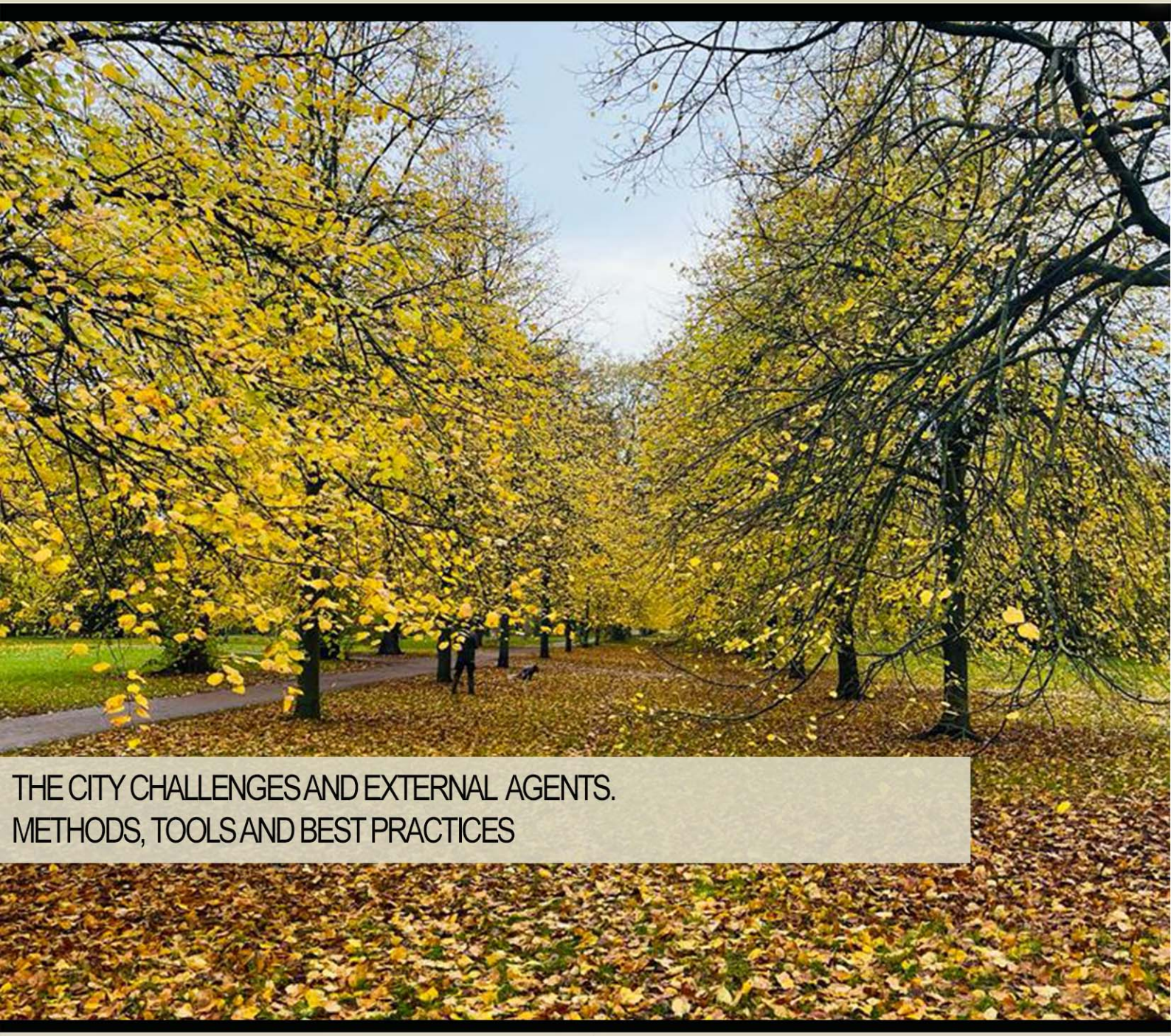
TeMA

Journal of Land Use, Mobility and Environment

The climatic, social, economic and health phenomena that have increasingly affected our cities in recent years require the identification and implementation of adaptation actions to improve the resilience of urban systems. The three issues of the 16th volume will collect articles concerning the challenges that the complexity of the phenomena in progress imposes on cities through the adoption of mitigation measures and the commitment to transforming cities into resilient and competitive urban systems.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.



THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

Vol.16 n.3 December 2023

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of Land Use, Mobility and Environment

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

3 (2023)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | online ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.serena.unina.it/index.php/tema
e-mail: redazione.tema@unina.it

The cover image shows a view of Hyde Park in London (United Kingdom) during the autumn season.
The photo was taken by Enrica Papa in November 2023.

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

With ANVUR resolution of April 2020, TeMA Journal and the articles published from 2016 are included in A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. TeMA Journal has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 4.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

EDITOR IN-CHIEF

Rocco Papa, University of Naples Federico II, Italy

EDITORIAL ADVISORY BOARD

Mir Ali, University of Illinois, USA
Luca Bertolini, University of Amsterdam, Netherlands
Luuk Boelens, Ghent University, Belgium
Dino Borri, Politecnico di Bari, Italy
Enrique Calderon, Technical University of Madrid, Spain
Roberto Camagni, Politecnico di Milano, Italy
Pierluigi Coppola, Politecnico di Milano, Italy
Derrick De Kerckhove, University of Toronto, Canada
Mark Deakin, Edinburgh Napier University, Scotland
Carmela Gargiulo, University of Naples Federico II, Italy
Aharon Kellerman, University of Haifa, Israel
Nicos Komninos, Aristotle University of Thessaloniki, Greece
David Matthew Levinson, University of Minnesota, USA
Paolo Malanima, Magna Græcia University of Catanzaro, Italy
Agostino Nuzzolo, Tor Vergata University of Rome, Italy
Rocco Papa, University of Naples Federico II, Italy
Serge Salat, UMCS Institute, France
Mattheos Santamouris, NK University of Athens, Greece
Ali Soltani, Shiraz University, Iran

ASSOCIATE EDITORS

Rosaria Battarra, CNR, Italy
Matteo Caglioni, Université Cote D'azur, France
Alessia Calafiore, University of Edinburgh, UK
Gerardo Carpentieri, University of Naples Federico II, Italy
Luigi dell'Olio, University of Cantabria, Spain
Isidoro Fasolino, University of Salerno, Italy
Romano Fistola, University of Naples Federico II, Italy
Stefano Franco, Politecnico di Bari, Italy
Federica Gaglione, University of Sannio, Italy
Carmen Guida, University of Naples Federico II, Italy
Thomas Hartmann, Utrecht University, Netherlands
Markus Hesse, University of Luxemburg, Luxemburg
Zhanat Idrisheva, D. Serikbayev EKTU, Kazakhstan
Zhadyra Konurbayeva, D. Serikbayev EKTU, Kazakhstan
Seda Kundak, Technical University of Istanbul, Turkey
Rosa Anna La Rocca, University of Naples Federico II, Italy
Houshmand Ebrahimpour Masoumi, TU of Berlin, Germany
Giuseppe Mazzeo, CNR, Italy
Nicola Morelli, Aalborg University, Denmark
Enrica Papa, University of Westminster, United Kingdom
Yolanda Pena Boquete, AYeconomics Research Centre, Spain
Dorina Pojani, University of Queensland, Australia
Nailya Saifulina, University of Santiago de Compostela, Spain
Athena Yiannakou, Aristotle University of Thessaloniki, Greece
John Zacharias, Peking University, China
Cecilia Zecca, Royal College of Art, UK
Floriana Zucaro, University of Naples Federico II, Italy

EDITORIAL STAFF

Gennaro Angiello, Ph.D. at University of Naples Federico II, Systemica, Bruxelles, Belgium
Annunziata D'Amico, Ph.D. student at University of Naples Federico II, Italy
Valerio Martinelli, Ph.D. student at University of Naples Federico II, Italy
Sabrina Sgambati, Ph.D. student at University of Naples Federico II, Italy

TeMA
Journal of
Land Use, Mobility and Environment

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

3 (2023)

Contents

REVIEW NOTES

TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2023) 545-564
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6093/1970-9870/10271
Received 9th September 2023, Accepted 20th November 2023, Available online 30th December 2023

Licensed under the Creative Commons Attribution – Non Commercial License 4.0
www.tema.unina.it

The investments of NextGenerationEU vs urban competitiveness of Italian metropolitan areas

Carmela Gargiulo [a]*, Sabrina Sgambati [b]

[a] Department of Civil, Architectural and Environmental Engineering, University of Naples Federico II
Piazzale Vincenzo Tecchio, 80, 80125, Naples, Italy
e-mail: gargiulo@unina.it
ORCID: https://orcid.org/0000-0001-6481-0908
* Corresponding author

[b] Department of Civil, Architectural and Environmental Engineering, University of Naples Federico II
Piazzale Vincenzo Tecchio, 80, 80125, Naples, Italy
e-mail: sabrina.sgambati@unina.it
ORCID: https://orcid.org/0000-0001-8900-278X

Abstract
The social, economic, and environmental challenges imposed by the complexity of the ongoing phenomena require the rapid transformation of cities into resilient, competitive urban systems. The recent European program NextGenerationEU is oriented in this direction. It allocates the resources to turn the Covid-19 pandemic into a trigger of development through the implementation of recovery plans aimed at increasing the competitiveness of the territories involved. Hence, it is urgent to find a way not only to manage the available resources but distribute them effectively, identifying priorities of interventions. This paper examines Italian metropolitan areas to support decision-makers in the prioritization/management of urban transformations in the framework of the Italian Recovery and Resilience Plan (PNRR). 53 variables belonging to five macro-areas of competitiveness were identified and elaborated. Two composite indexes were developed to compare the cities' actual competitive performance with the distribution of resources defined by the PNRR. The aim is to understand if the PNRR investments are consistent with the case studies assets and vocations that, if boosted, may determine their competitive development. Among the main findings, it emerged a substantial deviation between competitive performance and allocated resources, especially for southern cities which received a greater boost from the PNRR than their actual competitive potential in order to overcome the North-South existing disparities.

Keywords
Urban competitiveness; Urban planning; Recovery Plans.

How to cite item in APA format
Gargiulo, C. & Sgambati, S. (2023). The investments of NextGenerationEU vs urban competitiveness of Italian metropolitan areas. *TeMA - Journal of Land Use, Mobility and Environment*, *16* (3), 545-564. http://dx.doi.org/10.6093/1970-9870/10271

1. Introduction

In the light of the numerous challenges cities have to face in the coming decades - climate change, ageing population, the management of migratory flows, increasing demand for travel, economic crisis, and so on – (Höjer & Wangel, 2015; Granberg & Nyberg, 2017; Volk et al., 2022) the shape and the organization of cities is destined to change (Guida & Caglioni, 2020; Mondschein et al., 2021). The complexity of the ongoing phenomena requires their rapid transformation into resilient and competitive urban systems (Sharifi, 2019; Ghahremani et al., 2021). The long-term impact of these phenomena is inevitable and can represent both a threat and an opportunity for the systems involved (Drobniak, 2012; Capasso & Mazzeo, 2020; Bănică et al., 2022), to the extent that they are able to renew their development by becoming more resilient, just and sustainable, and, thus, more competitive (Kutty, 2022).

Over the last few decades, the debate on urban competitiveness has expanded considerably due to different phenomena, such as globalization, the digital revolution, and urbanization, moving from a business to a territorial perspective (Papa et al., 2014; Mazzeo, 2011; Komasi et al., 2022; Nasi et al., 2022). Nowadays, as being competitive for cities means combining economic development (Encarnacion et al., 2023) with well-being and quality of life, decision-makers consider increasing urban competitiveness essential to transforming territories (Camagni, 2002; Blakely et al., 2019; Li, 2019; Ni et al., 2021). Competitiveness strategies have evolved in the scenario outlined by the above-mentioned challenges (Granberg & Nyberg, 2017; Jakobsen et al., 2022). In this regard, not only is urban competitiveness the ability to attract talented people, investments, and high-quality activities (Burlina et al., 2022) but also to adapt to the effects of external agents by transforming threats into opportunities (Bănică et al., 2022; A.A:, 2022). The latest climatic, social, economic, health, and environmental changes – last but not least the Ukrainian war and the consequent resources crisis – require the identification and implementation of strategies (Volk et al., 2022) to increase the preparedness, liveability, competitiveness, and sustainable performance of urban systems (Hu, 2015; Blakely et al., 2019; EIU, 2022).

The search for a new state of equilibrium that the whole world has been experiencing since 2020 - due to the spread of Covid-19 - is representative of this scenario since the pandemic has triggered new dynamics in the competition between countries and cities (Činčikaitė & Meidutė-Kavaliauskienė, 2022), in a recovery perspective that has the potential to redistribute resources and opportunities at the international level. The European Union, in particular, has approved the Next Generation EU (NGEU) program to recover from the pandemic while, in parallel, accelerating the ecological and digital transition, pursuing social and economic equity, and overcoming existing generational, gender, and territorial disparities (European Commission, 2021). Each Member State has been invited to develop its recovery and resilience plan to access the funds under the Recovery and Resilience Facility. By seizing this opportunity, Italy presented the National Recovery and Resilience Plan (PNRR), a programmatic proposal structured into missions and components, approved by the European Commission on July 31, 2021 (Governo Italiano, 2021). The rise of urban competitiveness pervades many sectors of the plan, such as the digitalization of public administration, the promotion of tourism and culture, the acceleration of the ecological transition, the encouragement of sustainable mobility, and the regeneration of territories at risk (Picek, 2020). Many local actors are called upon to implement the reforms and the planned interventions. Among them, metropolitan areas have proposed projects involving several municipalities and sectors of investment (Openpolis, 2022).

Hence, it is urgent to find a way not only to manage the available resources but distribute them effectively, identifying priorities of interventions (Kunzmann, 2020; Longsheng & Shah, 2022). To fill this gap, it is essential to keep in mind that the increase in competitiveness relies on the cities' intrinsic suitability for competition and the ability of administrators to orient development strategies according to their distinctive and successful assets (Turok, 2009; Pino et al., 2015; Carrera Portugal, 2019). In other words, the competitive growth of cities can occur properly if decision-makers are able to orient urban development according to the competitive

potential of cities (Komasi et al., 2022). This potential depends on the intrinsic structure of the urban system, which can be interpreted by considering functional, social, physical, and territorial characteristics which correspond to a certain number of variables.

This paper examines the competitiveness of the Italian metropolitan areas investigating the relationship between their characteristics and the competitive processes that are expected to occur with the implementation of the PNRR. Firstly, by taking a multidimensional approach, five Macro-areas of Competitiveness were identified (Tourism and Culture, Ecological Transition, Digitalization/Smartness, Sustainable Mobility, and Social Cohesion). Secondly, the urban characteristics able to spark competitive processes were highlighted (especially if pushed by the resources deployed by the PNRR), defining, subsequently, the descriptive variables and indicators. Multivariate statistical analysis was implemented to obtain a two-fold result: i) the investigation of which variables work synergically in improving urban competitiveness and the evaluation of the competitive potential of the Italian metropolitan areas; ii) a ranking based on a composite index of competitiveness to be compared with a similar ranking constructed on the basis of the actual PNRR allocation of resources. Furthermore, the results were discussed in light of the strategies, projects, and interventions promoted in the 14 metropolitan areas to date. The assessment of such interventions allows to verify the consistency between the choices of investments of the PNRR and the cities' main assets of competition, with the aim of supporting decision-makers in the prioritization/management of future urban transformations.

The following section describes the developed approach and the utilized materials, while the third section regards the application to the 14 Italian metropolitan areas. The fourth section discusses the study results, highlighting the characteristics that, if implemented, may well determine the development of the Italian metropolitan areas in the coming years. The fifth section draws the conclusions of the work.

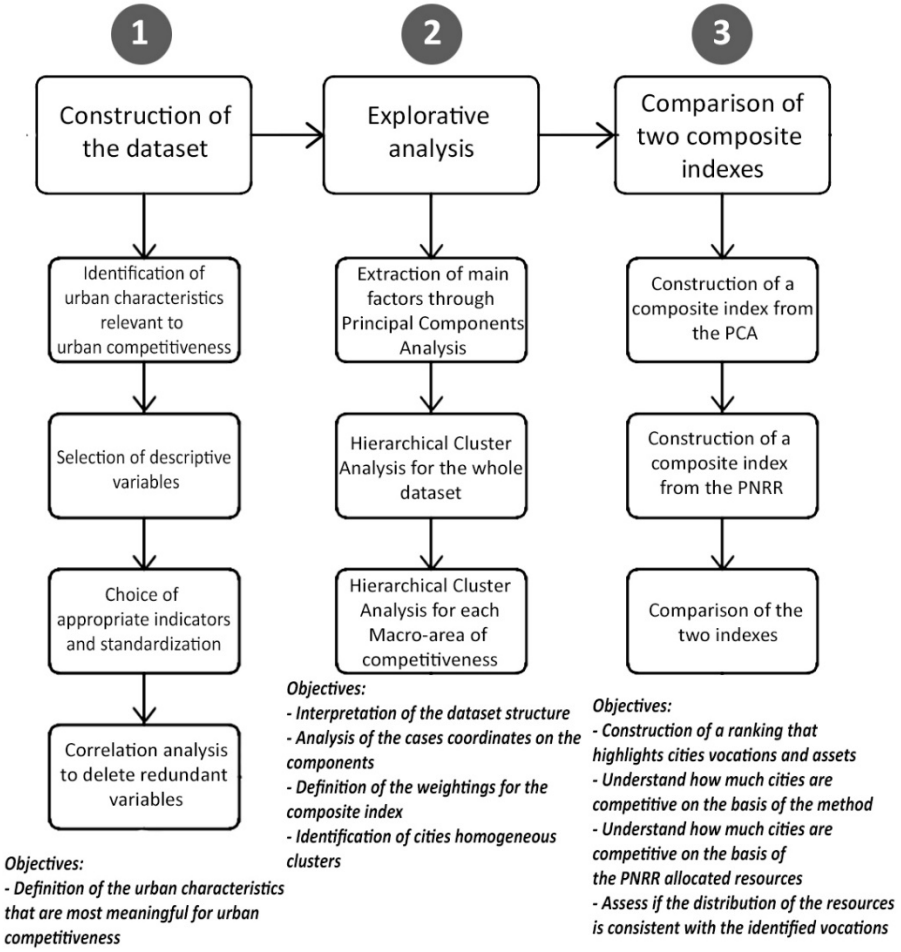


Fig.1 The three phases of the methodology with the relative methodological objectives

2. Materials and methods

Assuming as a hypothesis the availability of resources to invest in a certain territory, the proposed method aims at comparing the fields of investment with territorial assets and vocation. In this specific case, the objective is to understand if the PNRR resources have been distributed adequately among metropolitan areas. The method can be divided into three phases, as shown in Fig.1.

Firstly, the construction of the dataset (Tab.1) consists of the identification of urban characteristics – relevant to urban competitiveness - structured in Macro-areas of Competitiveness (namely Tourism and Culture, Ecological Transition, Digitalization/ Smartness, Sustainable Mobility, and Social Cohesion) that refer, inter alia, to some of the sectors of investment of the PNRR. They were identified by adopting a holistic and multidimensional approach, not only considering the city's economic and productive performance but also its social, cultural, and environmental features. In particular, the macro-areas were selected by looking at the results of a previous study, specifically a bibliometric analysis (Sgambati & Gargiulo, 2022) and at the categories of interventions of the plan. The 61 resulting indicators are then standardized through z-score and wiped through correlation analysis, which is necessary to eliminate redundant indicators, namely those affected by strong correlation ratios (Pearson coefficients > 0.75). The correlation analysis was implemented by looking at the Pearson coefficient between variables belonging to the same Macro-area of Competitiveness, thus identifying 5 different correlation sub-matrices (as reported in the appendix).

Macro-area	ID	Variable	Date	Measurement unit	Source
Tourism and culture	T1	Number of museums	2019	n.	Ministry of Cultural Heritage and Tourism
	T2	Public libraries	2020	n./inh.	IlSole24ore
	T3	Bars and restaurants	2020	n./inh.	IlSole24ore
	T4	Number of cinemas	2020	n./inh.	IlSole24ore
	T5	Density and relevance of cultural heritage	2019	n/km2	BES ISTAT
	T6	Gyms, pools and spa	2021	n/km2	IlSole24ore
	T7	Number of shows	2020	n./inh.	IlSole24ore
	T8	Number of international sport events	2020	n.	IlSole24ore
	T9	Rate of tourist accommodation	2020	n./km2	ISTAT
	T10	Tourists rate	2020	-	ISTAT
	T11	Foreign tourists arrivals	2020	%	ISTAT
	T12	Average stays of tourists	2020	n.	ISTAT
	T13	Hotel facilities	2020	n.	ISTAT
Ecological transition	E1	Separate waste collection per capita	2019	Kg/inh*year	ISTAT
	E2	Landfill of waste	2019	%	ISPRA
	E3	Urban waste per capita	2019	Kg/inh*year	ISTAT
	E4	Energy management certificates	2019	n.	ISTAT
	E5	Energy from photovoltaic systems	2019	%	ISTAT
	E6	Energy from renewable resources	2019	%	BES ISTAT
	E7	Gas consumption	2019	Mln m3	ISTAT Ambiente urbano
	E8	Dispersion of water network	2018	%	ISTAT
	E9	Energetic start-ups	2020	n.	Camera di Commercio Bologna
	E10	Incidence of green urban areas	2019	%	ISTAT and Corine Land Cover
	E11	Air quality	2020	m2/inh.	IlSole24ore
	E12	Energy requalification	2020	n.	IlSole24ore
	E13	Increase of soil consumption	2020	m2/km2	ISPRA
	E14	Climate liveability index	2022	-	IlMeteo.it and Corriere della sera
Digitalization/ smartness	D1	Number of university facilities	2018	n.	IlSole24ore
	D2	University attractiveness	2019	%	Città Metropolitana di Bologna
	D3	Number of graduates	2019	n.	Città Metropolitana di Bologna
	D4	Employees in technological sectors	2020	%	ISTAT

	D5	E-commerce firms	2021	%	IlSole24ore
	D6	Number of patents	2019	%	Start City
	D7	Services for economic activities	2019	-	ISTAT
	D8	POS services	2021	n./inh.	IlSole24ore
	D9	Online services PA	2019	%	ISTAT
	D10	Digital transformation index	2020	-	IlSole24ore
	D11	Digital Agenda Funds	2020	€/inh.	IlSole24ore
	D12	Ultra-broad band	2021	%	IlSole24ore
	D13	Innovative star-ups	2020	%	Camera di Commercio Bologna
Sustainable mobility	M1	Digitalization of viability services	2019	-	ISPRA
	M2	Exchange parking areas	2019	n.	ISPRA
	M3	Incidence of standard cars emissive	2016	n.	ISPRA
	M4	Road accidents	2016	n./inh.	ISTAT-ACI
	M5	Public transport demand	2019	%	ISTAT
	M6	Public buses	2019	n.	ISTAT
	M7	Electric vehicles	2019	%	ISTAT
	M8	Bike sharing	2019	n./inh.	ISTAT
	M9	Cycle lanes density	2019	Km/km2	ISTAT
	M10	Pedestrian areas	2019	m2/inh.	ISTAT
	M11	Car sharing	2019	n./inh.	ISTAT
Social cohesion	S1	Net migration	2019	Inh./1000 inh.	ISTAT
	S2	Foreigners	2019	%	ISTAT
	S3	Structural dependency ratio	2019	%	ISTAT
	S4	Youth employment ratio	2020	%	ISTAT
	S5	Female employment ratio	2020	%	ISTAT
	S6	Crime index	2019	n,/inh.	IlSole24ore
	S7	Local expenditure for social issues	2020	€	Istituto Tagliacarme
	S8	Female enterprises	2020	%	Camera di Commercio
	S9	Acquisitions of citizenship	2021	n./inh	IlSole24ore
	S10	Accidents in the workplace	2021	n./n. employees	IlSole24ore

Tab.1 The selected indicators divided per Macro-area of Competitiveness

The second phase is made up of explorative analyses of the dataset whose objectives are the identification of the most meaningful variables and the definition of metropolitan areas' distinctive features. Specifically, Principal Components Analysis (PCA) is run to identify and interpret the main factors behind urban competitiveness and figure out how metropolitan areas are arranged against these factors (Sáez et al., 2017). The work by Annoni & Kozovska (2010) was used as a reference to define the threshold value for the explained variance (60%). In this phase, for each component, the most meaningful variables are those having loadings higher than 0.65, while the ones with loadings between -0.1 and 0.1 are considered not very significant to the component.

The application of a Hierarchical Cluster Analysis (HCA), typical of urban and territorial studies (Scaramuzzino et al., 2019), allows for further insights into the case studies' competitive assets. The cluster analysis is run both for the whole dataset and for single Macro-areas of Competitiveness, obtaining different clusters. The chosen method of clustering is the "furthest neighbors" with the interval set on squared Euclidean distances since all the variables are quantitative and continuous. For the reliability of the model, the Cronbach alpha test was carried out, considering the indicators most correlated with each component as input variables. The higher the Cronbach coefficient (considering a threshold value of 0.5) the greater the reliability is (Tavakol & Dennick, 2011).

The third phase consists of the comparison of two indexes obtained from the elaboration of the previous two phases' output.

The first index I_{UC} is constructed by firstly aggregating the indicators of urban competitiveness (weighted through PCA loadings) into intermediate indices corresponding to the extracted components. Secondly, the intermediate indices (weighted proportionally to the components' explained variance) are, in turn, aggregated into a composite index of competitiveness, namely I_{UC}, standardised on a scale from 0 to 100. The second index I_{UC_PNRR}, instead, is calculated by aggregating indicators (weighted with Equal Weighting Method) into

five intermediate indexes corresponding to the Macro-areas of Competitiveness (see Tab.2), then aggregated and weighted proportionally to the resources allocated by the PNRR in each Macro-area.

Macro-area	PNRR resources [billion €]	IUC_PNRR Weightings
Tourism and Culture	6.68	0.05
Ecological Transition	42.31	0.30
Digitalization/Smartness	33.64	0.24
Sustainable Mobility	37.29	0.27
Social Cohesion	19.81	0.14
Total	139.73	1

Tab.2 The weightings assigned to the Macro-areas of Competitiveness according to the PNRR resources

The index I_{UC_PNRR} was corrected considering that 40% of the PNRR's resources were earmarked for Southern Italy in order to overcome the existing socio-economic and territorial gaps.

3. Case study

The case study regards the 14 Italian metropolitan areas (Bari, Bologna, Cagliari, Catania, Florence, Genoa, Messina, Milan, Naples, Palermo, Reggio Calabria, Rome, Turin, Venice), that, for their strategic role, are among the main actors of the Italian competitive development. The software used for these analysis was SPSS.

3.1 Results

The application of the first phase of the methodology produced different results. The first is the identification of urban characteristics suitable to increase the competitiveness of metropolitan areas in the context of the PNRR. The correlation analysis allowed for the identification and the consequent elimination of the redundant variables (T9, E3, E7, D1, D4, D5, M5, M11 – see Tab.1) and the transformation of the dataset into a 53x14 matrix. It is worth emphasizing a strong correlation between the variables of the submatrix "Social Cohesion", which are of fundamental importance for the objectives of the study and cannot be neglected in the subsequent phases (Rogerson, 1999; Güzey, 2009).

Regarding the second phase of the methodology and, specifically, PCA, the first 5 components explain 76.5% of the total variance, a result that can be considered acceptable to explain the structure of the data system. The first component alone explains 36.7% of the total variance, a not very high percentage but that is triple compared to the others. In addition, the variance explained by the second, third, fourth, and fifth components is around 10%, which means that these components other have a comparable weight for urban competitiveness. By analyzing the loadings of the first component, most variables have a positive correlation. Only 3 are inversely correlated.

Considering the variables with higher loadings on the first component (Tab.3a), it is evident that at the top there are highly significant characteristics for urban quality, welfare, and economic performance. Thus, this component can be titled "Quality of life and welfare". Among the 17 most correlated variables 7 belong to the group "Social Cohesion". This might depend on the high correlation ratios, but it is also important to highlight how social aspects are relevant to the competitiveness of Italian metropolitan areas (Kamiya et al., 2022). Looking at the distribution of the cases on this component (Tab.3b), it reflects the substantial disparities existing between the North and the South of the countries, with Milan in the first place, followed by Bologna, Florence, Rome, Turin, Venice, and Genoa. After Genoa, southern cities are arranged in the following order: Cagliari, Bari, Naples, Palermo, Messina, Catania, and Reggio Calabria.

ID	Significant indicators for the I component	Loading
M7	Electric vehicles	0.922
S1	Net migration	0.912
S5	Female employment ratio	0.884
S4	Youth employment rate	0.874
T6	Gyms, pools and spa	0.873
D13	Innovative start-ups	0.855
E12	Energy requalification	0.852
S6	Crime Index	0.831
S2	Foreigners	0.824
D10	Digital Transformation Index	0.789
D8	POS services	0.752
M8	Bike sharing	0.745
E1	Separate waste collection per capita	0.728
M3	Incidence of standard cars emissive	-0.743
S8	Female enterprises	-0.805
E8	Dispersion of the water network	-0.823

(a)

Observed cases	Coordinates in relation to the I component
Milan	2.068
Bologna	1.412
Turin	0.733
Florence	0.566
Genoa	0.444
Venice	0.357
Rome	-0.099
Bari	-0.155
Cagliari	-0.274
Catania	-0.646
Reggio Calabria	-0.921
Naples	-1.002
Palermo	-1.035
Messina	-1.448

(b)

Tab.3 (a) Significant variables for the first component; (b) Coordinates of the observed cases (Metropolitan areas) on the first component

The second component (Tab.4 a and b) records variables that are mostly connected to the cultural development of metropolitan areas, thus it may be titled "Level of education and culture". 17 indicators have an inverse correlation with component 2. Many of them concern the aptitude for digitization including Digital Agenda Funds, Digitalization of viability services, and Innovative start-ups. Although the digital transition and the promotion of culture belong to the same mission of the PNRR, digital and cultural vocations seem to be separated aspects for urban competitiveness.

ID	Significant indicators for the II component	Loading
T1	Number of museums	0.904
T13	Hotel facilities	0.789
D12	Ultra-broadband	0.691
T5	Density and relevance of cultural heritage	0.666
D3	Number of graduates	0.646

(a)

Observed cases	Coordinates in relation to the II component
Rome	2.848
Naples	0.901
Turin	0.684
Florence	0.542
Palermo	-0.028
Bologna	-0.147
Venice	-0.159
Bari	-0.399
Messina	-0.560
Genoa	-0.593
Reggio Calabria	-0.670
Milan	-0.702
Cagliari	-0.736
Catania	-0.981

(b)

Tab.4 (a) Significant variables for the second component; (b) Coordinates of the observed cases (Metropolitan areas) on the second component

The third component (Tab.5 a and b) has a high correlation ratio with just two indicators, namely acquisitions of citizenship and the structural dependency ratio.

This component can be considered a proxy of the "socio-economic fragility" of the metropolitan territory. This interpretation might be confirmed by the positive correlation with the rate of employment of women and youth, foreign population and migration balance, the number of female enterprises, the number of innovative start-ups, and the number of patents.

The variables that do not affect this component, having a correlation close to zero, are the average days of stay of tourists, the foreign tourist arrivals, and the number of gyms, pools and spas, a sign of how the presence of accommodation facilities and tourist-tertiary activities has little influence on these fragile categories.

ID	Significant indicators for the III component	Loading
S9	Acquisitions of citizenship	0.816
S3	Structural dependency ratio	0.669

(a)

Observed cases	Coordinates in relation to the III component
Turin	1.630
Reggio Calabria	0.945
Bologna	0.890
Genoa	0.834
Florence	0.708
Messina	0.317
Palermo	0.166
Venice	0.123
Bari	-0.412
Rome	-0.434
Catania	-0.467
Cagliari	-0.845
Naples	-1.543
Milan	-1.910

(b)

Tab.5 (a) Significant variables for the third component; (b) Coordinates of the observed cases (Metropolitan areas) on the third component

The fourth component (Tab.6 a and b) is highly correlated with the variables pedestrian areas and tourism rate. Other variables positively correlated with this component and with a high loading are the following: the average days of stay of tourists, the density of the bike lanes, the foreign touristic arrivals, and the exchange parking areas. This component is representative of the "touristic usability of the city".

ID	Significant indicators for the IV component	Loading
M10	Pedestrian areas	0.974
T10	Tourists rates	0.963

(a)

Observed cases	Coordinates in relation to the IV component
Venice	3.333
Florence	0.407
Messina	-0.057
Naples	-0.078
Cagliari	-0.136
Bari	-0.157
Catania	-0.183
Palermo	-0.199
Rome	-0.267
Bologna	-0.293
Reggio Calabria	-0.452
Milan	-0.595
Turin	-0.618
Genoa	-0.708

(b)

Tab.6 (a) Significant variables for the fourth component; (b) Coordinates of the observed cases (Metropolitan areas) on the fourth component

ID	Significant indicators for the V component	Loading
E6	Energy from renewable resources	0.868
M6	Public buses	0.777
D11	Digital agenda Funds	0.730

(a)

Observed cases	Coordinates in relation to the V component
Bari	2.163
Cagliari	2.018
Bologna	0.451
Rome	0.411
Turin	0.128
Venice	-0.136
Catania	-0.283
Palermo	-0.376
Reggio Calabria	-0.402
Firenze	-0.422
Genova	-0.646
Messina	-0.846
Naples	-0.935
Milan	-1.127

(b)

Tab.7 (a) Significant variables for the fifth component; (b) Coordinates of the observed cases (Metropolitan areas) on the fifth component

The most significant variables for the fifth component (see Tab.7 a and b) are Energy from renewable sources, Buses used for local public transport, and Digital Agenda Funds. Other positively correlated variables are energy from photovoltaic systems, the digitalization of road services, the incidence of green urban areas, and the dispersion of the water network. This component can be titled "Energy and digital transition".
The application of the Hierarchical Cluster analysis produced the following dendrograms, which add information on the vocations shared by different metropolitan areas.

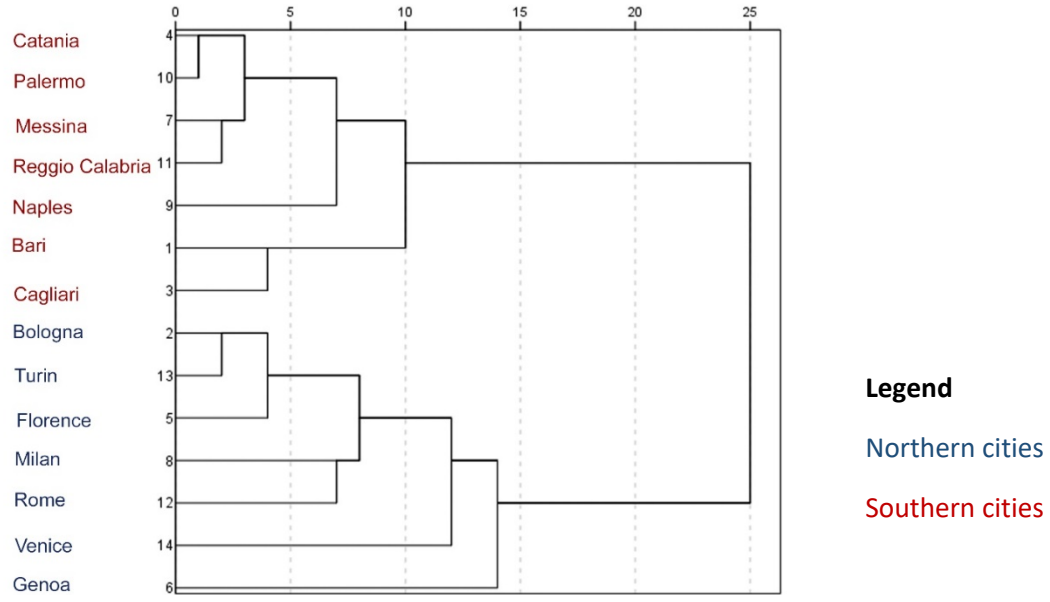
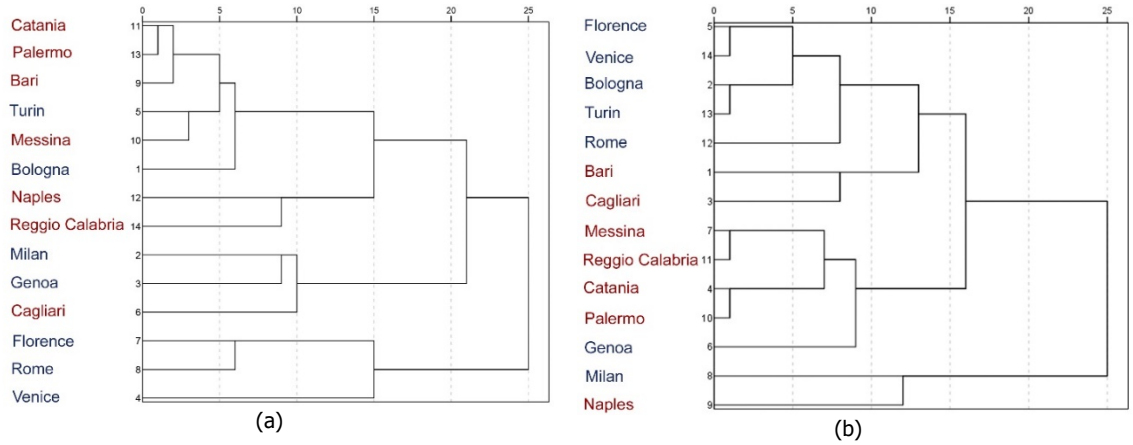


Fig.2 Dendrogram from the cluster analysis relative to the entire database

In these dendrograms (Figg. 2 and 3) Northern cities were reported in blue, whilst Southern cities in red. The dendrogram obtained from the whole dataset (Fig.2) is in line with the distribution of the cases on the first component, showing a net distinction between the cities of the North and the South, which cluster at a high distance.
The second dendrogram (Fig.3a) refers to the sub-matrix Tourism and culture. The first bifurcation highlights a cluster made up of Florence, Rome, and Venice, and a second cluster, made up of Catania, Palermo, Bari, and Messina. Milan, Genoa, and Cagliari seem to create another cluster. Looking at the dendrogram of the ecological transition and that of digitalization/smartness (Figg. 3b and 3c), there is a significant homogeneity. The dendrogram relative to sustainable mobility (Fig.3d) sees a subdivision between Bologna, Florence, Milan, and Venice with other cities. Finally, the dendrogram on Social Cohesion (Fig.3e) reflects the trend of the dendrogram relative to the whole dataset (Fig.2).



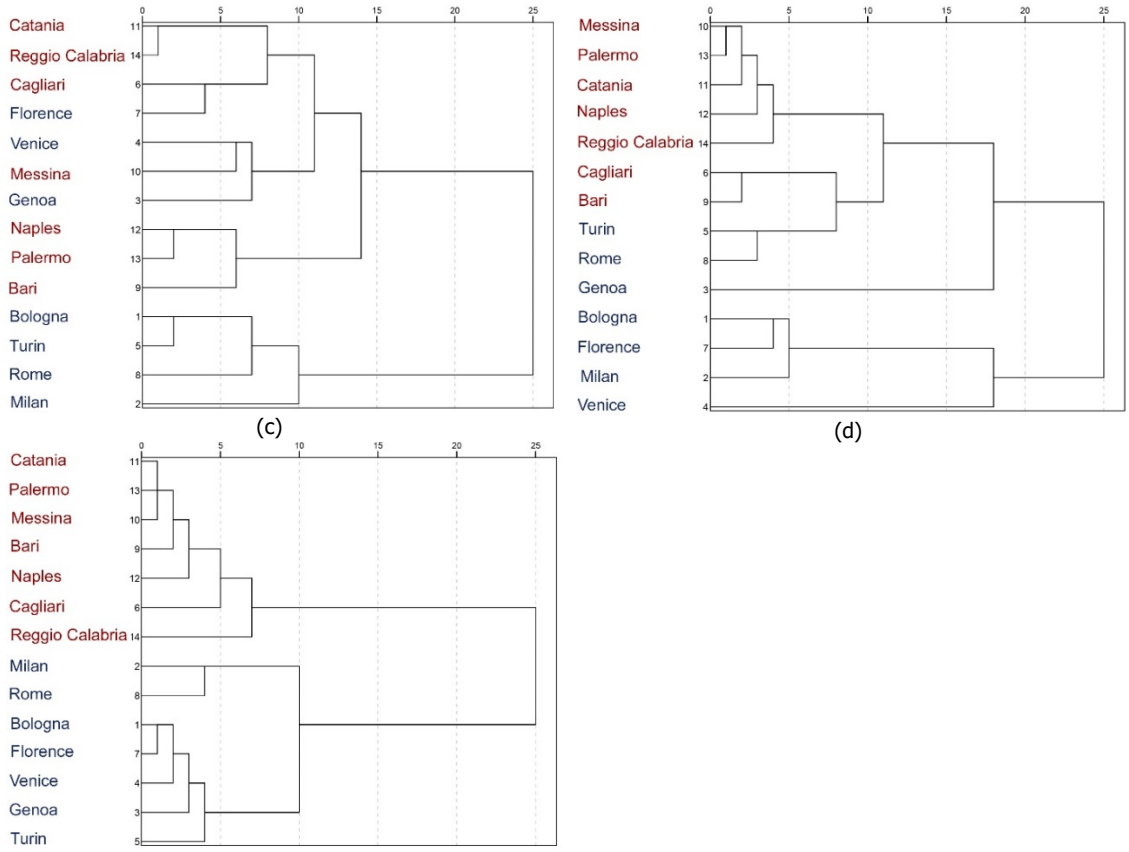


Fig.3 Dendrogram from the cluster analysis relative to the macro-areas: (a) Tourism and culture (b) Ecological transition (c) Digitalization/smartness (d) Sustainable mobility (e) Inclusion and cohesion

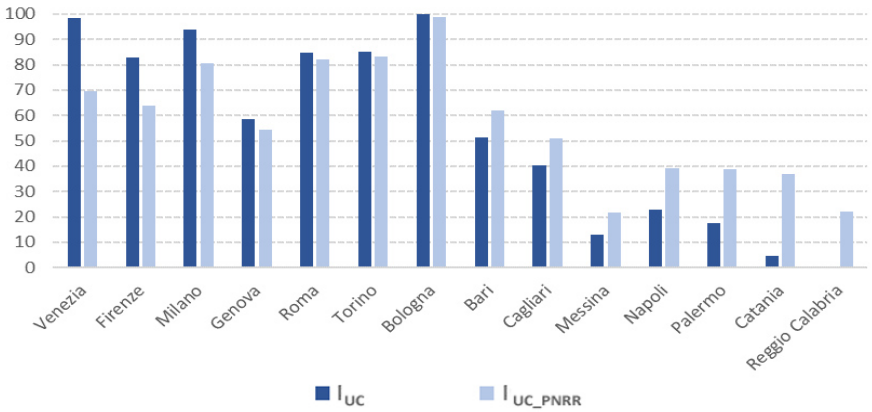


Fig.4 Comparison between the two indexes of competitiveness, one (IUC) resulting from the application of the methodology and the second (IUC_PNRR) based on the PNRR resources distribution.

For the third part of the methodology, two indexes of competitiveness were built and compared. The first index I_{UC} is representative of the potential of competitiveness and is calibrated through the PCA, by utilizing the weight assumed by metropolitan areas' distinctive characteristics. On the other hand, the second index I_{UC_PNRR} measures competitiveness by taking into account the weight assigned by the PNRR investments to the Macro-areas of competitiveness. The comparison between the two indices is fundamental for understanding the difference between the intrinsic vocations of metropolitan areas and the actual distribution of economic resources defined by the plan's investments. Figg. 4 and 5 show a substantial deviation between the two indexes, especially for southern cities, which received a greater boost from the plan than their actual competitive potential. On the other hand, while cities like Rome, Turin and Bologna present fairly aligned performances, cities like Venice and Florence have not received enough impetus from the plan despite their

high competitive potential. Regarding the reliability of the method, a high Cronbach alpha coefficient was obtained for all the components (Tab.8).

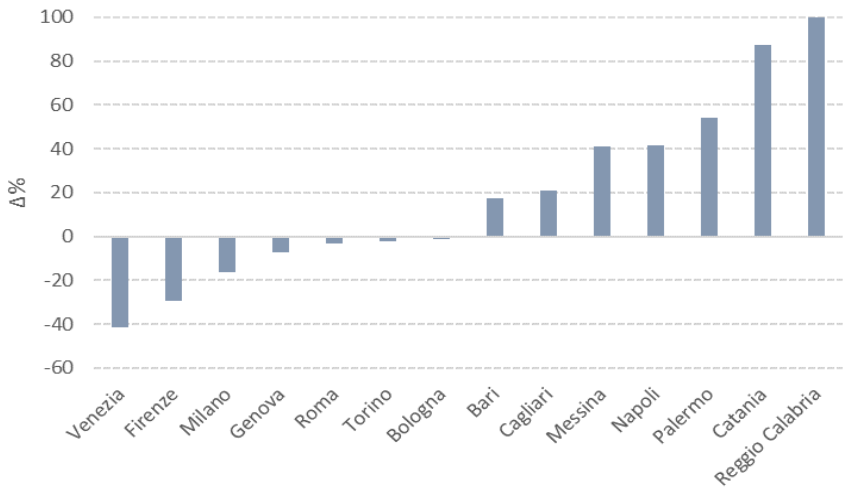


Fig.5 Difference between IUC and IUC_PNRR

Component	Cronbach alpha
1	0.913
2	0.884
3	0.914
4	0.988
5	0.860

Tab.8 Cronbach alpha test results

4. Discussion

In this section, a comparison between the results of the analyses and the interventions activated by the PNRR is proposed. In particular, this section discusses relationships between metropolitan competitive assets, emerged from explorative analyses, and the main strategies and projects promoted within the 14 Italian metropolitan areas. Tab.9 facilitates this comparison by showing, for each metropolitan area, the objectives of the activated projects and the assets of competitiveness identified in this research.

Metropolitan area	PNRR projects' main objectives	Assets of competitiveness identified by the analyses
Bari	Environmental sustainability, sustainable mobility, enhancement of identity places, urban/economic regeneration.	Green and Digital transition
Bologna	Ecological transition, combating climate change, reducing inequalities, promoting knowledge/research.	Social cohesion and quality of life, green and digital transition
Cagliari	Sustainable mobility, green revolution and valorisation of local production capacities.	Green transition and sustainable mobility
Catania	Creation of green spaces and public buildings, enhancement of pedestrian and cycle mobility.	Green transition
Firenze	Territorial regeneration, increased provision of services, greater territorial cohesion.	Tourism, cultural development, social cohesion and quality of life
Genova	Environmental protection, improved public transport, urban regeneration and ecological transition.	Social cohesion
Messina	Regeneration of public spaces, heritage enhancement, social inclusion and rehabilitation of squatter settlements, optimisation of resources.	Dealing with Social fragility

Milano	Sustainable mobility and accessibility, school rehabilitation, urban forestation, inclusive spaces and services, combating climate change.	Digital transition, quality of life, social cohesion
Napoli	Territorial cohesion, social inclusion and sustainable mobility.	Tourism, cultural development, Social cohesion
Palermo	Urban regeneration, sustainable economic revitalisation, renovation and re-functionalisation of the built environment, energy efficiency/transport.	Dealing with Social fragility
Reggio Calabria	Urban regeneration, improvement of urban and social infrastructure, enhancement of environmental resources.	Dealing with Social fragility
Roma	Sustainable mobility, urban regeneration, enhancement of the cultural/tourist system, valorisation of historic villages.	Tourism, cultural development, sustainable mobility, green and digital transition
Turin	Inclusion and social cohesion, school building improvement, soil conservation and urban forestation.	Tourism, cultural development, quality of life, dealing with social fragilities
Venice	Urban and suburban forestation, improving housing quality, regeneration and inclusion.	Tourism, sustainable mobility

Tab.9 Comparison between PNRR projects' main objectives and the assets of competitiveness emerged from the analysis for the 14 Italian metropolitan areas

By looking at the results of the analyses, the main factor that appears to influence most urban competitiveness of Italian metropolitan areas is their level of quality of life and welfare. Particularly, the availability of urban services and accessibility to key amenities along with the quality of the urban environment determine greater attractiveness for people, investments, and businesses. Social inclusion factors contribute to heightening the level of competitiveness by overcoming territorial disparities and reducing vulnerabilities of degraded areas. Furthermore, the "quality of life" component relates to environmental and sustainability characteristics as well as economic dynamism and innovation ability. The combination of different variables of a social, economic, and environmental nature highlights the multidimensionality and complexity of the contemporary notion of urban competitiveness. On the other hand, an interesting finding is that urban well-being does not receive sufficient impetus from the digitization and tourism sectors, which appear to be separate competitive sectors, still influencing urban competitiveness but in a different way. These sectors cannot be considered drivers of the liveability of urban areas, although they are important for the creation of new jobs and occupation opportunities. Also, it is worth noting from the analysis that quality and economic well-being does not always go hand in hand with justice and security, since many metropolitan areas with a high quality of life have a high crime rate. The group of the northern cities is characterized by higher levels of quality of life and urban quality, a more active labor market, and higher levels of education and competences. Southern cities are disadvantaged in many fields, suffering from the lack of consolidated governance systems, lower incomes, lower levels of education, poor dynamics in the work environment, diffuse fragilities of the urban structure, and degradation of the built environment. Specifically, Catania, Palermo, Messina, and Reggio Calabria constitute a separate group, resulting less competitive in terms of quality of life and overall supply of services and facilities. This may be caused, *inter alia*, by territorial marginalization and scarce accessibility due to their geographical location (three out of the four cities are insular cities). Although there is not a specific field of investment aiming at improving quality of life in cities, many projects funded by the PNRR embed this goal. The Florence plan "Sport and well-being" and the Venice project "Più sprint" are an example since they are dedicated to the promotion of wellness and physical activities through the empowerment of urban facilities and cyclo-pedestrian networks. The city of Rome invested in sustainable mobility and public infrastructure, as well. Many southern cities proposed projects for the improvement of green infrastructure, public transport and urban services (e.g., Catania, Reggio Calabria and Naples).

Another important factor of urban competitiveness identified by this study is cultural development. The availability of cultural amenities such as museums and libraries and the relevance of cultural heritage, firstly, has the potential of increasing the number of opportunities for the city's inhabitants. Secondly, it contributes to tourist attractiveness and gives shape to the city's historical and cultural identity, making it internationally

recognizable (Sinniah et al., 2014). Looking at the case studies, in cities with a prevalent cultural vocation, the historical, architectural, artistic, and landscape heritage can be the starting point for competitive growth. Tourism can be one outlet since it is able to trigger competitive processes through the creation of new commercial, accommodation, leisure, and cultural activities (La Rocca, 2015). Also, promoting cultural activities in urban areas has the positive side effect of attracting not only tourists but also new residents, skills, and creativeness that can enrich the urban human capital with increased competitiveness in the creative industry, know-how, and skilled economy. Florence, Rome, and Venice are tourist cities par excellence, thanks to their historic, architectural, and artistic heritage but also the consolidated cultural supply and the high quality of the urban environment. They are also the most sought-after destinations by foreigners and, indeed, they are characterized by significant tourist accommodation. Catania, Palermo, Bari, and Messina are homogeneous in being seaside destinations. Milan and Geona can be considered big cities with multidimensional tourism (which embraces different branches of tourism) whilst Cagliari and Naples are cities with a seaside destination vocation and with a rich cultural, historical, and artistic heritage (ISTAT, 2017). Bologna is a polycentric destination, combining innovative city stays with tours, culture, markets, shopping, nature, and gastronomic tourism.

It is worth emphasizing that, although tourism and culture are among the main assets of Italian metropolitan areas, PNRR dedicates little resources to the enhancement of this sector in big metropolitan attractors. Instead, many of the allocated resources are reserved for the enhancement of small villages, to tackle depopulation processes and redistribute tourist flows also towards less known destinations. The only project deliberately oriented in this direction, is "Caput Mundi" for the metropolitan area of Rome.

Along with these aspects, touristic competitiveness is influenced by the physical and functional predisposition to support tourists' travels within the city (walking, cycling, presence of exchange parking areas, and so on). As was expected, Venice distinguishes itself due to its incomparable touristic attractiveness at the international level and the high level of walkability in the city center. Similarly, Florence and Naples count on great tourist flows and benefit from recent interventions to improve the accessibility of historical centre and cultural heritage.

Socio-economic fragility emerged as another aspect to pay attention to. Decision-makers should watch out the labor supply for the foreign population, and the dynamic and multicultural characterization of the metropolitan area, in order to guarantee the integration of ethnic minorities within the urban community and make it a strength more than a weakness for the city's competitiveness. Also, population categories characterized by social fragilities – such as the elderly or youth – may, on the one hand, weaken the economic structure of the system, or, on the other hand, constitute a resource for new revenue streams throughout the opening up of new economic activities such as reception or healthcare. The most significant cases for this component (see Tab.5b) are Turin, Reggio Calabria, and Bologna, while Milan and Naples (together with Cagliari, Catania, Rome, and Bari) seem to be on the opposite side. Milan and Rome stay alone, being great centers of attraction for foreigners, young people, and new enterprises, counting on more mature and long-lasting social dynamics. The South of the country presents substantial shortcomings if compared with the other cities. Catania, Palermo, and Messina are very close to each other reflecting a situation of social marginalization and lack of territorial cohesion in Sicily. Instead, regarding the investments effectively activated by the PNRR to reduce social marginalization, Bologna and Florence seem to go hand in hand, thanks to the investments to increase social cohesion and reduce inequalities. Many southern cities have activated projects to reduce marginalization in degraded districts (e.g., Catania with the Redevelopment plan of San Berillo), revitalize social fabric (e.g., Bari with the project "Identità è Comunità" and the regeneration plans for many degraded districts), favour social inclusion (e.g., the cases of Messina, Reggio Calabria, and Palermo).

The last sector in which Italian cities are called upon to compete, according to the analyses, is linked to the energy and digital performance of urban systems and transport systems, concerning the dual transition (digital and ecological) that cities are experiencing to adapt to international sustainability and smartness targets (Lin

& Wang, 2019). According to the analysis, cities more suitable to grow in digital and green sectors are, Bari, Cagliari, Bologna, and Rome. Milan owes its strength to the digitalization of infrastructure, the competencies of the citizens, and the availability and accessibility of online services. In the ecological transition dendrogram, there is still a remarkable division between the North and the South, with Catania, Palermo, Messina, and Reggio Calabria composing a separate cluster, due to the delay in the transition to more sustainable forms of development. Cities in the South continue to lag in environmental performance because of air pollution, water loss, inefficient mobility, lack of public transport, and inadequate waste collection and show a clear lag in digital transformation. Bari is the only exception: thanks to the most recent initiatives and investments in the fields of green energy and ecological redevelopment, it is the first city to regroup with the first ones ranked in the field, and more tangible results are still expected. Rome appears together with Turin, Milan, and Bologna in the digitalization sector. Regarding the PNRR investments for dual transition (green and digital), Bari distinguishes for its project "Verde Metropolitano", that aims at improving environmental sustainability, sustainable mobility, and ecological performances. Cagliari and Catania invest in sustainable mobility (especially cycling and walking) and green revolution (new green areas, adaptation of public buildings, green networks). Genoa includes green transition among its future lines of development. Venice, Turin, and Milan promote urban reforestation and sustainable mobility, with Milan also promoting a plan for climate change adaptation. Palermo and Reggio Calabria claim for the optimization of energy and natural resources. By and large, green transition has been much more driving than digital transition in the allocation of PNRR resources. Yet, this study has highlighted how the two transitions should have been considered linked to each other, especially if we look at the results of metropolitan areas' competitive potential.

In conclusion, many cities have proposed solutions and projects aimed at enhancing the territory's resources and vocations while increasing social resilience, especially in the most problematic urban realities. It is the case of Bari, which has focused on ecological transition, promoting the sustainable use of resources, and renewable energy, along with greening interventions for the redevelopment of the urban, social and economic fabric. Other cities are on an already advanced and mature path in terms of ecological-digital transition (Bologna, Florence, Milan), focusing on further improving urban liveability (accessibility, equity, quality of urban space, services, adaptation to climate change) and economic-employment opportunities (innovation, digitalization) in order to attract new people, skills and investment. Touristic cities (e.g. Venice and Rome), where tourism already constitutes a resource, have proposed interventions to improve citizens' quality of life and accessibility to services. In southern metropolitan areas, urban regeneration projects and eco-sustainable building redevelopment prevail. In this sense, the regeneration plans proposed in Southern cities may have the dual effect of improving the quality of urban space and life and activating new competitive processes. This is in line with one of the declared objectives of the PNRR, i.e., increase territorial cohesion between the north and south of the country, reducing the social and economic gap that currently exists. In this sense, the regeneration plans proposed in southern Italy could have the dual effect of improving the quality of life and urban space while activating new competitive processes.

5. Conclusions

In the globalizing world economy - that has characterized the end of the last century and the first decades of the new millennium - cities are the principal sources of social, economic, and technological development (Yun & Nam, 2021; Komasi et al., 2022) since they offer high-quality spaces for people where to live and supply investors and firms with a dynamic environment in which to perform (Sáez et al., 2017). Given the many challenges that cities are called upon to face in the coming years - climate change, social inequalities, health emergencies, increased demand for travel, energetic transition, and so on - this key position of urban systems is expected to evolve: the long-term impact of these phenomena is inevitable and it can represent both a threat and an opportunity for the systems involved, to the extent that they are able to renew their degree of

development and react to the external agents by increasing their resilience/competitiveness. Thus, drawing up urban policies in this direction is fundamental to ensure resilient responses to the crisis while turning threats into development opportunities. It is necessary to understand where to invest and what are the priorities of interventions.

In this view, this contribution considered the resources provided by the European Union in the post-covid recovery era, and the fundings provided by the Italian PNRR as a likely pool for urban competitiveness, comparing the main sectors of investment with the vocations and competitive potential of Italian metropolitan areas. In other words, the analytical results have been interpreted with the aim of verifying if the strategies of development activated within the PNRR are consistent with the intrinsic potential of the Italian metropolitan areas, and, thus, can increase their urban competitiveness. Although the PNRR does not operate directly on territorial and urban development, it recognizes the importance of managing future challenges with an integrated, coherent, and comprehensive approach involving all sectors, administrative levels, and the different parts of the territory (Li, 2019).

The proposed comparison between the characteristics of 14 Italian metropolitan areas and the identified Macro-areas of Competitiveness, through multivariate statistical analysis, allows for verifying where it is worth investing in the future to achieve a significant increase in competitiveness. Among the main findings, it emerged that quality of life has become the main driver for urban competitiveness for Italian cities. Furthermore, the evidence from the analyses suggests that investments for green transition and digital transition should be strongly linked, while, differently from the organization of the PNRR, digitalization and tourism are on separate stages.

Furthermore, the comparison of the two indexes of competitiveness highlighted a non-negligible deviation between the PNRR distribution of resources and the actual competitive potential of metropolitan areas. It emerged a substantial division between the Northern and the Southern Italian cities, which is the sign of a recognized and dramatically known quality crisis in the cities of the South that show productive, functional, and quality marginalization (Daniele, 2021). The deviation of the two indexes is certainly a reflection of one of the main PNRR line of intervention that, responding to the European Union demands, focuses on the necessity to support disadvantaged cities in overcoming their shortcomings (Boczy et al., 2020). Nevertheless, it is the author's belief that it is also necessary to work on the already existing potentialities and vocations of territories. Many cities are already growing along specific development trajectories, proposing solutions and projects to enhance the urban resources while increasing resilience, especially in the most problematic urban contexts.

Although its limitations, this work may contribute to the monitoring of the PNRR coming results. Future developments of this work may regard the verification of consistency between investment choices and the potential to competition of urban areas, considering the progressive advancement of the interventions and the consequent changes in the set of indicators, so as to support decision-makers in the choices of investment/intervention to increase the competitiveness of urban areas by investing the resources of the plan. Furthermore, the authors are working on the application of the method to single case studies and to different territorial scales (urban and neighborhood scales) with the aim of suggesting more nuanced and tailored strategies of intervention to increase urban competitiveness. Another future development of this work will regard the behavioural side of the social sphere, which characterize the multiform shapes of upcoming competitive communities.

Appendix

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
T1	1	0.170	0.367	0.375	0.487	0.304	0.232	-0.153	0.093	-0.068	0.482	0.043	0.679
T2	0.170	1	0.413	0.469	-0.245	0.238	0.491	-0.180	-0.209	0.026	0.269	-0.039	-0.137
T3	0.367	0.413	1	0.233	0.223	0.539	0.314	-0.673	0.492	0.462	0.567	0.225	0.54
T4	0.375	0.469	0.233	1	0.018	0.297	0.192	-0.118	-0.387	-0.372	0.130	-0.527	-0.090
T5	0.487	-0.245	0.223	0.018	1	0.325	-0.035	-0.182	0.511	0.013	0.334	0.321	0.727
T6	0.304	0.238	0.539	0.297	0.325	1	0.477	-0.390	0.290	0.055	0.574	-0.382	0.345
T7	0.232	0.491	0.314	0.192	-0.035	0.477	1	-0.333	0.140	0.218	0.658	-0.172	0.217
T8	-0.153	-0.180	-0.673	-0.118	-0.182	-0.390	-0.333	1	-0.269	-0.165	-0.425	-0.210	-0.290
T9	0.093	-0.209	0.492	-0.387	0.511	0.290	0.140	-0.269	1	0.835	0.658	0.548	0.739
T10	-0.068	0.026	0.462	-0.372	0.013	0.055	0.218	-0.165	0.835	1	0.604	0.537	0.449
T11	0.482	0.269	0.567	0.130	0.334	0.574	0.658	-0.425	0.658	0.604	1	0.144	0.681
T12	0.043	-0.039	0.225	-0.527	0.321	-0.382	-0.172	-0.210	0.548	0.537	0.144	1	0.436
T13	0.679	-0.137	0.54	-0.090	0.727	0.345	0.217	-0.290	0.739	0.449	0.681	0.436	1

Tab.10 Correlation matrix for the submatrix Tourism and Culture

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	1	-0.414	0.762	0.255	0.223	0.261	0.356	-0.502	-0.255	0.227	0.395	0.637	0.146	-0.148
E2	-0.414	1	0.038	-0.085	-0.010	-0.090	-0.179	0.346	-0.062	-0.231	0.125	-0.181	-0.033	-0.007
E3	0.762	0.038	1	0.188	0.122	-0.002	0.219	-0.330	-0.234	0.299	0.444	0.530	-0.207	-0.007
E4	0.255	-0.085	0.188	1	0.409	-0.377	0.937	-0.638	-0.254	0.378	0.538	0.495	-0.084	-0.184
E5	0.223	-0.010	0.122	0.409	1	0.555	0.523	-0.087	0.018	0.228	0.365	0.104	0.270	0.284
E6	0.261	-0.090	-0.002	-0.377	0.555	1	-0.232	0.254	0.049	-0.158	-0.075	-0.080	0.57	0.457
E7	0.356	-0.179	0.219	0.937	0.523	-0.232	1	-0.75	-0.298	0.340	0.708	0.533	-0.112	-0.152
E8	-0.502	0.346	-0.330	-0.638	-0.087	0.254	-0.75	1	0.256	-0.195	-0.73	-0.746	0.339	0.009
E9	-0.255	-0.062	-0.234	-0.254	0.018	0.049	-0.298	0.256	1	0.025	-0.454	-0.196	-0.306	0.006
E10	0.227	-0.231	0.299	0.378	0.228	-0.158	0.340	-0.195	0.025	1	0.121	0.152	0.003	0.013
E11	0.395	0.125	0.444	0.538	0.365	-0.075	0.708	-0.73	-0.454	0.121	1	0.609	-0.169	0.160
E12	0.637	-0.181	0.530	0.495	0.104	-0.080	0.533	-0.746	-0.196	0.152	0.609	1	-0.207	-0.017
E13	0.146	-0.033	-0.207	-0.084	0.270	0.57	-0.112	0.339	-0.306	0.003	-0.169	-0.207	1	0.454
E14	-0.148	-0.007	-0.007	-0.184	0.284	0.457	-0.152	0.009	0.006	0.013	0.160	-0.107	0.454	1

Tab.11 Correlation matrix for the submatrix Ecological Transition

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13
D1	1	0.026	0.806	0.66	0.403	0.500	0.423	0.270	0.286	0.254	-0.317	0.616	-0.087
D2	0.026	1	0.304	0.337	0.397	0.304	0.017	0.315	0.429	0.397	-0.339	0.300	0.474
D3	0.806	0.304	1	0.913	0.781	0.704	0.440	0.614	0.329	0.55	-0.402	0.627	0.409
D4	0.66	0.337	0.913	1	0.718	0.847	0.256	0.614	0.227	0.702	-0.408	0.544	0.386
D5	0.403	0.397	0.781	0.718	1	0.501	0.291	0.824	0.049	0.701	-0.359	0.422	0.717

D6	0.500	0.304	0.704	0.847	0.501	1	0.010	0.312	0.250	0.569	-0.138	0.414	0.401
D7	0.423	0.017	0.440	0.256	0.291	0.010	1	-0.080	0.067	0.171	-0.068	0.441	0.077
D8	0.270	0.315	0.614	0.614	0.824	0.312	-0.080	1	0.139	0.656	-0.479	0.257	0.553
D9	0.286	0.429	0.329	0.227	0.049	0.250	0.067	0.139	1	0.183	-0.073	0.464	0.154
D10	0.254	0.397	0.55	0.702	0.701	0.569	0.171	0.656	0.183	1	-0.253	0.480	0.503
D11	-0.317	-0.339	-0.402	-0.408	-0.359	-0.138	-0.068	-0.479	-0.073	-0.253	1	-0.073	-0.252
D12	0.616	0.300	0.627	0.544	0.422	0.414	0.441	0.257	0.464	0.480	-0.073	1	0.068
D13	-0.087	0.474	0.409	0.386	0.717	0.401	0.077	0.553	0.154	0.503	-0.252	0.068	1

Tab.12 Correlation matrix for the submatrix Digitalization/smartness

	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
M1	1	-0.221	0.084	0.105	-0.248	0.408	-0.348	-0.734	-0.243	-0.059	-0.648
M2	-0.221	1	-0.355	-0.250	0.591	0.124	0.194	0.067	0.547	0.585	0.287
M3	0.084	-0.355	1	-0.547	-0.669	0.112	-0.745	-0.515	-0.743	-0.387	-0.504
M4	0.105	-0.250	-0.547	1	0.271	-0.435	0.551	0.372	0.122	-0.072	0.254
M5	-0.248	0.591	-0.669	0.271	1	-0.319	0.651	0.348	0.661	0.77	0.435
M6	0.408	0.124	0.112	-0.435	-0.319	1	-0.384	-0.530	-0.093	-0.092	-0.387
M7	-0.348	0.194	-0.745	0.551	0.651	-0.384	1	0.685	0.59	0.091	0.697
M8	-0.734	0.067	-0.515	0.372	0.348	-0.530	0.685	1	0.457	-0.041	0.858
M9	-0.243	0.547	-0.743	0.122	0.661	-0.093	0.59	0.457	1	0.579	0.300
M10	-0.059	0.585	-0.387	-0.072	0.77	-0.092	0.091	-0.041	0.579	1	-0.072
M11	-0.648	0.287	-0.504	0.254	0.435	-0.387	0.697	0.858	0.300	-0.072	1

Tab.13 Correlation matrix for the submatrix Sustainable mobility

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
S1	1	0.756	0.490	0.855	0.915	0.727	0.754	0.701	-0.775	0.342
S2	0.756	1	0.559	0.861	0.848	0.826	0.866	0.529	-0.696	0.464
S3	0.490	0.559	1	0.591	0.62	0.443	0.434	0.052	-0.288	0.842
S4	0.855	0.861	0.591	1	0.919	0.689	0.747	0.491	-0.749	0.54
S5	0.915	0.848	0.62	0.919	1	0.692	0.749	0.642	-0.676	0.527
S6	0.727	0.826	0.443	0.689	0.692	1	0.973	0.471	-0.729	0.409
S7	0.754	0.866	0.434	0.747	0.749	0.973	1	0.534	-0.757	0.407
S8	0.701	0.529	0.052	0.491	0.642	0.471	0.534	1	-0.678	-0.261
S9	-0.775	-0.696	-0.288	-0.749	-0.676	-0.729	-0.757	-0.678	1	-0.092
S10	0.342	0.464	0.842	0.54	0.527	0.409	0.407	-0.261	-0.092	1

Tab.14 Correlation matrix for the submatrix Social Inclusion

References

Annoni, P. & Kozovska, K. (2010) EURegional Competitiveness Index 2010 European Commission, Joint Research Centre, EUR 24346. https://doi.org/10.2788/88040

Bănică, A., Corodescu-Roșca, E., Kourtit, K. & Nijkamp, P. (2022) Threats and Opportunities for Global Cities–A Comparative Study of Resilience, Sustainability and Liveability. *Sustainability and Liveability*.

Blakely, E. J., Hu, R., Blakely, E. J. & Hu, R. (2019). Australian Cities in Competition. Crafting Innovative Places for Australia's *Knowledge Economy*, 51-83.

Boczy, T., Cefalo, R., Parma, A., Nielsen, R.S. (2020). Positioning the Urban in the Global Knowledge Economy: Increasing Competitiveness or Inequality in Aarhus, Milan and Vienna. *Social inclusion, 8*(4), 194-207. https://doi.org/10.17645/si.v8i4.3332

Burlina, C., Casadei, P. & Crociata, A. (2022). Economic complexity and firm performance in the cultural and creative sector: Evidence from Italian provinces. *European Urban and Regional Studies*, 09697764221125336. https://doi.org/10.1177/09697764221125336

Camagni, R. (2002). On the concept of territorial competitiveness: sound or misleading?. *Urban studies, 39*(13), 2395-2411, https://doi.org/10.1080/0042098022000027022

Capasso, S. & Mazzeo, G. (2020). Health emergency and economic and territorial implications. First considerations. *TeMA - Journal of Land Use, Mobility and Environment*, 45-58. https://doi.org/10.6092/1970-9870/6866

Carrera Portugal, A. (2019). The role of city rankings in local public policy design: Urban competitiveness and economic press. *Global Media and China, 4* (2), 162-178. https://doi.org/10.1177/2059436419853892

Činčikaitė, R.; Meidutė-Kavaliauskienė, I. An Integrated Assessment of the Competitiveness of a Sustainable City within the Context of the COVID-19 Impact. *Sustainability* 2022, 14, 7575. https://doi.org/10.3390/su14137575

Daniele, V. (2021). Territorial disparities in labour productivity, wages and prices in Italy: What does the data show? *European Urban and Regional Studies, 28*(4), 431–449. https://doi.org/10.1177/09697764211020057

Drobniak, A. (2012). The urban resilience–economic perspective. *Journal of Economics and Management*, 10, 5-20.

Economist Intelligence Unit (2022). The Global Liveability Index 2021 How the Covid-19 pandemic affected liveability worldwide. Retrieved from: https://www.eiu.com/n/campaigns/global-liveability-index-2021/ (accessed 10 September 2022)

Encarnacion, R.H.; Magnaye, D.C.; Castro, A.G.M. Spatial Analysis of Local Competitiveness: Relationship of Economic Dynamism of Cities and Municipalities in Major Regional Metropolitan Areas in the Philippines. *Sustainability* 2023, 15, 950. https://doi.org/10.3390/su15020950

European Commission (2021). Next Generation EU. Retrieved from: https://ec.europa.eu/info/strategy/recovery-plan-europe_en#nextgenerationeu (accessed 20 January 2023)

Fistola, R. (1988). *Area metropolitana metodologie di definizione: un esempio*. DOCT, Atena, Napoli.

Gargiulo, C., Guida, N., Sgambati, S. (2022). NextGenerationEU in major Italian cities. *TeMA - Journal of Land Use, Mobility and Environment, 15* (2), 287-305. https://doi.org/10.6093/1970-9870/9260

Ghahremani, H., Afsari Bajestani, S., McCarthy, L. & Jalalianhosseini, M. (2021). Transformation of urban spaces within cities in the context of globalization and urban competitiveness. *Journal of Urban Planning and Development, 147*(3), 05021026.

Governo Italiano (2021). Italia Domani – Piano Nazionale di Ripresa e Resilienza. Retrieved from: https://www.governo.it/sites/governo.it/files/PNRR.pdf (accessed 7 April 2023)

Granberg, M. & Nyberg, L. (2017). Climate change adaptation, city competitiveness and urban planning in the city of Karlstad, Sweden. In *Local action on climate change* (pp. 111-125). Routledge.

Guida, C. & Caglioni, M. (2020). Urban accessibility: the paradox, the paradigms and the measures. A scientific review. *TeMA - Journal of Land Use, Mobility and Environment, 13*(2), 149-168. https://doi.org/10.6092/1970-9870/6743

Güzey, Ö. (2009). Urban regeneration and increased competitive power: Ankara in an era of globalization. *Cities, 26*(1), 27-37, https://doi.org/10.1016/j.cities.2008.11.006OECD

Höjer, M. & Wangel, J. (2015). Smart sustainable cities: definition and challenges. In *ICT innovations for sustainability* (pp. 333-349). Springer International Publishing.

Hu, R. Sustainability and Competitiveness in Australian Cities. *Sustainability* 2015, 7, 1840-1860. https://doi.org/10.3390/su7021840

Jakobsen, S.-E., Uyarra, E., Njøs, R. & Fløysand, A. (2022). Policy action for green restructuring in specialized industrial regions. *European Urban and Regional Studies, 29*(3), 312–331. https://doi.org/10.1177/09697764211049116

Kamiya, M., Scuderi, R. & Tesoriere, G. (2022). Municipal finance, density, and economic development. Empirical evidence from a global sample of cities. *TeMA - Journal of Land Use, Mobility and Environment, 15*(1), 49-65. https://doi.org/10.6093/1970-9870/8298

Komasi, H.; Hashemkhani Zolfani, S.; Prentkovskis, O.; Skačkauskas, P. Urban Competitiveness: Identification and Analysis of Sustainable Key Drivers (A Case Study in Iran). *Sustainability* 2022, 14, 7844. https://doi.org/10.3390/su14137844

Kunzmann, K. R. (2020). Smart cities after covid-19: Ten narratives. *disP-The Planning Review, 56*(2), 20-31.

Kutty, A. A., Wakjira, T. G., Kucukvar, M., Abdella, G. M. & Onat, N. C. (2022). Urban resilience and livability performance of European smart cities: A novel machine learning approach. *Journal of Cleaner Production*, 378, 134203.

La Rocca, R. A. (2015). Tourism and Mobility. Best Practices and Conditions to Improve Urban Livability. *TeMA - Journal of Land Use, Mobility and Environment, 8*(3), 311-330. https://doi.org/10.6092/1970-9870/3645

Li, B. (2019). Research on Municipal Financing Based on Linear Regression to Promote Urban Competitiveness. In 2019 *International Conference on Economic Management and Model Engineering* (ICEMME), 394-398. IEEE. DOI: https://doi.org/10.1109/ICEMME49371.2019.00086

Lin, X. & Wang, Y. (2019). Measuring Resource, Environmental, and Economic Efficiency of China's Urban Agglomerations Based on Hybrid Directional Distance Function. *Journal of Urban Planning and Development, 145*(3), 05019011.

Longsheng, C. & Shah, S. A. A. (2022). Smarter and Greener Cities After COVID-19: An Integrated Decision-Making Framework to Prioritize Investment Alternatives. *Advanced Sustainable Systems, 6*(9), 2200166.

Mazzeo, G. (2011). Campania: Territory and City in front of the Challenge of Logistics. *TeMA - Journal of Land Use, Mobility and Environment,* 3. https://doi.org/10.6092/1970-9870/493

Mondschein, J., Clark-Ginsberg, A. & Kuehn, A. (2021). Smart cities as large technological systems: Overcoming organizational challenges in smart cities through collective action. *Sustainable Cities and Society*, 67, 102730.

Nasi, G., Choi, H., Cucciniello, M., Christensen, R. K. (2022). A systematic literature review of city competitiveness: A 30-year assessment and future agenda for public administration. *Public Management Review*, 1-25. https://doi.org/10.1080/14719037.2022.2029550

Ni, P., Kamiya, M., Shen, J., Gong, W. (2021). Global Urban Competitiveness Ranking 2018-2019. In *Global Industry Chains: Creating a Networked City Planet*, 1-32. Springer, Singapore. https://doi.org/10.1007/978-981-16-2058-4_1

Openpolis (2022). Le risorse del Pnrr nei territori, tra aggiornamenti e carenze di dati. Retrieved from: https://www.openpolis.it/rassegnastampa/le-citta-metropolitane-e-i-fondi-del-pnrr/

Papa, R., Gargiulo, C., Franco, S., Russo, L. (2014). The Impacts of the 2008-09 Financial Crisis on Urban Competitiveness in Italy, *Journal of Economy, Business and Financing*, ISSN 1339-3723, Vol. 2, issue 1, 84-89.

Picek, O. (2020). Spillover effects from next generation EU. *Intereconomics, 55*(5), 325-331.

Pino, G., Guido, G., Peluso, A.M. (2015). Perceived images and vocations of local territorial systems: implications for place branding strategies. *Journal of Product & Brand Management*. https://doi.org/10.1108/JPBM-03-2014-0528

Rogerson, R. J. (1999). Quality of life and city competitiveness. *Urban studies, 36*(5-6), 969-985. https://doi.org/10.1080/0042098993303

Sáez, L., Periáñez, I., Heras-Saizarbitoria, I. (2017). Measuring urban competitiveness: ranking European large urban zones. *Journal of Place Management and Develoment*: https://doi.org/10.1108/JPMD-07-2017-0066

Saha, R., Tariq, M. T., Hadi, M., Xiao, Y. (2019). Pattern recognition using clustering analysis to support transportation system management, operations, and modeling. *Journal of Advanced Transportation*, 2019. https://doi.org/10.1155/2019/1628417

Scaramuzzino, C., Garegnani, G., Zambelli, P. (2019). Integrated approach for the identification of spatial patterns related to renewable energy potential in European territories. *Renewable and Sustainable Energy Reviews*, 101, 1-13. https://doi.org/10.1016/j.rser.2018.10.024

Sgambati, S., Gargiulo, C. (2022). The evolution of urban competitiveness studies over the past 30 years. A bibliometric analysis. *Cities*, 128, 103811. https://doi.org/ 10.1016/j.cities.2022.103811

Sharifi, A. (2019). Resilient urban forms: A macro-scale analysis. *Cities*, 85, 1-14.

Sinniah, G., Shah, M., Vigar, G. & Aditjandrad, P. (2014). Residential Location Preferences. The Significance of Socio-Cultural and Religious Attributes. *TeMA - Journal of Land Use, Mobility and Environment, 7*(2), 223-238. https://doi.org/10.6092/1970-9870/2656

Tavakol, M. & Dennick, R. (2011). Making sense of Cronbach's alpha. *International journal of medical education*, 2, 53.

Turok, I. (2009). The distinctive city: pitfalls in the pursuit of differential advantage. *Environment and planning A, 41*(1), 13-30. https://doi.org/10.1068/a37379

Volk, R.; Rambhia, M.; Naber, E.; Schultmann, F. Urban Resource Assessment, Management, and Planning Tools for Land, Ecosystems, Urban Climate, Water, and Materials—A Review. *Sustainability* 2022, 14, 7203. https://doi.org/ 10.3390/su14127203

Yun, B. H. & Nam, J. (2021). Development of evaluation model of urban growth stage considering the connectivity between core and periphery. *Journal of Urban Planning and Development, 147*(2), 04021004.

Image and Table Sources

All figures and tables have been elaborated by authors.

Author's profile

Carmela Gargiulo

Full professor of Urban Planning Techniques at the University of Naples Federico II. Since 1987 she has been involved in studies on the management of urban and territorial transformations. Since 2004, she has been Member of the Researcher Doctorate in Hydraulic, Transport and Territorial Systems Engineering of the University of Naples "Federico II". Her research interests focus on the processes of urban requalification, on relationships between urban transformations and mobility, and on the estate exploitation produced by urban transformations. On these issues she has coordinated many research groups as scientific manager of operational units or as principal investigator of competitive projects. As scientific manager of the Dicea-University of Naples Federico II operative unit: "Impacts of mobility policies on urban transformability, environment and real estate market" from 2011 to 2013, as part of the PRIN project; Cariplo Foundation project "MOBILAGE. Mobility and aging: support networks for daily life and welfare at the neighborhood level "2018-2020; ERASMUS + Key Action2: Project "Development of a Master Program in the Management of Industrial Entrepreneurship for Transition Countries" (MIETC), with European and Asian partners 2020-2022. As Principal Investigator of the Smart Energy Master Project for territorial energy management funded by PON 04A2_00120 R&C Axis II, from 2012 to 2015. Author of over 160 publications.

Sabrina Sgambati

She is an engineer, Ph.D. student in Civil Systems Engineering at Department of Civil, Architectural and Environmental Engineering of University of Naples Federico II. Currently, her Ph.D. research concerns the topic of urban competitiveness.