	11.43	49.25	10.10	158.85	3972.00	70.22
St.2	percentile (0.8)	420420.00	8.00	22.60	57.80	15.24	53.86	23.17	213.92	4968.00	71.41
St.1	percentile (1)	18156284.00	55.00	72.00	278.00	33.20	75.89	1199.40	596.08	30238.00	74.59

(b) Definition of Thresholds of Attractivity (ssd.n) for Indicators ID.n

	SD.1 **Tourist Vocation ID.1**			
	ID.1.1	***ID.1.2***	***ID.1.3***	***ID.1.4***
cdm.n = 0.2	0.00>ID.1.1≥243.20	0.00>ID.1.2≥0.20	0.00>ID.1.3≥4.20	0.00>ID.1.4≥11.20
cdm.n = 0.4	243.20>ID.1.1≥16.821.00	0.20>ID.1.2≥2.00	4.20>ID.1.3≥8.00	11.20>ID.1.4≥19.00
cdm.n = 0.6	16.821.00>ID.1.1≥104.831.00	2.00>ID.1.2≥3.00	8.00>ID.1.3≥15.40	19.00>ID.1.4≥27.00
cdm.n = 0.8	104.831.00>ID.1.1≥ 412.735.00	3.00>ID.1.2≥8.00	15.40>ID.1.3≥22.40	27.00>ID.1.4≥57.20
cdm.n = 1	412.735.00>ID.1.1≥18.156.284.00	8.00>ID.1.2≥55.00	22.40>ID.1.3≥72	57.00>ID.1.4≥278.00
	SD.2 **Infrastructural endowment for transport**			
	ID.2.1	***ID.2.2***	***ID.2.3***	***ID.2.4***
cdm.n = 0.2	2.1>ID.2.1≥4.29	6.09>ID.2.2≥9.13	0.15>ID.2.3≥1.39	22.71>ID.2.4≥77.01
cdm.n = 0.4	4.29>ID.2.1≥7.97	9.13>ID.2.2≥34.60	1.39>ID.2.3≥5.25	77.01>ID.2.4≥113.51
cdm.n = 0.6	7.97>ID.2.1≥11.22	34.60>ID.2.2≥48.74	5.25>ID.2.3≥9.50	113.51>ID.2.4≥158.80
cdm.n = 0.8	11.22>ID.2.1≥15.09	48.74>ID.2.2≥53.81	9.50>ID.2.3≥22.51	158.80>ID.2.4≥213.66
cdm.n = 1	15.09>ID.2.1≥33.00	53.81>ID.2.2≥76.00	22.51>ID.2.3≥1.199.00	213.66>ID.2.4≥596.00
	SD.3 **Productive Vocation**			
	ID.3.1	***ID.3.2***		
cdm.n = 0.2	505.00>ID.3.1≥1.690.00	45.46>ID.3.2≥66.77		
cdm.n = 0.4	1690.00>ID.3.1≥2.125.00	66.77>ID.3.2≥68.76		
cdm.n = 0.6	2.125.00>ID.3.1≥3.972.00	68.76>ID.3.2≥70.22		
cdm.n = 0.8	3.972.00>ID.3.1≥4.968.00	70.22>ID.3.2≥71.41		
cdm.n = 1	4.968.00>ID.3.1≥30.238.00	71.41>ID.3.2≥74.59		

Output data can thus be useful to qualify and quantify the parameters upon which the construction of the second-level network should be based, which will need to be adequately distributed in order to cover the national territory and connect with other modes of transport.

The evaluation model proposed, based on sets of assessment elements that are used to obtain results for JLA "structural classification", JLB "services classification", JLC "overall classification of resources", JLD "territorial attractiveness classification", and JLE "airport potential classification" Judgment Levels, can be integrated with and/or replaced by other descriptive elements of additional and/or supplementary profiles for alternative *A.n*. A sensitivity analysis can be conducted on the JLCw and JLD levels, analyzing the repercussions on the JLE level, in that they are a combination of previous Judgment Levels, shifting Thresholds of Attractiveness by a few percentage points *(ssd.n)*. These can be defined by taking into account a variation of the St.n. percentage values obtained here on the basis of further statistical analyses. In this way, the robustness of the results can be measured.

The work put forward here can provide regulatory bodies and air traffic managers with decision-making support when developing improvement programmes and plans in the short, medium, and long term, designed to create a minor airport network that takes into account ongoing territorial and

Table 11: MCSD implementation for JLD: concise classification.

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	*Value classification and related score (cdm.n)*										Mean (M)	Concise classification
					SD.1 Tourist Vocation ID.1				*SD.2* Infrastructural endowment for transport				*SD.3* Productive Vocation			
					ID.1.1	*ID.1.2*	*ID.1.3*	*ID.1.4*	*ID.2.1*	*ID.2.2*	*ID.2.3*	*ID.2.4*	*ID.3.1*	*ID.3.2*		*JLD (csnt.n)*
North-West (ITC)	Piemonte	1	Alessandria	AL	0.40	0.40	0.60	0.60	0.80	1.00	0.40	1.00	0.40	1.00	0.66	H
		2	Biella Cerrione	BL	0.20	0.20	0.40	0.40	0.60	0.60	0.20	0.40	0.20	0.80	0.40	L
		3	Casale Monferrato	AL	0.40	0.40	0.60	0.60	1.00	1.00	0.40	1.00	0.40	1.00	0.68	H
		4	Novi Ligure	AL	0.40	0.40	0.20	1.00	0.60	0.80	0.40	1.00	0.40	1.00	0.62	H
		5	Torino Aeritalia	TO	1.00	1.00	0.60	1.00	0.60	0.80	1.00	0.20	1.00	0.80	0.80	H
		6	Vercelli	VC	0.20	0.20	0.40	0.40	0.80	1.00	0.20	0.20	0.20	0.80	0.44	A
North-West (ITC)	Lombardia	7	Alzate Brianza	CO	0.20	0.20	0.80	0.80	0.40	1.00	0.80	1.00	0.60	0.60	0.64	H
		8	Como Idroscalo	CO	0.20	0.20	1.00	0.80	0.40	0.80	0.80	1.00	0.60	0.60	0.64	H
		9	Calcinate del Pesce	VA	0.40	0.40	1.00	0.80	0.60	0.80	0.60	0.60	0.80	0.60	0.66	H
		10	Cremona Migliaro	CR	0.40	0.40	0.40	0.20	0.40	0.80	0.20	0.80	0.20	0.60	0.44	A
		11	Milano Bresso	MI	1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	VH
		12	Valbrembo	BG	0.20	0.20	0.80	1.00	1.00	0.80	0.80	0.80	1.00	0.20	0.68	H
		13	Varese Venegono	VA	0.40	0.40	0.80	0.80	0.40	0.60	0.60	0.60	0.80	0.60	0.60	A
		14	Vergiate	VA	0.40	0.40	0.60	0.80	0.60	1.00	0.60	0.60	0.80	0.60	0.64	H
		15	Voghera Rivanazzano	PV	0.60	0.60	0.60	0.40	1.00	0.80	0.60	0.60	0.60	0.80	0.66	H
North-West (ITC)	Liguria	16	Sarzana Luni	SP	0.40	0.60	0.80	0.40	0.20	0.20	0.80	1.00	0.20	0.80	0.54	A
North-West (ITC)	Val D'Aosta	Region without minor airports														
North-East (ITD)	Trentino Alto-Adige	17	Trento Mattarello	TN	0.20	0.20	1.00	1.00	0.40	0.40	0.80	0.40	0.60	0.80	0.58	A
North-East (ITD)	Veneto	18	Asiago	VI	0.20	0.20	0.20	0.40	0.20	0.20	0.60	0.80	0.60	0.40	0.38	L
		19	Belluno	BL	0.40	0.40	0.40	0.20	0.20	0.20	0.40	0.20	0.20	1.00	0.36	L
		20	Legnago	VR	0.40	0.40	0.20	0.60	1.00	1.00	1.00	0.40	0.80	0.40	0.62	H
		21	Padova	PD	0.60	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.40	0.84	VH
		22	Thiene	VI	0.20	0.20	0.40	0.80	0.20	0.80	0.60	0.80	0.60	0.40	0.50	A
		23	Venezia	VE	1.00	1.00	0.20	0.40	1.00	1.00	1.00	0.40	0.80	0.40	0.72	H
		24	Verona Boscomantico	VR	0.40	0.40	1.00	0.80	0.80	0.60	1.00	0.40	0.80	0.40	0.66	H

TABLE 11: Continued.

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	*Value classification and related score (cdm.n)*										Mean (M)	Concise classification
					SD.1 Tourist Vocation ID.1				*SD.2* Infrastructural endowment for transport				*SD.3* Productive Vocation			
					ID.1.1	*ID.1.2*	*ID.1.3*	*ID.1.4*	*ID.2.1*	*ID.2.2*	*ID.2.3*	*ID.2.4*	*ID.3.1*	*ID.3.2*		*JLD (csnt.n)*
North-East (ITD)	Emilia Romagna	25	Carpi Budrione	MO	0.60	0.60	0.20	0.20	0.60	0.60	0.80	0.60	0.80	0.80	0.58	A
		26	Ferrara Aguscello	FE	0.80	0.80	1.00	0.60	0.80	0.60	0.60	0.20	0.20	1.00	0.66	H
		27	Ferrara	FE	0.80	0.80	1.00	0.60	1.00	0.40	0.60	0.20	0.20	1.00	0.66	H
		28	Modena	MO	0.60	0.60	0.80	0.40	0.60	0.60	0.80	0.60	0.80	0.80	0.66	H
		29	Pavullo nel Frignano	MO	0.60	0.60	0.20	0.20	0.20	0.20	0.80	0.60	0.80	0.80	0.50	A
		30	Lugo di Romagna	RA	0.80	0.80	0.20	0.20	0.20	0.40	0.60	0.20	0.40	1.00	0.48	A
		31	Ravenna	RA	0.80	0.80	0.80	0.80	1.00	1.00	0.60	0.20	0.40	1.00	0.74	H
		32	Reggio Emilia	RE	0.40	0.40	0.80	0.60	0.80	1.00	0.80	0.20	0.60	0.60	0.62	H
North-East (ITD)	Friuli V Giulia	33	Gorizia	GO	0.20	0.20	0.60	0.60	0.60	0.40	0.20	0.60	0.20	0.40	0.40	L
		34	Udine Campoformido	UD	0.80	0.80	0.80	0.60	1.00	1.00	0.80	1.00	0.60	0.40	0.78	H
Centre (ITE)	Toscana	35	Arezzo	AR	0.80	0.80	0.80	0.40	0.40	0.40	0.40	0.40	0.40	1.00	0.58	A
		36	Lucca Tassignano	LU	0.60	0.40	1.00	1.00	0.40	0.40	0.40	0.40	0.60	0.60	0.58	A
		37	Massa Cinquale	MS	0.20	0.20	0.80	0.80	0.20	0.20	0.20	0.80	0.20	0.40	0.40	L
Centre (ITE)	Umbria	38	Foligno	PG	0.80	1.00	1.00	1.00	0.40	0.60	1.00	0.40	0.60	1.00	0.78	H
Centre (ITE)	Marche	39	Fano	PU	0.80	0.60	0.20	0.60	0.80	0.40	0.40	0.60	0.40	0.40	0.52	A
Centre (ITE)	Lazio	40	Aquino	FR	1.00	0.80	0.40	0.20	0.20	0.20	0.20	0.80	0.20	1.00	0.50	A
		41	Guidonia	RM	1.00	1.00	0.60	1.00	0.80	0.60	0.20	0.80	1.00	0.60	0.76	H
		42	Latina	LT	0.80	0.80	0.20	0.20	0.80	0.60	0.20	0.20	0.60	0.20	0.46	A
		43	Rieti	RI	0.20	0.20	0.20	0.20	0.40	0.20	0.40	0.40	0.20	0.20	0.26	L
		44	Roma Urbe	RM	1.00	1.00	0.20	1.00	0.20	0.20	0.20	0.80	1.00	0.60	0.62	H
		45	Viterbo	VT	1.00	1.00	0.40	0.20	0.60	0.40	0.40	0.20	0.40	0.20	0.48	A
South (ITF)	Abruzzo	46	L'Aquila Preturo	AQ	0.60	1.00	0.40	0.20	0.20	0.20	0.40	0.20	0.20	0.20	0.36	L
	Molise				Region without minor airports											
	Campania	47	Capua	CE	1.00	1.00	0.40	0.40	0.80	0.80	0.40	1.00	1.00	0.20	0.70	H
		48	Salerno Pontecagnano	SA	1.00	0.80	0.60	0.60	1.00	0.60	0.60	1.00	1.00	0.20	0.74	H
	Puglia	49	Lecce Lepore	LE	0.40	0.40	0.60	0.60	0.20	0.20	0.40	0.40	0.80	0.20	0.42	A
	Basilicata				Region without minor airports											
	Calabria				Region without minor airports											
Islands (ITG)	Sicilia	50	Palermo Boccadifalco	PA	1.00	1.00	0.40	0.80	0.80	0.40	1.00	0.80	1.00	0.20	0.74	H
	Sardegna	51	Oristano Fenosu	OR	0.80	0.60	0.60	0.40	0.40	0.20	0.20	0.60	0.20	0.20	0.42	A

M = Arithmetic Mean
If 0 < M≤ 0.20; csnt.n= VL
If 0.20 < M≤ 0.40; csnt.n= L
If 0.40 < M≤ 0.60; csnt.n= A
If 0.60 < M≤ 0.80; csnt.n= H
If 0.80 < M≤ 1; csnt.n= VH

Table 12: MCSDA implementation for JLE: definition of the airport potential classification scores.

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	JLC: Weighted General Equipment Classification JLCw	JLC: Classes $Cl.n(A.n)$	JLD: Territorial Service Classification (csnt.n)	JLD: Value Classification Scores	JLE: Final Classification Scores	JLE: Classes $Cl.n(A.n)$
North-West (ITC)	Piemonte	**1**	**Alessandria**	AL	0.00	1.00	H	0.75	0.75	0.00
		2	**Biella Cerrione**	BL	2.75	1.00	L	0.25	3.00	1.00
		3	**Casale Monferrato**	AL	1.00	0.00	H	0.75	1.75	0.50
		4	**Novi Ligure**	AL	1.25	0.50	H	0.75	2.00	0.50
		5	**Torino Aeritalia**	TO	2.50	1.00	H	0.75	3.25	1.00
		6	**Vercelli**	VC	0.25	0.00	A	0.50	0.75	0.00
North-West (ITC)	Lombardia	**7**	**Alzate Brianza**	CO	0.00	1.00	H	0.75	0.75	0.00
		8	**Como Idroscalo**	CO	2.00	1.00	H	0.75	2.75	1.00
		9	**Calcinate del Pesce**	VA	0.25	0.00	H	0.75	1.00	0.00
		10	**Cremona Migliaro**	CR	0.00	1.00	A	0.50	0.50	1.00
		11	**Milano Bresso**	MI	1.00	0.00	VH	1.00	2.00	0.50
		12	**Valbrembo**	BG	0.25	0.00	H	0.75	1.00	0.00
		13	**Varese Venegono**	VA	1.00	0.00	A	0.50	1.50	0.50
		14	**Vergiate**	VA	1.25	0.50	H	0.75	2.00	0.50
		15	**Voghera Rivanazzano**	PV	3.00	1.00	H	0.75	3.75	1.00
North-West (ITC)	Liguria	**16**	**Sarzana Luni**	SP	1.00	0.00	A	0.50	1.50	0.50
North-West (ITC)	Val D'Aosta				Region without minor airports					
North-East (ITD)	Trentino Alto-Adige	**17**	**Trento Mattarello**	TN	1.75	1.00	A	0.50	2.25	1.00
North-East (ITD)	Veneto	**18**	**Asiago**	VI	1.00	0.00	L	0.25	1.25	0.00
		19	**Belluno**	BL	1.00	0.00	L	0.25	1.25	0.00
		20	**Legnago**	VR	0.00	1.00	H	0.75	0.75	0.00
		21	**Padova**	PD	2.00	1.00	VH	1.00	3.00	1.00
		22	**Thiene**	VI	1.25	0.50	A	0.50	1.75	0.50
		23	**Venezia**	VE	2.00	1.00	H	0.75	2.75	1.00
		24	**Verona Boscomantico**	VR	1.50	1.00	H	0.75	2.25	1.00
North-East (ITD)	Emilia Romagna	**25**	**Carpi Budrione**	MO	1.00	0.00	A	0.50	1.50	0.50
		26	**Ferrara Aguscello**	FE	0.25	0.00	H	0.75	1.00	0.00
		27	**Ferrara**	FE	1.50	1.00	H	0.75	2.25	1.00
		28	**Modena**	MO	1.00	0.00	H	0.75	1.75	0.50
		29	**Pavullo nel Frignano**	MO	1.75	1.00	A	0.50	2.25	1.00
		30	**Lugo di Romagna**	RA	1.00	0.00	A	0.50	1.50	0.50
		31	**Ravenna**	RA	1.25	0.50	H	0.75	2.00	0.50
		32	**Reggio Emilia**	RE	1.50	1.00	H	0.75	2.25	1.00

Table 12: Continued.

NUTS 1: Geographical areas	NUTS 2: Regions	N°	Minor airport	NUTS 3: Provinces	JLC Weighted General Equipment Classification JLCw	JLC Classes *Cl.n(A.n)*	JLD Territorial Service Classification (csnt.n)	JLD Value Classification Scores	JLE Final Classification Scores	JLE Classes *Cl.n(A.n)*
North-East (ITD)	**Friuli V Giulia**	**33**	**Gorizia**	GO	1.00	0.00	L	0.25	1.25	0.00
		34	**Udine Campoformido**	UD	0.25	0.00	H	0.75	1.00	0.00
Centre (ITE)	**Toscana**	**35**	**Arezzo**	AR	0.50	0.00	A	0.50	1.00	0.00
		36	**Lucca Tassignano**	LU	2.25	1.00	A	0.50	2.75	1.00
		37	**Massa Cinquale**	MS	0.50	0.00	L	0.25	0.75	0.00
Centre (ITE)	**Umbria**	**38**	**Foligno**	PG	1.25	0.50	H	0.75	2.00	0.50
Centre (ITE)	**Marche**	**39**	**Fano**	PU	1.50	1.00	A	0.50	2.00	0.50
Centre (ITE)	**Lazio**	**40**	**Aquino**	FR	1.00	0.00	A	0.50	1.50	0.50
		41	**Guidonia**	RM	1.75	1.00	H	0.75	2.50	1.00
		42	**Latina**	LT	2.75	1.00	A	0.50	3.25	1.00
		43	**Rieti**	RI	1.25	0.50	L	0.25	1.50	0.50
		44	**Roma Urbe**	RM	2.75	1.00	H	0.75	3.50	1.00
		45	**Viterbo**	VT	1.00	0.00	A	0.50	1.50	0.50
South (ITF)	**Abruzzo**	**46**	**L'Aquila Preturo**	AQ	1.00	0.00	L	0.25	1.25	0.00
	Molise				Region without minor airports					
	Campania	**47**	**Capua**	CE	1.50	1.00	H	0.75	2.25	1.00
		48	**Salerno Pontecagnano**	SA	1.00	0.00	H	0.75	1.75	0.50
	Puglia	**49**	**Lecce Lepore**	LE	0.50	0.00	A	0.50	1.00	0.00
	Basilicata				Region without minor airports					
	Calabria				Region without minor airports					
Islands (ITG)	**Sicilia**	**50**	**Palermo Boccadifalco**	PA	2.50	1.00	H	0.75	3.25	1.00
	Sardegna	**51**	**Oristano Fenosu**	OR	2.75	1.00	A	0.50	3.25	1.00

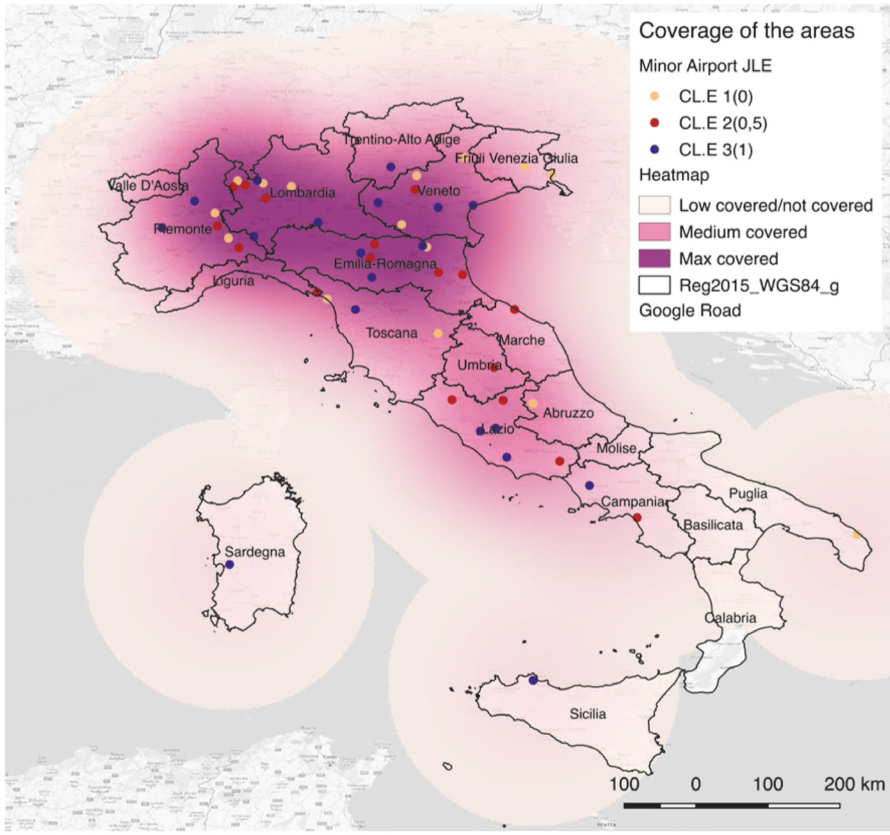


FIGURE 12: Definition of coverage of the areas by minor airports throughout the country: heatmap.

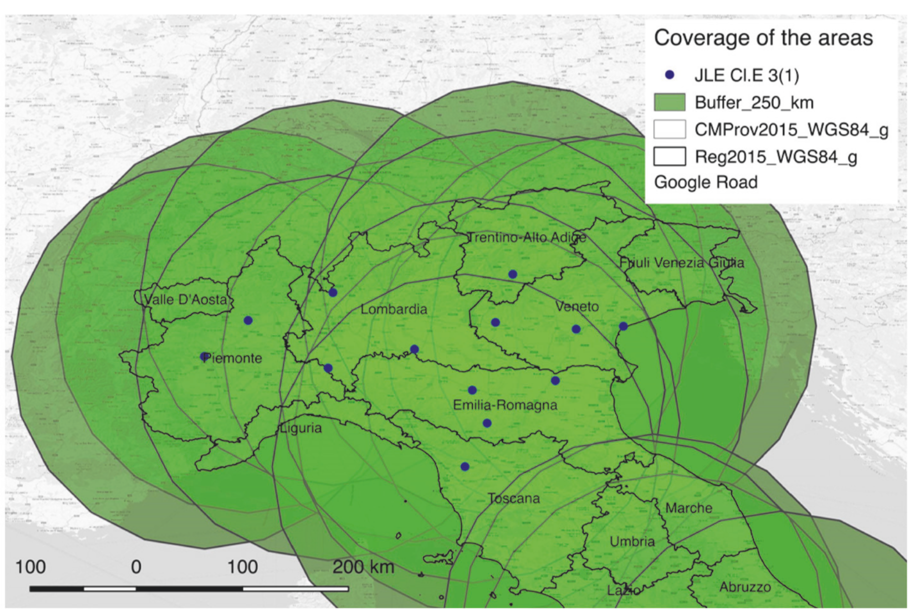


FIGURE 13: Definition of the coverage of the areas by minor airports through the country: buffering.

Table 13: MCSDA implementation for JLE: statistical analysis (a) and Thresholds of Attractiveness construction (b).

(a) Statistical Analysis

	Percentile functions	Values
St.4	percentile (0.0)	0.50
St.3	percentile (0.3)	1.25
St.2	percentile (0.6)	2.00
St.1	percentile (1)	3.75

(b) Attractiveness Thresholds (ssd.n)

Classes Cl.n(A.n)	JLEw Thresholds (ssd.n)
Cl.n(A.n) = 0	0.50 >JLE_Scores≥ 1.25
Cl.n(A.n) = 0.5	1.25>JLE_Scores≥2.00
Cl.n(A.n) = 1	2.00>JLE_Scores≥3.75

infrastructural mechanisms and processes of socioeconomic development.

Abbreviations

JLA: Judgment Level A
JLB: Judgment Level B
JLC: Judgment Level C
JLD: Judgment Level D
JLE: Judgment Level E
MCDA: Multicriteria Decision Analysis
MCSDA: Multicriteria spatial decision analysis
SDSS: Spatial Decision Support Systems
A.n: Alternative of evaluation
Cj.A: Criteria Judgment Level A
Sj.A: Subcriteria Judgment Level A
Ij.A: Indicators Judgment Level A
iIj.A: Specific resource parameter Judgment Level A
Cj.B: Criteria Judgment Level B
Sj.B: Subcriteria Judgment Level B
Ij.B: Indicators Judgment Level B
iIj.B: Specific resource parameter Judgment Level B
Cj.D: Criteria Judgment Level D
Sj.D: Subcriteria Judgment Level D
Ij.D: Indicators Judgment Level D
i(Ij.D): Specific resource parameter Judgment Level D
pcsp.n: Specific classification indicator
ppd.n: Potential resource parameter
[f(csnt.n)]: Concise classification function
csnt.n: Concise classification
cdm.n: Value classification and related score
ssd.n: Thresholds satisfaction
[f(cdm.n)]: Value classification function
[fnl(cdm.n)]: Weighting and standardization of value classification function
St.n: Percentile Values
Cl.n(A.n): Classes obtained from implementation of the procedure for different Judgment Levels
Cl.C.1: First Class for Judgment Level C
Cl.C.2: Second Class for Judgment Level C
Cl.C.3: Third Class for Judgment Level C
Cl.E.1: First Class for Judgment Level E
Cl.E.2: Second Class for Judgment Level E
Cl.E.3: Third Class for Judgment Level E.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

This paper is the result of the joined work of the authors Maria Rosaria Guarini and Anthea Chiovitti to whom the paper has to be attributed in equal parts. Francesco Rocca contributed to the development of geographical analysis of data and to the implementation of the model.

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