Territorial competitiveness as a pre-requisite for urban development
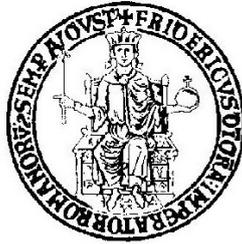
A decision-support tool to orient metropolises, cities and districts to urban competitiveness

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CHAPTER 1. THE RESEARCH PROJECT

1.1 Introduction

The term competitiveness refers to the ability to compete and, more generally, the ability to consider competition as a value (Treccani, n.d.). In urban planning it is considered an intrinsic characteristic of territories and cities and an essential element in transforming territories (Camagni, 2002; Blakely et al., 2019; Li, 2019; Ni et al., 2021), as being competitive for cities means combining economic development with well-being and quality of life (Encarnacion et al., 2023). Over the past three decades, the scientific debate on competitiveness as a fundamental characteristic for the development of cities and territories has evolved due to phenomena such as globalisation, digitalization, and the acceleration of urbanisation (Papa et al., 2014; Mazzeo, 2011; Komasi et al., 2022; Nasi et al., 2022). The development of such phenomena has gradually led to significant economic, social, cultural and political changes, especially in those territories whose governments have promoted initiatives and policies in favour of economic growth and development (Song & Xie, 2021; Sgambati & Gargiulo, 2022). Technological progress, the diffusion of new means of communication along with the increasing mobility of people, information and goods have shortened distances, facilitating international exchanges and the economic convergence of territories with different cultures and traditions (Abusaada & Elshater, 2021; Azzari et al., 2018). These changes have given impetus to the opening of new markets, triggering off highly competitive economic, social and cultural processes (Wang et al., 2021), the permanence and continuity of which produce alternating phases of growth and crisis, stimulating rivalries between cities and territories (Varvari & Bako, 2019). By virtue of these transformative processes, the notion of urban competitiveness has broadened, relying not only on the availability of physical, economic, and organisational resources, but also and above all on the ability to weave effective relationships within and outside the urban system, and to seize the opportunities offered by the continuous evolution of external contexts.

Given the irreversibility of these evolutionary phenomena, administrations and public decision-makers are called upon to continuously redefine their strategies (Tousi, 2023), check the effectiveness of the proposed actions, search for new tools

and methods to guarantee territories a prominent position in international competition (Cheraghi et al., 2021). This is even more so given the numerous social, economic, and environmental challenges that cities might well face in the future in order to keep their competitive edge (Komasi et al., 2022). In light of the emergence of challenges such as climate change, the management of migratory flows, growing demand for travel, increasing vulnerabilities, etc. (Granberg & Nyberg, 2017; Moraci et al., 2018; Verma & Raghubanshi, 2018; Delta & River, 2020; Pane, 2023) the role of cities in international competition is destined to change once again: the long-term impact of these phenomena is inevitable and can represent both a threat and an opportunity for the systems involved, to the extent that they are able to renew their development in a competitive key. And cities are the main bastions to cope with these challenges (Marvuglia et al., 2020) as they have the resources to do so thanks to their extension, high resource density, and their role as poles of technological advancement and social development (Benjelloun & Crainic, 2008). In other words, cities are the places where the challenges of our century are condensed, but they are also the catalysts for the most effective solutions, playing a key role as drivers of the global economy, places of connectivity, creativity and innovation, and reservoirs of resources for the surrounding areas (Appio et al., 2019). They are a breeding ground for science and technology, culture and innovation, for individual and community creativity (Batten, 1995; Zhao et al., 2020; De Bernard et al., 2022). In brief, they nurture and, at the same time, feed on competitiveness.

In this scenario, firstly the 2008 financial crisis and, secondly, the more recent 2020 Covid-19 emergency confirmed that the success of territories in international competition no longer depends exclusively on the pursuit of economic advantage, but also, and above all, on the ability to develop resilient and responsive behaviour in adverse conditions, turning challenges into opportunities (Carpentieri et al., 2020; Lee et al., 2020). Covid-19 was just the tip of the iceberg since the rise of the most recent energy crisis due to the Russian-Ukrainian conflict is further threatening the competitive advantages of many territorial realities (Pereira et al., 2023; Cutini et al., 2023). Hence, research must question how current challenges can become an

Chapter 1 – The research project

opportunity to increase the competitiveness of cities, spur innovation, attract people and activities, and improve quality of life and urban liveability (Molaei, 2019; Mitrică et al., 2021).

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. To respond to the pandemic, in 2021 the European Union approved the Next Generation EU (NGEU) program which, with a considerable amount of resources, envisages investments and reforms to increase territorial competitiveness by accelerating the ecological and digital transition, achieving greater social and economic equity, and overcoming existing territorial gaps (European Commission, 2021). 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 urban 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; Panse et al., 2021; Afsahhosseini, 2022).

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 the functional, social, physical, economic, and morphological characteristics of territories (Papa et al., 2021). Given the multiplicity of aspects that converge in the definition of urban competitiveness, over the past decades, the scientific community has proposed disparate methods and criteria to assess and classify territories and cities according to their competitive characteristics (Abusaada & Elshater, 2021; Lim & Adam, 2021; Sgambati et al., 2022; Hu, 2023). At present, there is no universally recognised paradigm, especially given the wide variety of issues that characterise the concept of compet-

itiveness. Nevertheless, studies on urban competitiveness have a common denominator: the multidimensional approach (Minghetti & Montaguti, 2010; Sáez & Periáñez, 2015). Through this approach, many academic researchers have developed methodologies to measure urban competitiveness. The first step for each study is to identify which urban characteristics are most relevant to competitiveness once the research has been set up with its objectives and background.

Bearing this in mind, this Ph.D. work considers urban competitiveness as the ability of an urban system:

− to increase the intensity and quality of the relationships it is able to establish with other systems;

− to attract investments, new activities, people, and talents, by virtue of its potential, assets, and vocations;

− to self-organise and adapt to the effects of external stresses to increase its competitive level.

Based on these revised notions of competitiveness, this research work has the purpose to define the relations between competitiveness and urban phenomena in a quantitative and operational key, producing technical-scientific advancements with respect to the issues raised above, and contributing to the development of a tool to support decision-making processes. Practically, the research project aims to design a holistic methodology to assess urban competitiveness in the context of NextGenerationEU. Furthermore, in the light of the existing distance between policy-making and academic results, the second aim of the research is to define a model to support decision-makers in the choice of the most suitable interventions to increase cities' competitive potential.

This work represents a concluding product of a Ph.D. programme in Civil Systems Engineering that has been developed between 2020 and 2023 in the Laboratory TeMALab, at the University of Naples Federico II and in cooperation with the School of Economics at the University of Porto.

The thesis is structured as follows. The following sections describe the research project, aims and goals, research questions, and elements of innovation provided by this work. Chapter 2 introduces the concept of competitiveness, by providing an overview of the topic, studying its evolution over time and highlighting approaches

and techniques used by scientific literature and international organisations that have expressed themselves on the subject. Chapter 3 focuses on the meaning of urban competitiveness through a more systemic approach and basing on scientific results, namely reporting the results of a bibliometric analysis that supported the knowledge of the topic, its evolution, as well as the methods and models developed by scholars to study cities' competitiveness. Chapter 4 illustrates the methodology developed during the past three years of Ph.D. course to measure urban competitiveness. Chapter 5 describes the experimentations developed to validate the methodology, that regarded the 14 Italian major cities (metropolitan cities), the municipalities within the metropolitan areas of Porto and Lisbon in Portugal, and the districts within the City of Naples. Chapter 6 illustrates the toolkit that has been developed on the basis of the methodological and analytical results to increase the competitiveness of metropolises, cities and districts. Finally, Chapter 7 draws the conclusions of the work.

1.2 Aim and Goals

The purpose of this Ph.D. work is to examine, in quantitative and operational terms, the role of territorial competitiveness in the development of an urban area that presents its connotations and opportunities for growth (susceptibilities), also in light of the objectives and resources of the NGEU program.

The research work had, firstly, the objective of identifying and deepening the existing relationship between urban phenomena and competitive processes, at three different urban scales (metropolitan area, urban perimeter, sub-municipal dimension). Secondly, it aimed to develop a paradigm to define, with a quantitative approach, the relationship between urban characteristics and territorial competition, especially in the period of the implementation of the NGEU. The final objective is to elaborate an interpretative model that, in different contexts and at different scales, allows to identify suitable actions and interventions to increase urban competitiveness. To this end, the research project was designed by setting several analytical/practical goals. Firstly, the first phase of development of the research was dedicated to the construction of a solid scientific framework, supported by a bibliometric analysis that returns the current orientations of international scientific production in the field of urban competitiveness and the gaps in the literature. This

goal is flanked by the study of the main international rankings and reports, in order to identify the most relevant territorial and urban characteristics that distinguish the most competitive territories and cities. Contextualised in the recovery period we are currently experiencing, triggered in Europe by the Next Generation EU program, the research domain is further specified by comparing the contents of the program with the results of the scientific framework construction. By drawing on the systematic scientific literature review and adapting to a real case (i.e., NGEU program), the second goal of the research was the proposal of a revised method (based on multivariate statistical analysis, composite indexes confrontations, and GIS applications) to evaluate competitiveness and susceptibilities of urban areas.

In particular, the first methodological objective concerns the identification, among the sectors of the PNRR, of the urban dimensions (from now on Macro-areas) that are most congenial to increasing the competitive gradient of an area, due to its competitive characteristics and potential (susceptibilities). The choice of the Macro-areas of Competitiveness is the result of the intersection between the dimensions of competitiveness traditionally examined by the scientific literature (emerged from the bibliometric analysis) and the main fields of competitiveness according to the NGEU. Concerning the territorial scale of the study, the goal was to consider differences and complementarities between cities in terms of size and characteristics, leading to the analysis of three different scales: metropolitan, municipal, and sub-municipal level.

Three case studies were chosen to test the method and verify its replicability in different contexts and at different scales, specifically: the 14 Italian metropolitan areas; the municipalities within the larger metropolitan areas of Porto and Lisbon, in Portugal; and the districts embedded in the perimeter of the city of Naples, in Italy. The examination of the case studies is intended to test the method proposed, as well as provide relevant insights for the development and management of tailored strategies to increase urban competitiveness in the territories that are the object of the applications. The expected output is the identification of urban areas where to primarily intervene, following mainly two lines of action:

− Improve the existing susceptibilities, creating competitive hubs.

− Bridging the existing gaps, reducing territorial disparities and making cities more liable and competitive as a whole.

1.3 Research gaps

This Ph.D. work aimed at covering some of the existing scientific gaps in the field of urban competitiveness, that have been identified in the first part of the Ph.D. work, i.e., the construction of the scientific framework. To do so, the research project was structured to answer the following research questions:

1) *How to formulate an updated definition of the notion of urban competitiveness in light of current urban challenges?*

This research question aims to explore the relationship between competitiveness and urban phenomena introducing the notion of "susceptibility", namely the ability/potential of an urban area to compete in a certain sector based on its intrinsic vocations and distinctive characteristics, as well as its responsive capacity to external challenges.

2) *In which way and in what measure competitiveness and city are related, especially in the context defined by the Next Generation EU program?*

The contextualization in the Next Generation EU program represents a novelty and a pretext to compare the research with a real case, bridging the gap between urban planning practice and scientific research.

3) *What are the load-bearing susceptibilities (competitive sectors) of cities?*

As part of an established literature that seeks to measure urban competitiveness, this research does not merely construct a ranking based on the competitive performance of territorial units but goes beyond. The methodology is designed to identify, quantitively and with an operative vision, urban areas' susceptibilities in order to not only identify the best and the worst performers but also to explore their strengths and weaknesses, providing valuable inputs to adequately distribute resources and, consequently, increase competitiveness. As explained in the following chapters, the competitive sectors to be analysed will be: Tourism and Culture, Green Transition, Digitalization/smartness, Sustainable mobility, and Economic and Social Resilience.

4) *How to explicate the relationship city/competitiveness at three different scales (metropolitan, municipal, and sub-municipal) to ensure complementarity and efficiency of development strategies?*

To the best of my knowledge, there is no research in the scientific literature that considers different territorial scales in an integrated way. All the examined studies focus on the examination of comparable territorial units, generally at the regional or metropolitan scale. If the municipal scale is little considered, the sub-municipal scale is even less so, because of scarcity of data and lack of theoretical basis from which to derive results that, instead, would be of great interest to local decision-makers. Yet, investigating the relationship existing between the three different territorial scales and, in particular, the examination of the sub-municipal dimension, allows to highlight the complementarity between metropolitan and urban competitiveness and local competitiveness and the just resettlement of their respective available resources.

5) *Are the NextGeneration EU resources distributed adequately?*

Linking to the second research question, the research is intended to verify the validity of a real program (which is Next Generation EU) that has been poorly evaluated from a scientific point of view, at least in the field of urban planning. To do so, the methodology was constructed *ad hoc* to overcome this deficiency and connect to a real case.

1.4 Research phases

In light of the proposed research objectives, the research was structured into the following phases:

i) **Scientific framework**

    a. Definition of the scientific framework on the topic of urban competitiveness, developed throughout the support of bibliometric analysis, to investigate the diachronic and territorial evolution of the topic.

    b. Study of the current direction of the scientific literature that sees urban challenges as a fundamental element for the future competitiveness of cities.

    c. Study of competitiveness rankings developed by international organizations and identification of the 'dimensions' of competitiveness.

d. Examination of the NextGeneration EU program with the lenses of competitiveness and identification of the competitiveness dimensions (Macro-areas) in the program.

e. Investigation of approaches, methods, criteria, and techniques utilized by the scientific community to measure urban competitiveness.

ii) **Development of the methodology**

a. Definition of the diverse territorial scales to be analysed (metropolitan, municipal, and sub-municipal scale).

b. Identification of Macro-areas of competitiveness from the scientific literature and of the physical, functional, and socio-economic characteristics that are more relevant to urban competitiveness (divided per Macro-area).

c. Development of the three systems of indicators divided per Macro-area, corresponding to the three territorial scales.

d. Identification of suitable statistical techniques to achieve the proposed objectives (multivariate statistical analysis, GIS elaborations, and construction and comparison of composite indexes).

e. Interpretation of the analysis and identification of the case studies competitive assets; definition of the weightings system and ranking construction; comparison between urban areas' potential and susceptibilities through data observations.

f. Verification of the model reliability.

g. Choice of the modalities of representation of results (GIS models, ranking, graphs).

iii) **Experimental phase**

a. Choice of the case studies (Italian metropolitan areas, municipalities embedded in the metropolitan areas of Porto and Lisbon, and the districts of the city of Naples).

b. Data recollection for each scale of application.

c. Application of the method.

d. Representation and interpretation of results.

iv) **Research validation**

v) **Construction of a toolkit**

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a.   Identification of the most suitable interventions to increase territorial competitiveness of metropolises, municipalities, and districts on the basis of the proposed method.

1.5 Originality of the work

This research project proposes some innovations, either theoretical, methodological and analytical-applicative.

Theoretically, this Ph.D. thesis fits into the not yet fully explored research strand that considers the relationship between competitiveness and urban challenges. The innovative aspect proposed – for what concerns the theoretical approach – lies in the intention to examine more challenges simultaneously, with a multidimensional approach, elaborating an interpretative model that restores the complexity and multidimensionality of the concept of urban competitiveness in relation to the phenomena identified. Furthermore, another element of originality consists of studying competitiveness on two different dimensions (susceptibilities vs. potential). The NGEU contextualization constituted another element of innovation and provided the opportunity to verify the applicability of the method to a real case. From a policy perspective, the confrontation with the NGEU program allows to reveal disparities or alignments between the resources allocated and the actual competitive potentials of urban areas.

A further element of innovation is the attempt to overcome the barriers between different disciplinary sectors that currently limit understanding the complex factors that influence competitiveness in contemporary cities. Following a multidimensional and integrated approach, different competitiveness components (Macro-areas) are considered in 3 different territorial levels - metropolitan area, urban perimeter, and sub-municipal dimension. The analysis of the sub-municipal dimension represents a novelty in the international scientific framework and stems from the need, highlighted by the study of the gaps in the literature, to bring out the complementarity between competitiveness at the urban and metropolitan level and that of the sub-municipal level, in order to support decision-makers in the integration of sectoral initiatives, with a broader impact on the territory, and more punctual initiatives. Administrative boundaries no longer correspond to the physical, social, economic, cultural, or environmental reality of urban development, and

new models are needed to take into account the specificities and intrinsic characteristics (susceptibilities) of urban areas due to their territorial dimension. It will be studied for the first time how urban competitiveness is expressed in the relationship between city centres and suburbs and the relationship between neighbourhoods within the same city. The fine-tuning of the interpretative model will make it possible to formulate, in different contexts and at different scales, operational tools useful for identifying the most effective initiatives and interventions to increase the competitiveness of metropolises, cities and districts respectively. In summary, the innovativeness introduced by the research depends precisely on the complementarity between competitiveness on a local and larger scale, a complementarity identified in the literature but never rigorously explored in depth. The development of the research aims at orienting urban areas towards development processes that arise from their specificities and susceptibilities, where susceptibility means the ability to grow in a given Macro-area of competitiveness, on the basis of urban characteristics and vocations. Competitiveness in the global economy must be flanked and supported by strong local economies that rely on their competencies and resources, and whose success depends heavily on the ability of decision-makers to exploit their strengths and mitigate their weaknesses.

About the methodological novelties introduced, they regarded different steps of the method, as deepened in Chapter 4. For example, the choice of the Macro-areas in which the data matrix is articulated relies on an innovative bibliometric analysis together with the confrontation with the Next Generation EU program. Elements of innovation can be found as well in the multivariate statistical analyses. For instance, the combination of principal component analysis (PCA) and cluster analysis results to deepen variables connections and validate the PCA interpretation, which is often subject to errors influenced by the operator's subjectivity. In parallel, the study of the Macro-areas that mostly influence the components extracted through PCA provides further insights into the homogeneity of the susceptibilities and vocations of the observed cases (whether metropolitan areas, cities, or districts alike). Another methodological novelty regards the comparison of two different rankings of competitiveness: the first depending on the theoretical approach and closely connected to notions – introduced within this Ph.D. thesis – such as competitive

potential and susceptibility; the second connected to the broader concept of competitiveness as afforded in the existing plan of investment Next Generation EU. Finally, as both methodological and applicative pieces of innovation, the representation of the results in GIS and through charts (representing, e.g., correlation between overall indexes and partial indexes) allows to derive innovative results from traditional techniques of analysis, facilitating relevant remarks to urban planning practice.

In conclusion, the aim and with it the originality of the work consists of studying competitiveness on two different dimensions – the potential of competitiveness and susceptibility - considering three different territorial scales, introducing, in addition to the metropolitan and urban dimensions, the sub-municipal scale. The innovative aspect proposed, with respect to previous research, is represented by the intention to jointly consider different urban phenomena and challenges, elaborating a method that, through a systemic, integrated, and holistic approach, restores the complementarity between the components of competitiveness, administrative levels, and territories, in order to ensure coherence between initiatives undertaken in different sectors and at different scales. The result will be an ordered sequence of activities mainly related to the identification of determinants and their elaboration, deepening the role of competitiveness in the development of an area with its own connotations and growth opportunities. The development of this work will result in an operational decision-support tool that, depending on the relationship between competitiveness and susceptibility, will be useful in outlining the most suitable initiatives and interventions to increase the competitive gradient of metropolitan areas, cities, and districts.

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CHAPTER 2. AN INTRODUCTION TO THE CONCEPT OF
URBAN COMPETITIVENESS

2.1 Introduction

At first glance, the term "competitiveness" merely refers to an economic sphere as being "competitive" commonly means being able to withstand market competition (Bhawsar & Chattopadhyay, 2015). However, the phenomena that, since the 1980s, have profoundly transformed the way we live – namely, globalisation, the emergence of rapidly growing economies, increased digitalization, and so on – led to significantly broadening the meaning of the term "competitiveness" (Aiginger et al., 2013). The gradual economic, social, cultural and political changes, accelerated by the pervasiveness of new media along with scientific advancements and the increasing mobility of people, information and goods, have facilitated international economic and cultural exchanges drawing new boundaries of the concept of competitiveness (Gargiulo et al., 1997). In this context, the search for efficient competitive strategies has established its role in governance processes, both at business and national levels, especially in those countries whose governments have promoted initiatives and policies to boost economic growth (Feurer & Chaharbaghi, 1994; Wilson, 2008).

Particularly, since the 1990s, the combined effects of globalisation and urbanisation have spurred researchers and politicians to start considering competition between territories, flanking the study of firms and nations' competitiveness with the analysis of competitive processes between smaller territorial entities (Wilson, 2008; Valdaliso & Wilson, 2015; Camagni, 2017). Thus, the scientific debate regarding territorial competitiveness has developed focusing, in the first instance, on competition among regions, in the belief that the development of regionally based policies would have improved the national economy as a whole (Martin et al., 2012; Huggins & Thompson, 2017). A country is competitive if its regions are able to sustain its economic position vis-à-vis other countries, by attracting and retaining resources, successful firms, skilled labour, and ensuring high standards of living for its inhabitants (Berger, 2011). In other words, according to this branch, a country's productivity, innovation system, and technological development largely depends on the ability of its regions to attract and retain resources, as well as enhance economic activities. The affirmation of knowledge economy and creative industry

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has further disrupted the notion of territorial competitiveness. In this new economy, the value of human capital and intellectual property is highly significant, and attracting and retaining highly skilled individuals has become crucial for regions seeking to thrive (Bontje & Musterd, 2009). Providing an environment that fosters innovation and creativity, along with the availability of job opportunities in knowledge-based industries, and, last but not least, the offer of high quality of living, have all become important factors for regions seeking to enhance their competitiveness, leading to the result of further exacerbating inter-regional competition (Martin, 2005).

Along with escalating levels of competition, the city has become the main subject as well as the core of the region (Gardiner et al., 2012). As a result, a much wider debate on competitiveness as an attribute of cities and, specifically, metropolitan areas has developed. The reason is that cities are the places where people, capitals and resources of various kind are concentrated. Suffice it to say that, according to the World Urbanization Prospects, currently 55% of the global population lives in urban areas and, in the next 30 years, this percentage is destined to reach the quote of 68% (UN, 2020). Furthermore, by 2050, the first ten global metropolitan economies will produce, together, $13,500 billion of the global GDP (IMF, 2023). Hence, it is possible to state that urban economies are and will be the engines of the global economy and that fostering cities' competitiveness is crucial to determining their own economic success (Begg, 1999). Stimulating cities to international competition can lead to a significant improvement of resources, opportunities and economic development, with the result of attracting investments, innovative activities, talents, and visitors (Kresl, 2013). The promotion of urban competitiveness requires the combination of the economic development of a territory with the well-being and quality of life of the people who live there (Royuela, 2014). A city is competitive if it is able to face competition guaranteeing, at the same time, environmental, economic, and social sustainability (Camagni, 2017).

As such, urban competitiveness has gradually become a central theme for administrators and decision-makers (Turok, 2004). It relies on the resources available in the territory, the synergies of various subjects and institutions, the integration of

Chapter 2 – An introduction to the concept of urban competitiveness

diverse economic sectors in a view of innovation, the cooperation with other territories and the adaptation to regional, national, and supra-national policies. Therefore, the construction of policies and strategies aimed at increasing urban competitiveness should derive from the combination of:

−   Social competitiveness, intended as the ability to intervene synergically, on the basis of a shared vision, and encourage participation and concertation.

−   Environmental competitiveness, intended as the ability to enhance the environment as a distinctive element of the city, guaranteeing at the same time the conservation and renewal of the existing resources, as well as their promotion through effective marketing and branding strategies.

−   Economic competitiveness, intended as the ability to produce and retain, within the territory, the maximum economic advantage, consolidating links between not only economic sectors but also resources of various kind (human, social, environmental, organizational, etc.)

−   Finally, the ability of the city to establish a defined position on the global background, as a result of the available resources and of the shared vision of development.

Because of all these aspects, urban competitiveness is studied in the scientific literature as a multidimensional and complex phenomenon (Esmaeilpoorarabi et al., 2016). Beyond urban economic growth, contemporary approaches to urban competitiveness see it as closely related to a city´s ability to provide high levels of quality of life, social inclusion, and equitable access to goods, services and urban provisions (Carvalho et al., 2017; McCann, 2004; Gargiulo & Sgambati, 2022). On the other hand, it has been argued that urban competitiveness has variegated forms and should therefore be studied in context (Malecki, 2002; Sgambati et al., 2022), both in relation to wider geographical scales and taking into consideration intra-metropolitan settings (Shen, 2007; Bruneckiene et al., 2012). However, the research on urban competitiveness is not always accompanied by the analysis of the factors and dimensions that drive and are more closely associate to competitiveness (Begg, 2002), something that, within this Ph.D. research, is called "susceptibility". This measurement challenge is currently heightened by the growing relevance of

immaterial competitiveness drivers associated with culture, environment, and urban atmospheres overall, which stretch the determinants and geographical scope of urban competitiveness (Manfredi & Costi, 2023; Shirvani Dastgerdi & De Luca, 2019). This suggests that urban competitiveness should not be directly equated with city size (e.g. Rodríguez-Pose & Griffiths, 2021), and that fostering national and metropolitan economic growth should take into consideration wider territorial assets, not only to address issues of underperformance but also to minimize socio-economic inequalities and political tension (Mel'Nikova, 2020). From a policy perspective, the need to re-think and allocate financial resources to relaunch the competitiveness of places following periods of crisis (such as the 2008 financial crisis, the 2020 Covid-19 emergency, or the recent Ukrianian-Russian conflict) makes the evaluation of competitive potential an important tool to design urban development strategies and allocate financial resources more effectively (Begg, 2002; Kresl, 2020; Činčikaitė & Meidutė-Kavaliauskienė, 2022).

2.2 Definitions of competitiveness

The notion of competitiveness is particularly elusive and lacks a comprehensive definition. The Oxford Compact English Dictionary defines competitiveness as "having a strong urge to win" (Oxford compact English Dictionary, n.d.), while the Enciclopedia Treccani defines it as "the ability to afford a competition" (Treccani). The concept was introduced in economics in the 1980s and developed by researchers like Krugman (1980), Porter (1990), Storper (1995), etc. At the firm scale, the term competitiveness was associated to the logic of profit of business companies, and it was defined as the ability to produce the right goods and services, of the right quality, at the right price and at the right time (UK Government White Paper, 1995). Any competitor must meet the requirements of open markets to remain in business, and the more competitive a firm is in relation to its rivals, the greater its ability to gain market share (Martin & Simmie, 2008). On the other hand, the term "competitiveness" gained ground to describe the economic rivalries between nations. At a national scale, competitiveness can be defined as "the degree to which a nation can produce goods and services which meet the test of international markets, whilst simultaneously maintaining and expanding the real incomes of its people over the long term" (OECD, 1990) or as "the set of institutions, policies and

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factors that determine the level of productivity of a country" (Porter et al., 2007)[1]. Even today, national and international governance strategies are often geared towards increasing the competitiveness of countries, although the term has now been enriched with meanings that go far beyond productivity and economic performance (Sun & Yang, 2022).

However, in the beginning, the association of the term competitiveness with the economic performance of territories encountered several obstacles (Martin & Simmie, 2008). The term itself tends to convey the impression of a win/lose situation, in which regions can improve their position only at the expense of others, whereas, in practice, there are mutual gains to be achieved from individual regions becoming more competitive. That is why many scholars have referred to competitiveness as a misleading concept: while Reich considered it a meaningless word (Reich, 1990), best known is Krugman's assessment of competitiveness as a "dangerous obsession" (Krugman, 1994). Another hot spot concerned the comparative meaning of the term "competitiveness". On the one hand, when planners and consultants speak of competitiveness, they tend to measure the performance of cities vis-à-vis others, orienting all policies and resources toward the goal of climbing the global rankings. In these terms, competitiveness is often viewed as a key indicator of the success or failure of policies (Filo, 2008). On the other hand, if an entity exhibits a high degree of competitiveness, it can be referred to as an attribute of that entity that can emerge, but not necessarily beating other competitors (Hu et al., 2013). From this second perspective, competitiveness must not be understood in comparative terms, but in an absolute perspective, as an attribute of that entity, or, more specifically, a territory (Camagni, 2002).

Despite these oppositions, the debate on territorial competitiveness expanded during the 90s' when authors such as Lee, Begg, and Camagni, definitely shifted the concept to a territorial scale: "In a globalising economy, territories and not just

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[1] In this sense, a nation's competitiveness is influenced by the presence of firms in the national territory and so by the territorial features favourable to the location of industries and enterprises (Rogerson, 1999; Turok, 2004). By the second half of the last century, it can be said that a nation's competitiveness relied on heavy industry, productivity and infrastructures, in brief those hard assets which contributed to the productivity of firms (Kresl & letri, 2017). Nowadays, the studies on nations' competitiveness mainly focus on differences in national values, culture, economic structures, institutions, and histories that may all contribute to competitive success and determine striking differences in the competitive patterns of each country. The relevant problem remains the analysis of which factors affect the crisis of territories and the search for tools aimed at reducing this risk. Particularly, this issue is of urgent demand in developing countries.

firms increasingly find themselves in competition with each other" (Camagni, 2002). However, shifting to a territorial perspective, the concept of competitiveness has become more difficult to define and measure. In the era of globalization, digitalization and urbanization, the contemporary economy, and so the territorial economy, is continuously changing (Begg, 1999; Lee et al., 2014), thus the factors that might come into play in the competition between territories are by no means certain. Furthermore, there remains the question of the comparative/absolute definition: an industrial region, for example, is not directly competing with a predominantly agricultural region or a financial centre, so the measurement of its relative competitiveness is problematic. Initially, however, territorial competitiveness was still connected to the presence of territorial characteristics favorable to the settlement of firms and business groups. According to Filò (2007), territorial competitiveness refers to the inclination to, firstly, compete in the market and, secondly, win and retain a relevant position, increasing market share and profitability, and eventually consolidating commercially successful activities.

More recently, this definition has been enriched by the relevance of the human component due to the rise of digitalization and the consequent development of the knowledge economy and creative industry sectors (Carvalho, 2012). The knowledge economy is a system of consumption and production that is based on intellectual capital that has become a large component of all economic activity in most developed countries, and recently also in developing countries (Powell & Snellman, 2004). On the other hand, the creative industry refers to a range of economic activities that are concerned with the generation and commercialization of creativity, ideas, knowledge, and information (Potts et al., 2012). This component of the economy relies greatly on intellectual capital instead of natural/physical resources contributions (hard assets) (Esmaeilpoorarabi et al., 2016). In the knowledge economy, a significant component of value may thus consist of intangible assets such as the value of its workers' knowledge or intellectual property. The development of a knowledge-based and creative economy shifted the attention to the need to attract qualified people in order to increase the competitiveness of a territory, enriching its social and economic capital and producing a competitive advantage (Du et al., 2014; Florida, 2002). Researchers and associations assess a

territory's human capital by focusing on the quantity and quality of basic skills, qualified graduate workforce, expertise in research, and creative production (Florida, 2002). Skilled and creative workers represent a driving force for innovation, growth and development of urban areas. According to this approach, territorial competitiveness depends on the educational quality of its workforce, the R&D and innovation sectors, along with its susceptibility to innovate and adapt to new technologies.

Therefore, an updated definition of territorial competitiveness can be "the ability of a region to offer an attractive environment for firms and residents to live and work" (European Commission, 2022) or "the ability of a locality or region to generate high and rising incomes and improve the livelihoods of the people living there" (Meyer-Stamer, 2005). It is at this point that factors such as quality of life, well-being and liveability become relevant in the definition of territorial competitiveness since they are able to attract people that nurture their economic system.

Due to the explosive economic and social development of urban areas, fed by urbanization and globalization, the scientific concern gradually shifted to cities as the main protagonists of international competition. This is because, over the centuries, cities have developed economic assets, political and social institutions and practices that are congenial to competitiveness in the modern market.

As already mentioned, different aspects have contributed to this change in perspective. First of all, we have to consider that nowadays more than half of the global population lives in urban areas, and by 2050 this percentage is going to significantly increase (UN, 2019). Secondly, cities present the largest number of opportunities and the resources necessary to compete in the international economy. Hence, urban competitiveness can be defined as "the ability of a city, in the process of cooperation, competition and development relaying on the internal organization efficiency and the external economic advantage which are formed by its endowments and space foundation, to create more values in a rapid and extensive way by means of attracting, controlling and transforming resources and dominating the market so as to continuously provide and maximize the benefits for its residents"(Ni & Kamiya, 2020).

According to Collins (2007), on the back of the knowledge and creative economy diffusion, cities engage in competition with each other as they seek to achieve improved economic development by attracting highly educated human capital and private investments. Therefore, as stated by Martin & Simmie (2008), competitiveness is "the ability of cities to continually upgrade their business environment, skill base, and physical, social and cultural infrastructures, so as to attract and retain high-growth, innovative and profitable firms, and an educated, creative and entrepreneurial workforce, to thereby enable it to achieve a high rate of productivity, high employment rate, high wages, high GDP per capita, and low levels of income inequality and social exclusion".

Additionally, urban competitiveness can be intended as "the ability/opportunity of cities to attract investments, new businesses, creativity, visitors" (EIU, 2013) and, above all, high-quality human capital (Malecki, 2002; Gabe et al., 2012; Du et al., 2014), or even "the degree to which a city, in comparison with other competing cities, is able to provide the jobs, income, cultural and recreational amenities, degree of social cohesion, governance and urban environment to which its current and targeted new residents aspire"(Kresl, 2007).

In summary, the role of cities as driving forces for global development is now recognized and urban competitiveness has become a fundamental aspect to be evaluated in order to ensure the economic and social growth of territories. However, there are external factors that can undermine their relevant position in the global economy. The 2008 global economic crisis (Papa et al., 2014) and the more recent Covid-19 emergency are just an example of the many challenges cities have to face to maintain their competitive advantage, not to mention climate change, sustainability, migration flows, natural disasters and so on (Acuto et al., 2013). The unavoidable effects of these occurrences, which cities around the world experience 'on their skin' day by day, suggest that urban competitiveness does not rely only on the search for economic advantage yet, but also on the development of resilience and adaptation to these challenges.

Just to refer to a recent event, during the period of the Covid-19 health crisis, lockdowns and social distancing have disrupted the daily course of urban life, with

effects that are still visible now (Carpentieri et al., 2020). In this context, competitiveness represents the ability of a city to seize the changes, generated by an external threat, as opportunities for development and growth (Sgambati & Gargiulo, 2022).

Under 'normal' conditions, cities rely on their internal organisation efficiency to create economic advantage, by attracting and transforming resources, as well as providing benefits for their residents (Ni & Kamiya, 2020). But, when an external event threatens their state of equilibrium, it is a resilient behaviour that guarantees the conservation of their competitive edge. That is why also resilience should be considered a fundamental component of competitiveness (Evans & Karecha, 2014; Sgambati et al., 2022). The resilience of an urban system is directly connected to its attractiveness, the location of new businesses, skilled workers and investments, because it is the measure of its ability to respond to external challenges (climate, economic, social etc.), modifying its structures, in case of necessity. Therefore, it can be said that a city is competitive when it is able to develop its assets when a major opportunity presents itself and later maintain its competitive position when faced with successive threats and challenges (Evans & Karecha, 2014).

In other words, urban competitiveness can be defined as the ability of an urban system to self-organise, increase its competitive level, enhancing the intensity and quality of relations (EIU, 2013; Zenker et al., 2013) and, lastly, adapting to the external changes (Kakderi et al., 2021). Urban competitiveness is a measure of a city's ability to outperform other cities in terms of generating wealth, enhancing productivity, stimulating societal advancement, and, above all, managing external influences within a specific timeframe (Sun & Yang, 2022).

From all these definitions it is clear that urban competitiveness develops alongside the evolution of cities, so researchers must consider the multiplicity of phenomena that influence urban systems to assess and measure their competitiveness. According to Nasi et al. (2022) "competitiveness is a multidimensional construct that focuses on a city's relevant attributes of the local environment that may be summarized around four main perspectives: economic, performance, sustainable development, and quality of life". Concluding, the vastness of the topic, together with

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the variety of aspects considered by scholars, implies that competitiveness should be treated as a multifaceted concept and by a multidimensional approach.

2.2.1 Competitiveness as a multidimensional concept[2]

The growing research interest in studying competitiveness and urban development is motivated by the central role that cities play in modern society (Bruneckienė et al., 2012). These territorial contexts have become the focal point for global economic and social development (Papa et al., 2014) starting a competition to offer the best conditions to attract investments, citizens, and skills. In this context of global competition, the traditional approach that envisaged the exclusive study of the relationships between a city and its neighbouring territorial context is now outdated. Nowadays, thanks to new communication and transport technologies, cities are able to interact, materially and immaterially, with other territorial entities, even ones that are geographically distant. This has enabled urban entities, located at a considerable distance away from each other, to compete in the most diverse sectors, from the production of goods and the provision of specific services to environmental protection. Large cities such as New York, London and Tokyo are increasingly orienting their future development choices by pursuing the priority objective of dealing with competition from other international urban entities of the same size, neglecting internal competition within their respective national borders (Jensen-Butler, 1999). In Europe, with the creation of the European common market and the free movement of goods and people, cities have become more attentive to the opportunities and threats arising from the European integration process in order to affirm their European leadership in the various sectors of competition. In Asia, in order for the city of Hong Kong to increase its importance as a reference economic-financial centre for the continent, it must compete with other Asian cities that aim to play the same role, such as Guangzhou and Shanghai (EIU, 2012; Godfrey & Zhou,1999; Jessop & Sum, 2000; Xu & Yeh, 2005).

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[2] This section is a formal elaboration of a part of a scientific paper published by the author. Sgambati, S., Carpentieri, G., & Gargiulo, C. (2022). Measuring Urban Competitiveness Through the Lens of Sustainability: An Application at the Urban Districts Level in the City of Naples (Italy). In *International Conference on Computational Science and Its Applications (pp. 93-108). Cham: Springer International Publishing*.

One of the most common definitions of urban competitiveness in the literature states that this concept represents a city's ability to confirm and/or improve its competitiveness within a specific area or context (regional, national or international) (Jiang & Shen, 2010). Urban competition takes place between similar territorial contexts that pursue the same objectives in order to preserve the resources and improve the well-being through optimal management of the many external and internal factors that can influence cities' development. Before the concept of competitiveness reached its full application in the urban planning field, numerous scholars sought to develop an adequate theoretical support base. In the first studies on territorial competitiveness, only the economic aspects capable of making a specific urban context attractive for companies, investors and the marketing of the goods produced were taken into consideration (Deas & Giordano, 2001). As shown in the previous section, territorial competitiveness was mainly connected to hard assets (Turok, 2004; Kresl & Ietri, 2017), namely tangible assets or resources having fundamental value that give shape to its physical and economic to systems. Typical examples of hard assets include traffic connections, labour market, local dues and taxes, terrain/construction/rent cost, availability of space, environmental constraints, proximity to infrastructure, proximity to distributors, physical resources, great facilities, location context, and R&D and innovation sectors. Yet, Kresl (1999) states that a vision of urban competitiveness aimed at identifying the factors capable of attracting productive investments is made up of two components: the economic and the strategic (Kresl & Singh, 1999). The first, indeed, includes aspects related to production, infrastructure, location, economic structure and urban services. The second component includes aspects such as government efficiency, urban development strategy, cooperation between the public and private sectors and institutional flexibility. Factors that are not preparatory to businesses are excluded from this type of consideration. Further in-depth studies have expanded the field of study with the inclusion of other tangible and intangible aspects (environmental, cultural, technological, human capital, artistic beauty, etc.) that can, directly and indirectly, influence the localisation choices of both businesses and citizens choosing an urban environment in which to reside and/or invest in order to satisfy their

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needs and aspirations (Sàez et al., 2017; Buck et al., 2005). These aspects are known as 'soft factors'[3].

For example, The World Bank (2019) defines a successful territorial economy according to four pillars:

− Institutional structures that provide incentives for entrepreneurship and the use of knowledge.

− Availability of skilled labor and a good education system.

− Access to information and communication technology (ICT) infrastructures.

− A vibrant innovation landscape that includes academia, the private sector, and civil society.

In this view, hard assets are of course essential, but not necessarily sufficient to make a territory more competitive. On the contrary, attracting human resources that can support the economic system is the key for the improvement of competitiveness. It follows that, to assess territorial and urban competitiveness, different dimensions should be considered, including both hard and soft factors (Esmaeilpoorarabi, 2016). Examples of soft factors are the following: urban quality, liveability, social cohesion, sense of community, residential environment, environmental quality, touristic attractiveness, schools and education, recreational value and retail, culture, urban safety, sustainability, creativity, availability of services, accessibility, etc.

Over the years, different scientific disciplines have paid particular attention to developing (quantitative and/or qualitative) methods that can provide a measure of the level of competition between cities by considering all these aspects. This has been motivated primarily by the interest of public and private decision-makers in identifying adequate information support to guide future development choices (Cheshire, 2009). Measuring the level of competitiveness of a territorial system (region, province, metropolitan city and city) is very complicated. The phenomena which typify such systems are characterised by a multiplicity of "facets" (such as the degree of well-being, quality of life, infrastructural endowment, services, etc.)

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[3] Soft factors link to the needs, aspirations and desires of the population. They refer to human, social and community sphere drawing socio-political, socio-economic, socio-cultural, socio-anthropological, and psycho-sociological characteristics of territories.

and therefore can be difficult to measure (Rogerson, 1999; Donald, 2001). In assessing cities' level of competitiveness, the analyses obtained through measurement tools that use single indicators cannot be considered exhaustive. There is a need to use large sets of indicators that can measure a great number of characteristic aspects. For cities, it is now evident that satisfying individual and collective needs in order to improve citizens' quality of life is a crucial element of urban competitiveness (Biagi et al., 2018). These new needs have gradually transformed the competitive priorities of cities from exclusive support of the productive sector (such as technical infrastructures or investment incentives) to the promotion of development oriented towards the well-being of the individual from a sustainable perspective. This evolution of the concept of urban competitiveness was well summarised by Porter, who formulated four development phases for this theme (Ni & Kamiya, 2020): 1) competitiveness aimed at the promotion of production, 2) competitiveness aimed at encouraging investments, 3) competitiveness aimed at innovation and 4) competitiveness aimed at improving quality of life.

Regarding this last aspect, it is worth expanding the branch of research on urban competitiveness to all those aspects related to 'quality of life', which was revealed to have a key role in attracting educated labour, entrepreneurs, and innovative firms to cities. For instance, cultural facilities and services make cities pleasant and vibrant environments in which to work and live. The availability and accessibility to services and facilities improve the quality of life of citizens, as well, and support economic and commercial activities, therefore public administrations should guarantee the offer of services to residents and firms (I'Hostis & Bozzani-Franc, 2010). Cultural economy and tourism, moreover, are essential resources, especially in the most stratified cities, in which cultural and historic heritage constitute an opportunity to enhance them on an international level (Alberti & Giusti, 2012). Successful regions and cities are argued to owe part of their superior economic performance to having favourable social, cultural and institutional set-ups that are accommodative of and actively encourage change, innovation and creativity (Lember et al., 2011). Scholars agree in recognising cultural and creative industry as potential resources for new jobs and investments, economic growth, enhancement of property

and better living standards (Moradi et al., 2019). For this reason, urban regeneration and revitalisation measures have become an important tool to enhance the "magnetism" of a city (Güzey, 2009; Sáez & Periáñez, 2017). Also, space quality contributes to urban competitiveness: the relationship between urban-architectural quality and economic competitiveness is twofold: on the one hand, the quality of space is the result of the economic development of the territory, on the other hand, urban design is used as a means for the economic development of cities (Ghahremani et al., 2021). Air quality, the presence of green, and clean water are all aspects that contribute to a better quality of life for citizens and city users. Furthermore, environmental benefits and environmental restraints may influence the allocation of firms and their competitiveness from an economic perspective (Panagopoulos et al., 2016). The competitiveness of an urban system lies also in its safety relating to different spheres: social security, climate security, the safety of the physical capital, criminality, and road safety (Shen, 2004). Accessibility to services, activities, and facilities is another important factor for the definition of the attractiveness of places, for industrial development and for the location of new businesses and commercial activities (Guida & Caglioni, 2020). It defines the quality of life and creates new opportunities for city users. Along with accessibility, the presence of an efficient system of infrastructure and transport system offers the possibility of an effective connection with the markets (supply of materials, outlet, transport) functional to the industrial activities (Mullen & Marsden, 2015). The presence of efficient transport infrastructure is one of the essential conditions in the localization of new enterprises. The digitalization of economic activities and public administration is essential for a territory to be more competitive on an international scale, considering the evolution of the global economy structure toward higher levels of technological competencies and digital transition (Carvalho, 2012). Finally, Research and Development (R&D) and, in general, investments in human capital generate spatially concentrated spillover effects which increase the productivity of both physical capital and the wider labour force (Buck et al., 2017).

It can be concluded that urban competitiveness is a multidimensional and complex phenomenon (Minghetti & Montaguiti, 2010; Sáez & Periáñez, 2015; Falciola et al., 2020). It has been defined as the ability of a city to attract and retain investment,

resources, people, and skills over time (Martin & Simmie, 2008; Pike et al., 2016; Ni et al., 2019; Carpentieri, 2020), becoming, over the last decades a topic of intense debate and renewed interest in the study of urban change and development (Camagni, 1999; Kresl & Ietri, 2014; Camagni et al., 2017; Blakely et al., 2019; Ni et al., 2021). The wide range of side topics reveals the multidisciplinary nature of urban competitiveness and explains the systemic and multidimensional/integrated approach used by a large part of the academic community.

To the end of this research, it can be stated that the characteristics of competitiveness are the following: susceptibility, dynamism, attitudes/assets, adaptive capacity, recognizability, and sustainability.

2.3 Competitiveness rankings

Empirically, many definitions and methods have attempted to measure territorial and urban competitiveness (Camagni, 2002; Nasi et al., 2022). The wide spectrum of the concept, along with the complexity of urban development phenomena (e.g., Gargiulo & Papa, 2021), called for multivariate approaches (Ciccarelli, 2006; Sinkienė, 2014; Komasi et al., 2022). In particular, composite indicators, rankings, and benchmarking exercises, despite their limitations, have been considered useful tools to assess these phenomena and support decision-making since they allow for the illustration of multidimensional phenomena with a relatively small amount of information (Papa et al., 2016; Sáez et al., 2020). Also, they facilitate performance comparisons by taking into account multiple dimensions, such economic structure, productivity, innovation, environment, social conditions, among others (Jiang & Shen, 2010; Huggins, 2003; Hu et al., 2013; Sáez and Periáñez, 2015; Ivaldi et al., 2016; Yigitcanlar et al., 2019; Chung et al., 2021; Lo-Iacono-Ferreira et al., 2022). Below is a review of the main rankings drawn up by international organisations to assess the competitiveness of various territorial entities.

2.3.1 The World Economic Forum Global Competitiveness Report

Globalisation and the fourth industrial revolution, although creating new opportunities, also provided disruption and polarisation of economies and societies. In this context, the World Economic Forum introduced the Global Competitiveness Index 4.0 in 2018, based on 40 years of experience in benchmarking (the first Report dates

back to 1979). The analysis carried out by the WEF looks at 2020 as the beginning of a new era and offers an overview of 141 economic realities. The Global Competitiveness Index represents, for policy-makers at the national scale, a yardstick for the country's productivity progress and a monitoring tool in short- and long-term planning. The results of the GCI 4.0 2019 show that many economies are far behind the competitiveness frontier in each of the three areas analysed:

- Competitiveness and development;
- Education, skills and work;
- Equity and social inclusion.

The GCI 4.0 is the product of an aggregation of 103 indicators, from different international organisations, grouped and reorganised into 12 categories: Institutions, Infrastructure, ICT technology adoption, Macroeconomic stability, Health, Skills, Production market, Labour market, Financial system, Market size, Business dynamism, Innovation capacity. A nation's performance is assessed with a progressive score from 0 to 100.

The report also looks to the future in terms of creating a sustainable economy and building shared wealth and questions the compatibility between these aspects and competitiveness and growth. There is an entire section devoted to sustainable development. Growth and development strategies, developed over the past decades, without regard for environmental sustainability and resource availability, have led to serious consequences for the planet and humanity. This has led in recent years to the need to move towards development strategies that are compatible with resource regeneration, such as low-carbon economies through and the implementation of green technologies. According to the GCR, success in the field of sustainable development can be achieved through greater openness to collaboration between nations, incentives for green energy, and the promotion of environmentally sustainable products.

2.3.2 The Regional Competitiveness Index by the European Commission

The Regional Competitiveness Index (RCI) measures competitiveness at the regional scale for all NUTS-2 level regions in the European Union. The index was constructed on the basis of 74 indicators, summarising a region's ability to offer an attractive sustainable environment for both businesses and people.

The RCI has the same structure as the Global Competitiveness Index compiled by the World Economic Forum as it consists of 11 areas of analysis. The Basic Group contains:

−   Institutions;
−   Macroeconomic stability;
−   Infrastructure;
−   Cheers;
−   Basic education.

And it is enriched with:

−   Higher education, training, learning;
−   Labour market efficiency;
−   Market size;
−   Technological advancement;
−   Corporate refinement;
−   Innovation.

The 2019 results are presented in the report published after the analysis and on the European Commission's website in the form of interactive maps (using GIS software for representation) and spider graphs that make it possible to compare the level of competitiveness achieved in the areas of analysis by different regions with the European average. Diachronic analyses also make it possible to compare the levels of competitiveness achieved by the same region over time.

The 2019 results show a clear advantage of capital cities and regions with larger cities, with the top performers being Stockholm, Utrecht and London.

The fully revised RCI 2.0 shows that there are still large differences between EU regions, but also that the less developed regions have been improving their competitiveness. Between the 2019 and 2022 editions, most eastern EU regions continued to catch up, including the Baltic States, Croatia, Hungary, Poland, and Slovenia. In the southern EU, the regions in Portugal, Spain and most of Greece improved their performance (albeit the latter from very low levels), but most of the regions in Italy and Cyprus moved away from the EU average.

2.3.3 Competitiveness according to the Economist Intelligence Unit

The EIU (2013) study was commissioned by Citi to assess the current and 2025 competitiveness of 120 cities around the world, selected on the basis of their size, economic importance at the regional scale and data availability. It turns to a smaller scale than the studies analysed so far, depending on the fact that it is necessary to look at competitiveness from an urban rather than a national or regional perspective. Today, cities are transforming rapidly, tending more and more towards large metropolitan areas or vast urban agglomerations.

The EIU defines a city's competitiveness as its ability to attract capital, business, talent and visitors. The methodology used involves the analysis of 32 indicators (27 qualitative and 5 quantitative) for each city, collected in 8 categories each with its own weight in the definition of competitiveness:

− Economic strength (30%): this category is indicative of the importance of the area to the national economy and the level of development measured in terms of per capita income.

− Physical capital (10%): measures the quantity and quality of infrastructure in the urban area (airports, railways, ports, roads, bridges, telecommunications network);

− Financial Maturity (10%): is indicative of corporate welfare and the financial level achieved;

− Institutions (15%): this category measures a city's ability to tax, plan, legislate and strengthen its legislative system, as well as the strengths and weaknesses of its institutions;

− Human capital (15%): is indicative of the quality of social capital, in terms of level of education, educational quality, health;

− Attractiveness (10%): with this category, the EIU tries to assess the overall attractiveness of a certain urban area, thus also considering its competitiveness from a tourism point of view;

− Social and cultural character (5%): a city characterised by diversity and tolerance attracts investors and visitors, making the city more dynamic and thus more competitive;

- Environmental and natural risk (5%): managing risks and reducing climate vulnerability by a strong and environmentally aware administration makes a city more attractive to both businesses and people. Environmental protection and sustainable development policies are, in the long term, a key instrument to preserve and increase urban competitiveness.

The scores per indicator are normalised and aggregated into categories to allow an overall comparison between the different cities analysed.

The study reveals accessibility (although, here, reference is mainly made to port accessibility), average income and demographic factors as determinants. Competitiveness hotspots in 2025 are concentrated in North America, Europe and the more advanced economic areas of Asia and the Pacific, a far cry from the competitiveness levels of some African and South American cities included in the analysis.

Also, as part of the comparative analysis, the Economist Intelligence Unit, in collaboration with Siemens (Infrastructure and Cities Sector), worked on a report on green cities and the development of a Green City Index (2012). The presence of green areas, although analysed at the metropolitan scale by the EIU, is of fundamental importance at the local scale. As we have already seen, the environment represents one of those competing variables in the concept of competitiveness, and analysing how it relates to urban development dynamics is crucial in delineating the new frontier of urban competitiveness. Indeed, cities are the centres of global growth and provide the world's population with opportunities for education, employment and prosperity, but at the same time they are also the places where the negative effects of growth (congestion, new settlements, traffic, pollution, resource depletion, climate change, land consumption) manifest themselves. Urbanisation has a huge impact on the environment, just think that cities are responsible for 70% of greenhouse gas emissions into the atmosphere. And this also has consequences for competitiveness. Today, environmental sustainability goes hand in hand with many of the variables that determine the competitiveness of an urban system, including economic development, improved quality of life, and poverty reduction.

Again, cities were chosen on the basis of size and importance as economic and production centres. There are 30 indicators selected, grouped in 8-9 categories according to the region they belong to:

- CO emissions2 ;
- Energy;
- Buildings;
- Land use;
- Transport;
- Water and hygiene;
- Waste management;
- Air quality;
- Environmental governance.

The indicator is also characterised by world region. For example, the African Index takes into account some specific indicators that consider the accessibility of electricity and drinking water. In the final part of the report, 'Seven steps to a greener city', some actions to be implemented at the metropolitan scale in order to increase the level of competitiveness from a green point of view (governance, technology, participation) are listed.

Another index to take into account in this analysis is the Global Liveability Index, the result of research by the EIU in 2018 on the liveability of 140 cities worldwide. By liveability, the EIU means the ability of a place to offer the best or worst living conditions to its inhabitants. This time, the 30 indicators taken into consideration are cultural, environmental and social, divided into qualitative and quantitative. The categories are as follows:

- Stability;
- Cheers;
- Culture and environment;
- Education;
- Infrastructure.

What is striking about this research is the evaluation of hitherto unaddressed phenomena that can, however, significantly affect the competitiveness and attractiveness of an area, including civil war or terrorism, a sign of how also citizens' safety enters the discourse on competitiveness.

2.3.4 The Mori Foundation's Global Power City Index

The Mori Memorial Foundation is a Japanese foundation specialising in research on urban development strategies. The Global Power City Index (GPCI) evaluates and ranks the largest cities on the planet according to their 'magnetism', i.e. their power to attract people, capital and businesses from all over the world. Competitiveness, in its multidimensional sense, is measured through the analysis of 6 functions:

− Economy;
− Research and Innovation;
− Cultural interaction;
− Livability;
− Environment;
− Accessibility.

A total of 70 indicators were used to define the GPCI 2022. The Mori Memorial Foundation's research does not end in 2022 but analyses diachronically the changes in competitiveness of the cities studied in relation to historical events or phenomena that affected each of the 6 functions considered. For example, Paris recorded a drop in score in 2015 compared to the past due to the repeated terrorist attacks suffered by France in those years, moving up in the ranking in 2017 thanks to its confirmation as host city of the Olympic Games in 2024. Or London, after holding the top spot in the rankings for eight consecutive years, experienced a drop in score in 2019, probably due to Brexit. These phenomena highlight the close relationship between competitiveness and urban transformation, highlighting how the unpredictable evolution of complex systems travels hand in hand with the issues affecting them.

2.3.5 City of opportunities by PricewaterhouseCoopers

Once again, we are talking about a ranking on a metropolitan scale: which metropolitan cities create the most opportunities? The 10 indicators are grouped into three groups: the first brings together indicators representing the tools a city possesses: innovation, technological readiness, and city gateway. The second concerns quality of life (transport and infrastructure, health and safety, sustainability and environment, liveability and demographics). The third measures the economic power of the city (costs, business, economic weight). Each indicator considers a number of variables for a total of 67 variables.

Of particular interest for the present study are a number of variables taken into account when measuring competitiveness in terms of the opportunities a city can create. These include the resilience of buildings against natural and human-induced disasters (terrorism, nuclear attacks, cyber attacks) as well as the threat of new diseases and pandemics.

2.3.6 Italy2Invest

In a scenario of continuous and rapid transformation, a factor of primary importance for cities and territories is represented by competitiveness, defined as the ability of a territory to attract, enhance and retain strategic resources, capital, technologies, human resources, to guarantee spillover and adequate payback of the resources employed. The ability to create and maintain high levels of performance in sensitive areas is an essential prerequisite for attracting investors who, even today, tend to favour - partly due to a lack of information - other destinations, even at a European level. According to this logic, and with the aim of bridging this gap, Italy2Invest adopts a multidimensional approach to measure the competitiveness of 7998 Italian municipalities. Multidimensionality is guaranteed by the integration of 16 domains that influence the attractiveness of a territory. The 601 indicators concerning each domain are constructed on the basis of data from 22 public and private sources with municipal data. The data is synthesised and processed with the NOMISMA I2I algorithm. The score of a municipality in the overall NOMISMA I2I SCORE ranking therefore depends on the scores obtained by that municipality in the individual analysis domains. All the regional capitals present indicators that

are above the Italian average, and 52% of them score high - at least 60 points out of 100.

The information gathered concerns:

- General Information
- Environment
- Municipal Budgets
- Socio-economic conditions
- Credit and Financing
- Taxation
- Companies
- Infrastructure and services
- Population displacement
- Recourse to justice
- Education
- Level of services offered
- Labour Market
- Property market
- Population
- Transport
- Tourism

Italy2Invest is conceived and developed to be a real business tool, useful to identify and map out new growth, development and valorisation paths for cities and territories, according to the actions of policy makers in the identified sectors.

2.4 Competitiveness and city challenges

The rankings analyzed, along with the study of how competitiveness is intended in different branches, not only revealed the multidimensionality of urban competitiveness but also the evolutionary nature of its meaning. Given the importance of the topic for the government of urban transformations, administrators and public decision-makers need to continuously check the effectiveness of the strategies they propose to safeguard the competitive position of cities and ensure their positive gradient. This is even more relevant if considering the numerous social, economic, or environmental challenges that cities are called upon to face in the near future in

order to respond to continuous, despite often unforeseeable, external stresses. Among these, the effects of climate change, the transformation of the urban environment due to globalization, the growing demand for travel, social tension, the challenges of sustainability and digitalization, and the increasing physical and functional vulnerability have entailed and entail disparate consequences in different geographical areas.

The current confluence of crises, dominated by Covid-19, climate change and, last but not least, the Ukraine-Russia war, is creating unprecedented impacts on cities, jeopardizing their resources, health, equity, and security. In this scenario, rapid and poorly planned urban interventions, far from being immediate solutions to these challenges, turn out to create further difficulties such as shortage of affordable housing, inequal accessibility, soil consumption, unsafe levels of air pollution, and increased climate and disaster risk (Bove, 2022). The competitive success of territories can no longer lie exclusively in the search for one-fits-all solutions intended to enhance their economic development but in the development of resilient systems able to respond to multiple challenges, involving all sectors, administrative levels, and different parts of the territory (Rota et al., 2020). In substance, urban competitiveness depends not just on physical, organizational, and functional resources, but also on the ability to respond to unforeseeable crises, building successful relationships within and outside of the system. It also involves capitalizing on the opportunities that come with change, adapting resiliently, and turning threats into chances for competitive growth.

Covid-19 is just one of the contemporary challenges that cities have had to face, as the most recent energy crisis due to the Russian-Ukrainian crisis demonstrates, as they have the resources to do so due to the urbanization explosion and high resource density. Future research must ask how current challenges can become an opportunity to increase the competitiveness of cities, attract people and improve their quality of life. In other words, cities are the places where the challenges of our century are condensed, but they are also the catalysts for the most effective solutions, playing a key role as drivers of the economy, places of connectivity, creativity and innovation, and reservoirs of resources for the surrounding areas.

In this sense, a renovated definition of urban competitiveness could be:

Competitiveness is a fundamental characteristic for the governance of urban trans-formations, especially in the future scenario outlined by the challenges cities will face in the coming years. In this scenario, urban competitiveness is defined as the ability of an urban system to self-organize to increase its competitive level, increase the intensity and quality of relations with other systems, attract people, skills, investments, and activities and adapt to external agents, exploiting the opportunities offered by global changes.

2.4.1 The challenges of European cities

Over the past decades, in Europe, economic growth has slowed dramatically with consequences for cities that range from the crisis in the industrial sector and the relocation of production sites, to rising unemployment and brain drain (Gargiulo, 2002; Sgambati & Gargiulo, 2022). Additionally, European cities, while having a historical value without comparison with other continents, pay the price of high physical vulnerability to natural disasters, earthquakes, and climate change effects (Gargiulo & Sgambati, 2022). Their urban environment is subject to relevant pressures due to urbanization, tourist arrivals, migration flows, the spread of economic activities, and soil consumption (Zucaro & Morosini, 2018). With pressure on land and natural resources come adverse effects on land sealing, agriculture and biodiversity. These impact the urban economy and overall urban efficiency. Gentrification, as one of the main phenomena characterizing European cities of the last decades, although improving levels of quality and wealth of many urban centres, also leads to social disparities and marginalization of already disadvantaged urban areas or peripheries, where migrants and social minorities are often concentrated (Carvalho et al., 2019). Significant discrepancies in development levels and living standards among territories and within the same urban area, together with the scarcity of resources, which are already negatively affecting urban economic systems, also pose challenges for sustainable development (Mitlin & Satterthwaite, 2014). Furthermore, European cities struggle with various issues related to urban mobility, including congestion, insecurity, air and noise pollution, as well as increased difficulties in ensuring mobility for vulnerable categories of the population

and covering the escalating costs of public transport infrastructure investment and management, also considering that in Europe, approximately 25% of CO_2 emissions are attributed to urban transportation, particularly urban freight and private cars (Viana et al., 2020). For what concerns demographic challenges, the population of the EU is ageing and this is demonstrated by the increase in the share of the elderly population (with 21% of people aged more than 65) the dependency ratio of the elderly and the median age (44 years old) (Carpentieri et al., 2020). Considering the relationship between urbanization and ageing, it is clear that in the future cities will be the places where the challenge of an ageing population will be most concentrated, but also the places able to provide the resources necessary to adapt to this epochal change (Guida & Carpentieri, 2021).

Since the early 2020, the abovementioned challenges have been exacerbated by the Covid-19 pandemic and the current energy crises – caused by the Ukrainian-Russian conflict – that have tested the ability of European cities to hold out and adapt to the new context of change (Gargiulo et al., 2022). Therefore, as urban growth intensifies and cities become new centres for similar challenges, new solutions are needed to reduce the risks associated with these challenges but also to transform them into opportunities to improve cities' quality of life and competitiveness. In particular, the Covid-19 emergency[4] has suddenly changed the life of our cities by imposing unprecedented measures and new planning patterns that, while being proposed as momentary experiments, have revealed their effectiveness and replicability in the post-covid era. In 2021 the European Union, indeed, reacted to the economic losses, health and social issues raised by the pandemic, by launching the program NextGenerationEU (NGEU), which provides resources and opportunities to give a chance for recovery and development to the EU countries (European Commission, 2021).

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[4] In the first months of 2020, the entire world saw the spread of a novel coronavirus first detected in China at the end of 2019, causing health emergencies and raising social and economic issues. Since 13 March 2020, Europe has recorded more cases than China, such that the WHO considered European countries the new active epicentre of the pandemic. The pandemic's spread is greatly amplified by the dense population, bustling activities, presence of services and leisure, and high mobility that characterize urban environments.

2.4.2   Urban competitiveness vs NextGenerationEU

NextGenerationEU is a temporary tool (accounting for €750 billion) that firstly aims to repair the economic and social damage caused by the coronavirus pandemic, also facing other present and future challenges such as climate change, digital and green transition, and the achievement of higher levels of equity (EC, 2021). The program is structured to respond concretely to the economic and social consequences of the pandemic and generate, additionally, competitive advantages. Thereby, the NGEU represents a unique opportunity to enhance the competitiveness of the country, and, notably, the competitiveness of urban areas. The European Commission initiative is structured on 6 pillars, namely: green transition, digital transformation, smart-sustainable and inclusive growth, social and territorial cohesion, health-economic and institutional resilience, and policies for the next generation. It represents an extraordinary opportunity to deal with these challenges, also at the urban scale, in order to get wider and shared economic advantages.

Although not explicitly, the concept of urban competitiveness pervades different pillars of the plan, linked specifically to the necessity of raising the competitive level of the territories involved, mitigating territorial gaps, and, more generally, all those 'missions' for which cities have a fundamental role. Hence, it is worth wondering how the plan can lead to higher levels of competitiveness in our cities and support, in this way, the national economic recovery. Research should answer if the financial resources have been distributed in the territory in relation to the suitability of urban contexts, also with a view of making territorial and social disparities fade away, overcoming the city centre-suburbs and north-south disparities. The comparison of urban competitiveness research with the NextGeneration EU gives the opportunity to understand in which fields cities are called actually to compete in order to attract the currently available resources. To ensure the success of the recovery plan, it is necessary that all the initiatives, especially those concerning urban areas, will have a complete implementation and provide an actual economic advantage. This is due firstly to the fact that cities are the main recipients of the financial resources for the implementation of several strategies. The success of cities' projects relies on the ability of policymakers to understand the territories'

vocations and steer their development in the right direction. If correctly distributed by reason of cities' suitability for development (susceptibilities), the European resources constitute a great opportunity for cities since they can determine the future economic performance and improve the quality of life of citizens.

If contextualized in the recovery period we are currently experiencing, triggered in Europe by the Next Generation EU program, this research work is further specified, broadening its objectives due to the contents of the plan. In particular, as shown in the next chapters the Macro-areas of competitiveness that I have chosen to investigate in this study are the result of the intersection between the components of competitiveness traditionally examined by the scientific literature and the pillars of the NGEU for which, following an in-depth analysis of the plan, the theme of urban competitiveness is most pervasive, namely: (i) Tourism and culture; (ii) Green transition; (iii) Digitalisation/smartness; (iv) Sustainable mobility; (v) Economic and Social Resilience.

The contribution of cities to the national economies' success greatly depends on their characteristics of competitiveness and on the ability of policymakers to understand and orient their intrinsic resources and vocations (Camagni, 2002; Boddy & Parkinson, 2004; Sharifzadegan & Nedae Tousi, 2016), ensuring the overcoming of territorial disparities and the adaptation to current global challenges. In this sense, given that urban competitiveness is a function of multiple components and features of urban systems (Ciccarelli, 2006; Sáez & Periáñez, 2015), it is worth comparing current research with the available resources.

In this framework, it is worth considering the role of cities in the NextGenerationEU implementation, since the scientific literature on urban competitiveness lacks a unified approach to the topic. And yet, it is fundamental to define which urban characteristics are suitable to describe the competitive potential of cities in relation to the challenges they will face in the future. In order to fill this gap, this Ph.D. work deepens the cities' suitability to competition (susceptibilities) and considers urban competitiveness as a fundamental aspect for the economic and social growth of territories (Begg, 1999; Carvalho et al., 2016; Ni & Kamiya, 2020). Thanks to the high concentration and availability of people, opportunities, and goods, cities have gradually become a driving force for global development (Mori Foundation, 2022),

especially in periods of economic transition (Papa et al., 2014) such as the one we are experiencing right now.

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CHAPTER 3. URBAN COMPETITIVENESS IN SCIENTIFIC LITERATURE

3.1 Introduction[5]

Assumed that the research project objective is to examine, in an operational key, the role of territorial competitiveness in the development of an area with its own connotations and growth opportunities, this chapter provides a systematic scientific framework of urban competitiveness, deepening how academics have dealt with the topic over the past decades through bibliometric analysis.

The scientific debate regarding competitiveness, originally referred to firms within the economic disciplines and then related to the productivity of countries and regions, has broadened to urban competitiveness over the last 30 years, going through many phases (Papa et al., 2016). Since the 1990s, along with the effects of globalisation, urbanisation and digitalisation, researchers started focusing on competitiveness as an attribute of cities and, specifically, metropolitan areas. This is due to the evolution of the role of cities in the global economic system. However, the use of the concept of competitiveness at the territorial level has led to a wide-reaching debate in the scientific community, sparking dissent among scholars such as Krugman and Lall, who underlined how the application of the concept of economic competitiveness on a territorial scale generates both conceptual and applicative criticism. These statements are mainly based on an assessment of the numerous differences between companies and territorial contexts from the point of view of both the organisational structure and the objectives pursued (Krugman, 1994; Lall, 2001).

Nevertheless, thanks to their extension, the consolidated transport system, and a large amount of human and physical resources (Ni & Kamiya, 2020) the performance of cities has been recognized as crucial for the success of economic systems. The urban economy is now the engine of global development. Thus, promoting urban competitiveness can lead to new resources and opportunities by attracting new businesses, investments, activities, creativity, talents, and visitors (Malecki, 2002; Gabe et al., 2012; Du et al., 2014). For these reasons, urban competitiveness has gradually become a central theme to govern the transformation of cities

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[5] This chapter is a formal elaboration of a scientific paper published by the author in a class A scientific Journal. Sgambati, S., & Gargiulo, C. (2022). The evolution of urban competitiveness studies over the past 30 years. A bibliometric analysis. *Cities*, 128, 103811.

for administrators and decision-makers (Turok, 2004). Before the concept of competitiveness reached its full application in the urban planning field, numerous scholars sought to develop an adequate theoretical support base. In the first studies on territorial competitiveness, only the economic aspects capable of making a specific urban context attractive for companies, investors and the marketing of the goods produced were taken into consideration (Deas & Giordano, 2001). Kresl & Singh (1999) state that a vision of urban competitiveness aimed at identifying the factors capable of attracting productive investments is made up of two components: the economic and the strategic. The first includes aspects related to production, infrastructure, location, economic structure and urban services. The second component includes aspects such as government efficiency, urban development strategy, cooperation between the public and private sectors and institutional flexibility. Further advancement is provided by Camagni (2002), who states that it is possible to consider phenomena such as globalisation and internationalisation as part of a shared heritage because all regions can be affected by the possible benefits and threats deriving from these phenomena depending on their extrinsic characteristics. This highlights how the specificities of each region can be essential elements of the competition between different territorial entities (Audretsch & Keilbach, 2004). These characteristics include aspects such as human capital, innovation capacities, geomorphological characteristics of the region, types of infrastructures and all the other factors (Turok, 2004; Papa et al., 2014) that contribute to the multidimensional nature of urban competitiveness. The economic and social importance of this competition has made competitiveness a topic of great interest, especially for those involved in the governance of urban and regional transformations.

Martin and Simmie (2008) contribute to broadening the scientific debate on this issue, defining urban competitiveness as "the ability of cities to continually upgrade their business environment, skill base, and physical, social and cultural infrastructures, so as to attract and retain high-growth, innovative and profitable firms, and an educated, creative and entrepreneurial workforce, to thereby enable it to achieve a high rate of productivity, high employment rate, high wages, high GDP per capita, and low levels of income inequality and social exclusion".

Further in-depth studies have expanded the field of study with the inclusion of other tangible and intangible aspects (environmental, cultural, technological, human capital, artistic beauty, etc.) that can, directly and indirectly, influence the localisation choices of both businesses and citizens choosing an urban environment in which to reside and/or invest in order to satisfy their needs and aspirations (Sáez et al., 2017; Buck et al., 2005). In addition, considering the city as a complex system, it is acknowledged that the study of urban competitiveness requires a multidimensional and systemic approach (Ciccarelli, 2006; Papa, 2009). As a matter of fact, it is recognized by several researchers that a competitive advantage is the result of the promotion of a wide 'system' of urban characteristics, even when the competitive advantage is sought only for a specific sector. These characteristics include aspects such as human capital, innovation capacities, physical assets, services and infrastructures that contribute to the multidimensional nature of urban competitiveness. The economic and social importance of this competition has made competitiveness a topic of great interest, especially for those involved in the governance of urban and regional transformations (Papa et al., 2014).

In recent years, cities all over the world have started a competition among themselves in order to offer the best conditions to attract investments, citizens and new skills. In this context of global competition, the traditional approach that envisaged the exclusive study of the relationships between a city and its neighbouring territorial context is now outdated. Today, thanks to new communication and transport technologies, cities are able to interact, materially and immaterially, with other territorial entities, even ones that are geographically distant. This has enabled urban entities, located a considerable distance away from each other, to compete in the most diverse sectors, from the production of goods and the provision of specific services to environmental protection.

This chapter deepens the evolution of the main factors and features behind urban competitiveness over the last thirty years and discusses the advancement of the scientific research that naturally occurred in parallel with phenomena such as globalization, digitalization and urbanization. The study followed both a temporal and a geographical scheme. The temporal scheme highlights the relationship with industrialisation (Turok, 2004), the intensified role of intellectual capital and creative

economy (Gabe et al., 2012; Dima et al., 2018), the importance of soft factors beyond that of hard factors to enhance cities' competitive level (Malecki, 2002) and so on. The geographic scheme points out how different aspects like quality of life, quality of place (Esmaeilpoorarabi, 2016; Gargiulo et al., 2016), culture (Moradi et al., 2019), environment (Zenker, 2013; Papa, 2016) hard and soft networks are considered elements of competitiveness in different countries.

To examine the worldwide scientific production, a bibliometric analysis was implemented, studying evolution and relations between documents, to build a systematic scientific framework. In detail, I examined the evolution over time of the concept of urban competitiveness, identifying the different approaches according to the geographic affiliation of authors and applications and the relationship of co-occurrence between keywords. 2,121 articles published between 1967 and 2020 were gathered from the Scopus database and elaborated following the PRISMA procedure and using bibliometric software tools such as VOSviewer and ScientoPy. In order to limit the disadvantages of using bibliometric analysis (publication bias, selection bias and heterogeneity of the studies) the work was integrated with an accurate study of the most significant documents, selected by reading titles, keywords and abstracts of the sample of articles.

What was found is a strong relationship between urban competitiveness and the ability of a city to tackle future challenges. In the scenario defined by the phenomena cities will afford in the future - such as climate change, the development of sustainable mobility, social challenges, and so on - the ability to adapt to external changes is crucial to develop a competitive advantage, transforming threats in opportunities. After the 2008 global financial crisis and the more recent Covid-19 crisis, the success of territorial economies does not lie only in the achievement of technological and economic advantages, but also in the development of resilience, adaptation and creative exploitation of changes (Rota et al., 2020). The ability of a city to face changes and challenges, rebuilding from a crisis like that we are currently experiencing, determines its worldwide competitive level (Papa et al., 2014). These findings, confirmed by the attention of many international organizations to the topic, constitute the basis for the research to implement a new methodology which will be addressed to bridge the gaps identified in this first phase.

The chapter is structured in four sections, besides this introduction. While the following section contains a description of the methods and criteria used to develop the review, the third section is a discussion regarding the results of the work and, in particular, the diachronic and geographical evolution of the studies on urban competitiveness. Furthermore, this chapter investigates, in the fourth section, quantitative approaches and models developed by the scientific community.

Finally, the last section refers to the results of the bibliometric analysis as the basis for the development of the research.

3.2 Bibliometric analysis

Bibliometric analysis is a statistical evaluation of published scientific articles, books, chapters of books, and so on. It consists of the quantitative study of production, growth, maturation and evolution of some scientific publications and has quickly perfected alongside the exponential digitalisation of science. The use of bibliometric analysis allows putting together results from a wide sample of documents, obtaining the following advantages: the opportunity to build a meaningful overview on urban competitiveness, based on the size of the sample; the possibility of sub-group analysis.

In this research, bibliometric analysis was implemented to assess and analyse researchers' production in the specific field of urban competitiveness to produce a systematic review of the articles published between 1967 and 2020 from the Scopus database. This analysis consisted of two phases:

- the first phase was conducted selecting an extended sample of publications, study trends, temporal and geographical evolution and relations between the articles;

- in the second phase, the sample of publications was further streamlined to identify a limited number of documents and build a scientific framework regarding urban competitiveness.

Both phases of the bibliometric analysis were conducted considering the specific disciplinary fields of urban studies and urban planning and the objective of understanding the current direction of the research and how it has evolved. This filtering operation has been possible thanks to the setting of a query in Scopus which limits the research by considering many subject areas. The analysis was run in

VOSviewer and ScientoPy, which are software tools that can create maps of science representing the relationship between different elements. A map of science is a spatial representation of how disciplines, fields, actors (authors, institutions, countries) and individual papers are related to each other. Specifically, VOSviewer is a software developed by the Centre for Science and Technology Studies (CWTS) at Leiden University (NL) in 2019. ScientoPy is an opensource Python script useful to perform diachronic analysis, processed by the University of Cauca in 2019. Both VOSviewer and ScientoPy were selected following a comparative analysis of the potentialities of the most recent software tools, considering the aim of the paper.

To perform a bibliometric analysis, the first stage is to decide the best data source that fits with the scientific coverage of the research area. Amongst the different bibliographic multidisciplinary databases, I chose Scopus, given that it is supported both in VOSviewer and in ScientoPy. Although WoS is also supported, I opted to use Scopus as it has a greater number of documents and fewer record limits. In addition, only ScientoPy allows users to merge both databases.

The first phase of the bibliometric analysis was processed using a sample of 2,121 documents from the Scopus database. The query was set searching «urban competitiveness» in the title, the abstract and/or the keywords of the entire database, in order to search for documents where the words «urban» and «competitiveness» appear together or separately. The query «"urban competitiveness"» would have restricted too tightly the sample of documents (from 2,121 to 265), limiting the results of the analysis. The workflow in Figure 3-1 synthesises the process, bringing 2,121 documents down to 1,631, throughout the PRISMA method (Preferred Reporting Items Systematic Review and Meta-Analysis), intending to improve the results of the review.

As shown in the diagram, I limited the research to the narrow fields of ENGINEERING, ENVIRONMENTAL SCIENCES and ALL SOCIAL SCIENCES, since they respectively include aspects that interest the field of expertise of urban planning or civil engineering.

The choice of the SUBJAREA fields in Scopus is in line with the premises and the aim of the research, given the multidisciplinarity of the topic. In the first phase, I

also excluded publication years 2021 and 2022, to avoid mistakes in the interpretation of data due to the still limited number of articles at the moment of the analysis. I limited the sample to articles, conference papers, books and/or book chapters. Lastly, I further reduced the number of documents, filtering them by language and considering only English records, to provide an international scientific panorama to the review. A dataset comprising 1,631 records was obtained.
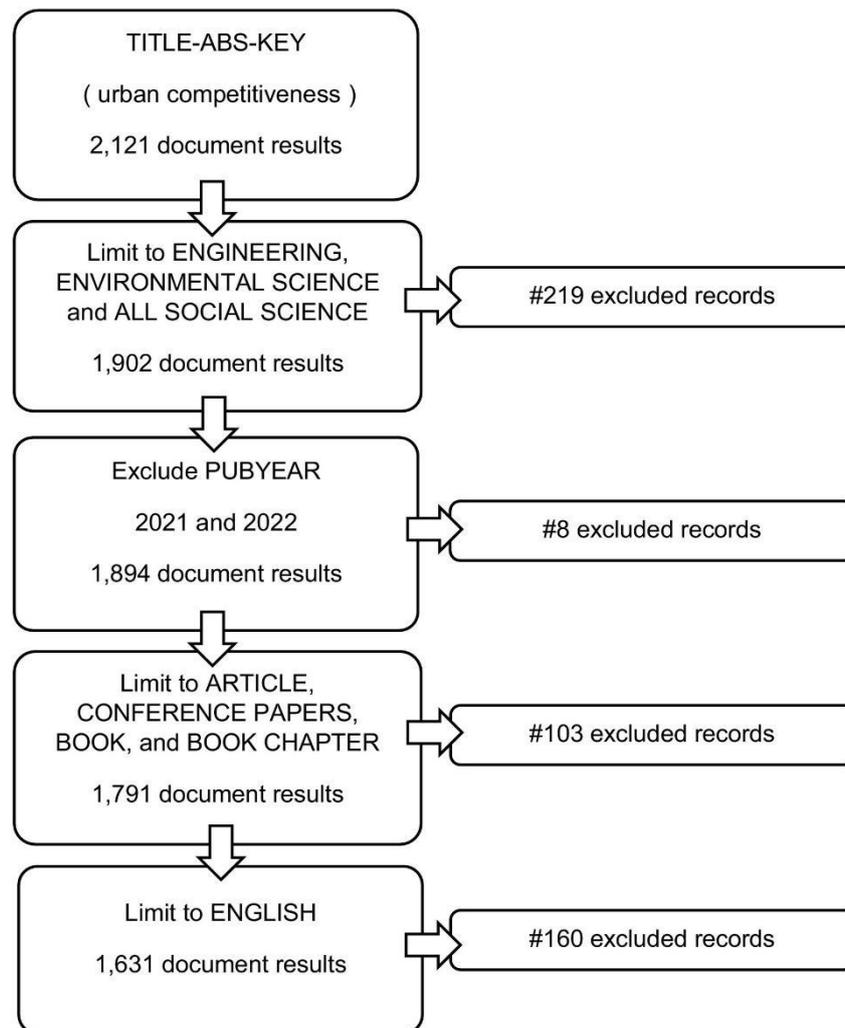
Figure 3-1. Workflow of the extensive analysis developed with PRISMA method (author's elaboration).

Trends and the distribution of the publications were analysed using ScientoPy (Ruiz-Rosero, Ramírez-González & Viveros-Delgado, 2019) and VOSviewer (Van-Eck & Waltman, 2010). ScientoPy is useful to perform temporal bibliometric analysis from the Scopus and WoS databases. Once the data (Citations information, bibliographical information, abstract and keywords) had been extracted in .csv format,

a pre-processing stage was performed, consisting of document type filtering, authors' name normalisation and duplicate removal. On the other hand, we used VOSviewer to detect the most prolific countries, institutions and scholars and provide a structured analysis made up of co-occurrence and/or co-authorship networks from a large body of information. The analysis was conducted to study the occurrence of the most frequent keywords in order to deepen the evolution of the main urban features behind the concept of urban competitiveness over the past 30 years.

Considering the disadvantages of using such a wide sample of articles (publication bias, selection bias and heterogeneity of the studies) the second part of the analysis consisted of more intensive research, intending to select a limited number of references. In this regard, I improved the interpretation of the analysis with an accurate study of the most significant documents, selected by reading titles, keywords and abstracts of the sample.

The workflow in Figure 3-2 represents a phase of the work subsequent to that showed in Figure 3-1 and reports different steps allowing for the detection of the sample from the Scopus database.
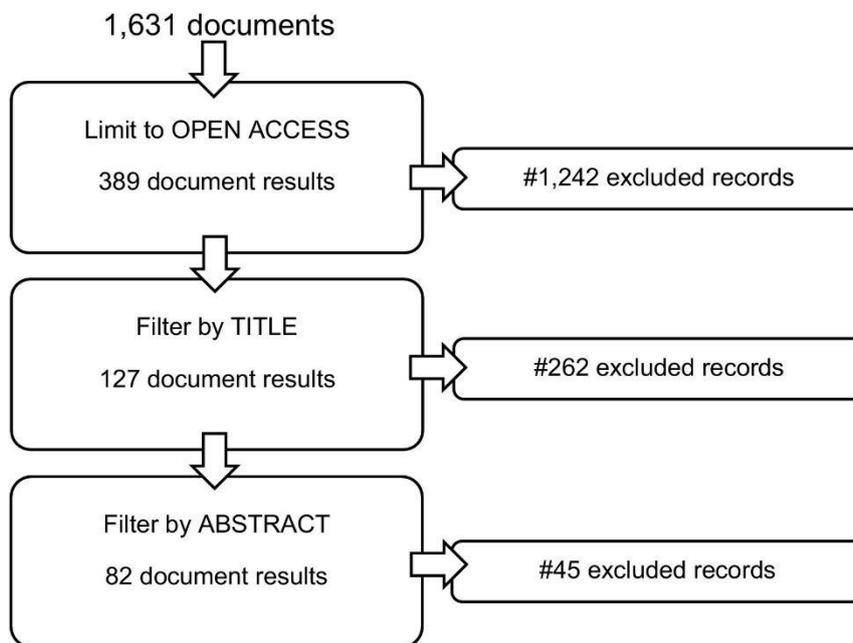
Figure 3-2. Workflow of the extensive analysis developed with PRISMA method (author's elaboration).

I limited the scientific field to ENGINEERING, ENVIRONMENTAL SCIENCE and SO-CIAL SCIENCE, even in this second phase. I also limited the research to open-access documents.

The sample was then filtered by selecting publications that reflect the results of the first phase of the analysis. Specifically, I filtered documents firstly by title – obtaining 127 documents - and then by abstract – obtaining 82 documents to which to refer for the scientific review.

In the next paragraph, we reported the results of the analysis, with the aim of defining a scientific framework, comprehensive of time and spatial implications.

3.3 Results

Given the sample of 1,631 documents, the average citation count per article is 14.78, whilst the median is 3. The total citation count was obtained from Scopus and shows the total number of times that a particular article has been cited by all journals listed in the database.

The most frequently cited article is "Smart cities in Europe" (Caragliu et al., 2011) published in the Journal of Urban Technology, cited 1,276 times since its publication and with a Field-Weighted Citation Impact of 13.22. The UK is the most cited country, with 6,892 citations, followed by the US, China, and Italy.

The Citation Overview from Scopus is reported in Figure 3-3 and testifies the increasing network of academics dedicated to the topic. The sample of articles has an h-index equal to 68.
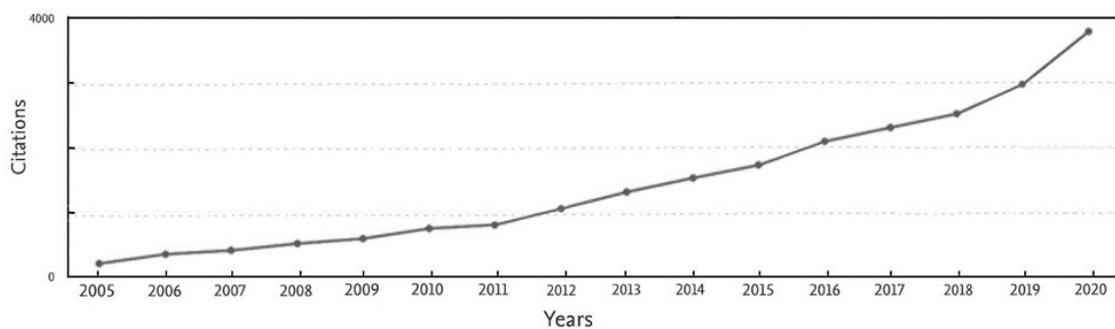
Figure 3-3. Citation overview of the 1,631 articles from Scopus in the period 2005-2020 (Source: Scopus).

Out of the 1,631 articles, 79.2% were written by 2 authors and only 131 of these produced more than 2 documents. Ni from China contributed to the highest number of articles with 13 documents, followed by Kresl (12 documents) from the USA

and Nijkamp from the Netherlands. Salvati from Italy, Shen from Hong Kong and Wu from the United Kingdom produced 7 documents. This first observation shows which are the countries involved in the scientific debate about urban competitiveness.

During 2021, 161 articles were published. Figure 3-4 shows the 5 most productive journals, distinguishing the number of documents per year by source.
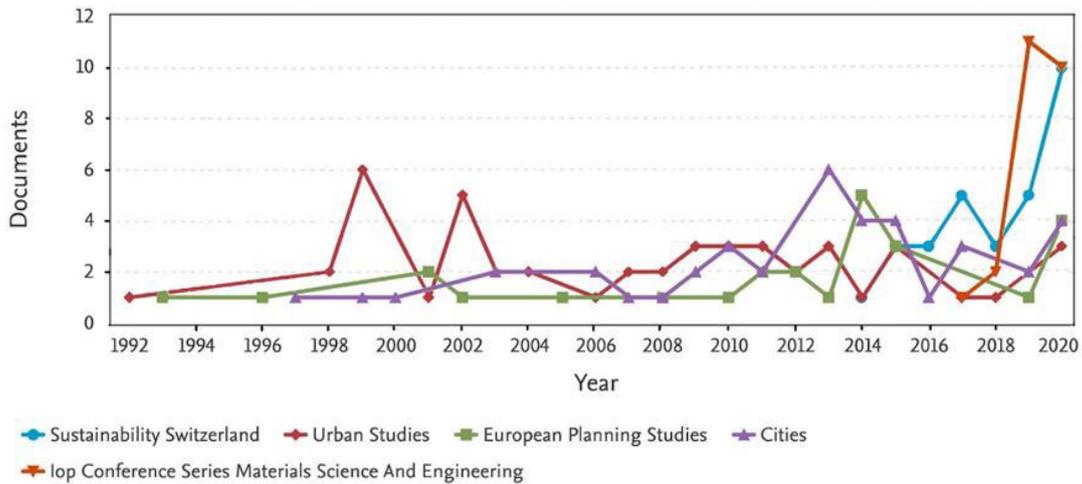
Figure 3-4. Number of documents per years by source (Source Scopus).

The diagram below (Figure 3-5) shows the annual number of documents published in Scopus from 1967 to 2020. The graph highlights the increasing concern of the scientific community, with an up and down trend during the 2010s, with soaring numbers in the last few years, thanks to the acknowledged relationship with sustainability (Kourtit et al., 2020).

On the other hand, figure 3-6 reveals the geographical distribution of documents. Amongst the 1,631 articles, 61 were independent publications and 69 articles have an undefined source.

The entire sample covers 85 countries, with the majority originating from China (255 – 15.6%), the United States (245 – 15.0%) and the United Kingdom (216 – 13.2%), followed by Italy and the Netherlands.

This is not surprising, given that China, the USA and Europe continue to be leaders in the global economy and cities are considered an essential resource to confirm this leadership.
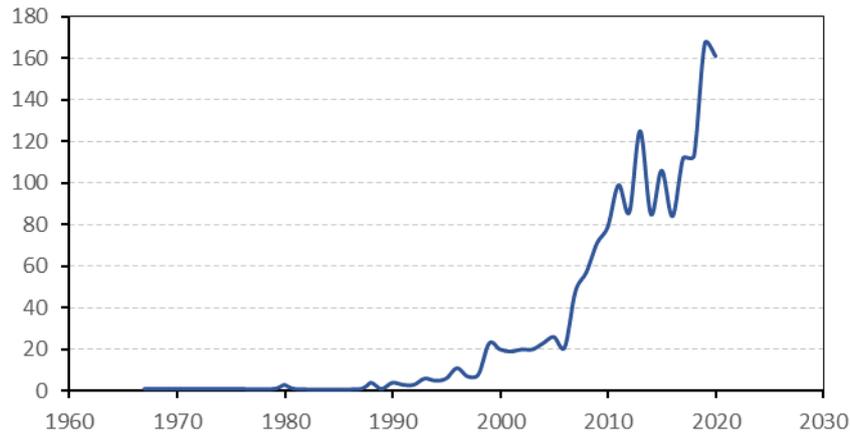
Figure 3-5. Annual number of documents about urban competitiveness published in Scopus from 1967 to 2020 (author's elaboration).
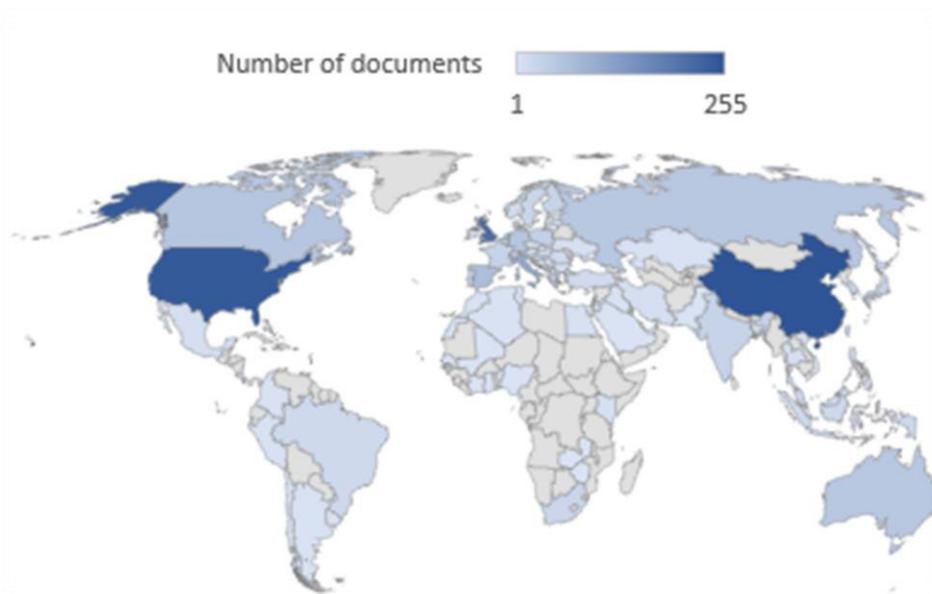
Figure 3-6. Geographical distribution of documents about urban competitiveness published in Scopus from 1967 to 2020 (author's elaboration).

Firstly, the temporal and geographical distribution of the records was examined. China, the USA and the UK – i.e., the most productive countries - show the most pronounced increase of an accumulative number of documents since 1990 - data from 1967 to 1989 were excluded as they were considered irrelevant due to the lower number of documents. Italy is the third country with the highest average documents per year between 2019 and 2020 (12.5 doc./year). It is responsible for 30% of the scientific production in these two years, together with China, followed by Spain (26%), Australia (20%) and the Netherlands (18%).

It is worth noting that 54.8% of the competitiveness studies published until 2020 were produced in European countries and that 7 of the leading 15 countries are part of the EU. The results of the geographical distribution described above suggest that urban competitiveness has not received the same concern in low-/middle-income countries and the upper-middle or high-income countries. However, it is expected that, in the near future, competitiveness will become a central topic also in developing countries, as demonstrated by recent studies about the topic (Kresl, 2020).

The rapid evolution of China's production since around 2008 is the mirror of the urbanisation process of the last decades, which led to China's urbanisation rate shift from 40% to more than 60% between 1978 and 2018, leading to a planned urban growth coupled with economic development (Xie et al., 2018). Urbanisation is due to the continuing integration of the Chinese economy into the globalising world and the increasing intercity competition (Bercht, 2013).
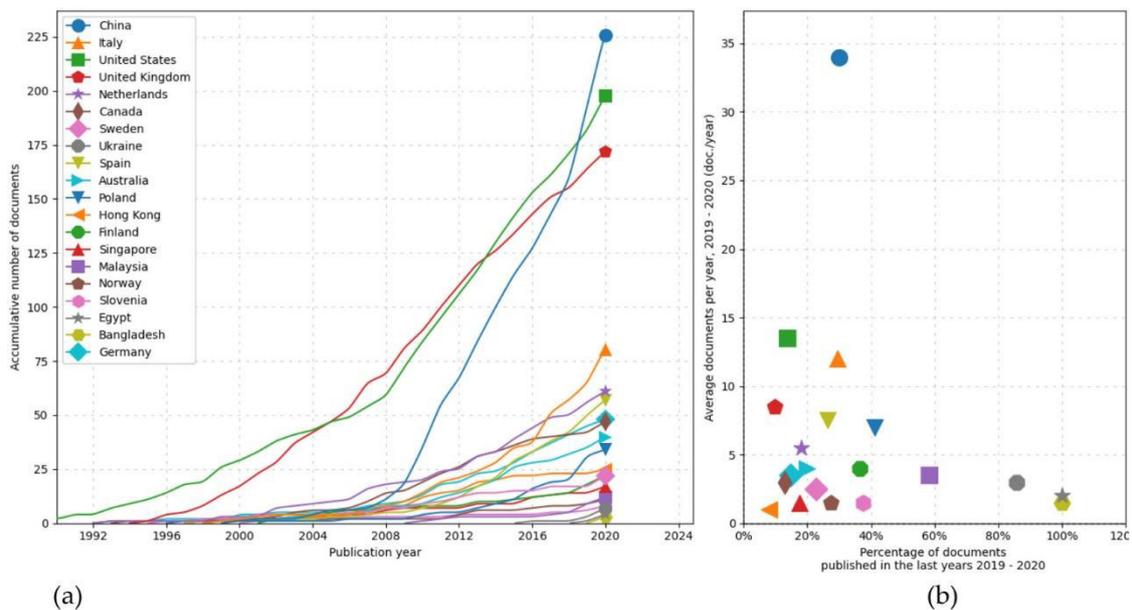
Figure 3-7. a) Evolution of the number of documents per year and per country from Scopus in the period 1990-2020. (b)Accumulative number of documents and average documents per year between 2019 and 2020. (author's elaboration obtained by ScientoPy).
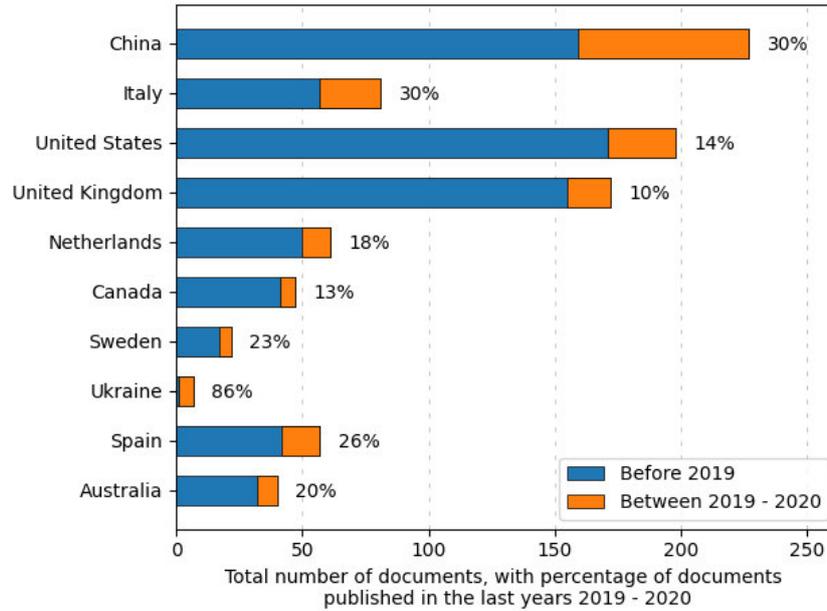
Figure 3-8. Bar trend of the total number of documents published in Scopus during the period 1967-2020. (author's elaboration obtained by ScientoPy).

The network in Figure 3-9, developed using VOSviewer, adds information about the co-authorship relations between countries, therefore not only the number of documents produced per author but also the interactions within the scientific community.
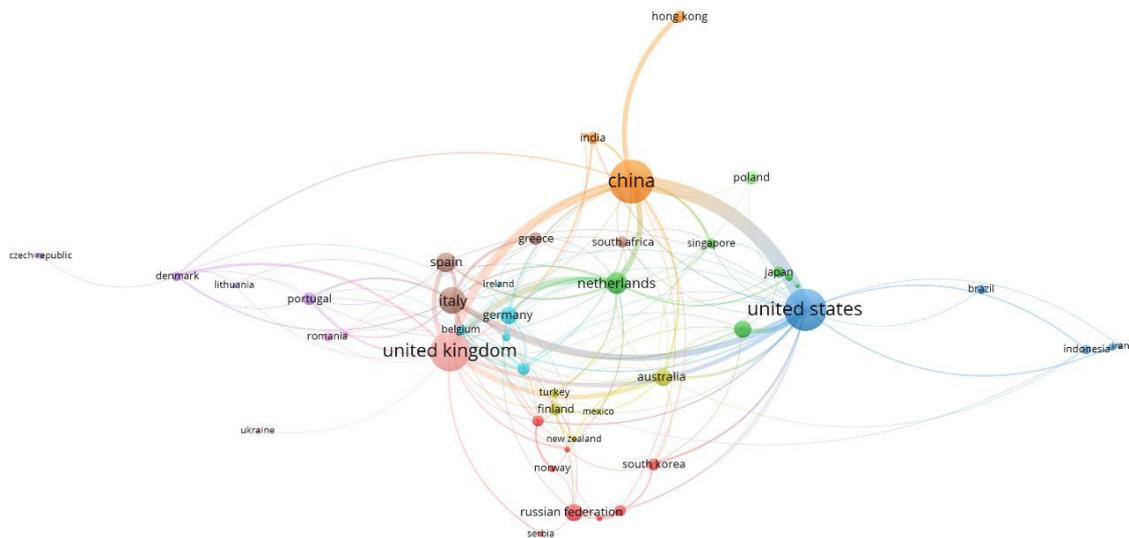
Figure 3-9. Co-authorship relations between countries in a network visualization of the articles published in Scopus during the period 1967-2020. (author's elaboration obtained by VOSviewer).

The network was built by setting a minimum number of documents per country equal to 5, therefore 52 countries were excluded. The size of the label and the circle of an item is determined by the weight of the item, whilst the colour of an item

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depends on the cluster to which the item belongs. Lines between items represent links of co-authorship, whilst the distance between two items approximately indicates the relatedness of the countries in terms of co-citation links. It is worth mentioning that the US, China and the UK have a central role in defining the scientific framework regarding urban competitiveness, with strong co-citation links with a lot of countries. In the global panorama, the Netherlands, Italy, and Spain – generally European countries - also count a high number of documents and co-authorship, whilst the Russian federation constitutes a different cluster, distant from other geographical affiliations, but with a modest number of co-citation links. This implies that competitiveness is differently approached in different countries, corresponding to different clusters, although it is possible to find points in common and analogies among the countries with a higher amount of co-citation.

The next step of the bibliometric analysis examines the most frequent keywords in the sample of documents obtained from Scopus, to learn about temporal and spatial evolution of concepts, definitions, and approaches of urban competitiveness. Software tools identified 7,503 keywords, 5,642 of which were used only once and 827 were used 2 times. The word cloud in Figure 3-10 shows the 100 most recurring keywords, whose dimension is proportional to their frequency. During the period 1967-1990, the low average number of documents published per year alongside the low keyword co-occurrence did not enable us to extract relevant information regarding the evolution of the topic. Therefore, the period was excluded from the Scientopy diachronic analysis. While at the country/region level competitiveness is influenced by the territorial features, which are favourable to the location of industries and enterprises (Rogerson, 1999; Turok, 2004; Kresl & Ietri, 2017), since the 1990s, authors such as Begg, Lall and Camagni, given the effects of a globalising economy, started considering competitiveness as an attribute of cities (Begg, 1999; Lall, 2000; Camagni, 2002). The increasing importance of urban economy is due to the huge amount of resources available in urban areas. It is estimated that, in 2050, 68% of people will live in cities, (Ni & Kamiya, 2020) therefore the performance of cities will become crucial for both attractiveness and economic success. Promoting cities in international competition can lead to new resources and opportunities, attracting investments, activities, talents and visitors.

The period 1991-2000 recorded 92 articles, with an average production per year of 9.2. The recurrence of keywords such as "Urban Economy" (5 times) or "Regional Economy" (4 times) highlights that the academic production drove the attention from the competition between productive countries to territorial competitiveness, focusing on the regional scale. Within 2001-2010, 383 documents were published, with an average production per year of 38.3. As shown in Table 3-1, cities and the urban environment were central items in the evolution of the topic. As regards geographical trends, Europe continued to be a pivotal keyword, but, at the same time, Asia and specifically China, appeared for the first time in the urban competitiveness panorama, due to the economic rise and the rapid urbanisation of China. Lastly, the period between 2011 and 2020 recorded over 1,000 documents, with an average production per year of 114. During this period, keywords such as "Sustainable Development" and "Sustainability" emerged, in line with the evolution of the scientific scenario, that increasingly relates to environmental matters, whilst environmental protection was previously considered a negative externality regarding territories' competitiveness. This demonstrates that competitiveness, differently to the past, when it was associated with the productiveness of a country/region or a firm, now goes hand in hand with the sustainability paradigm, referring to the promotion of the use of renewable resources and the construction of inclusive communities (Carvalho et al., 2016).

Figure 3-10. Wordcloud developed in ScientoPy, representing 100 most recurrent keywords in a sample of 1,631 articles from Scopus. (author's elaboration obtained by ScientoPy).

The results of Table 3-1 are synthetically reported in the ScientoPy timeline (Figure 3-11), which represents the temporal evolution of the first 20 keywords most recurrent in the overall sample of documents. The first two keywords "Competitiveness" and "Competition" were excluded since they are not significant to the scope of the research. In the last decade, "Regional Planning" and "Regional Economy" have been replaced with "Metropolitan Areas" and "Urban Area", meaning that more recent studies on urban competitiveness consider cities the leaders of economic growth. The increasing concern regarding sustainability, described above, is clear, as it is the progressive economic development of the Chinese metropolis. The sharp fall in the keyword "Eurasia" in around 2010 may be due to the deterioration of economic relations between the EU and the Russian Federation, ratified by the Ukrainian crisis in 2013 and the failure of the Stabilisation and Association Agreement.

In addition, the results show that urban competitiveness evolves alongside the evolution of cities (urban development, urban growth, globalisation), therefore researchers must consider the multiplicity of phenomena that influence urban systems to measure their competitiveness. In this context, innovation is an essential component of competitiveness, therefore a competitive city must be able to attract investments, resources and people to enhance technology advancements. Researchers assess a territory's human capital by focusing on the quantity and quality of basic skills, qualified graduate workforce, expertise in research and creative production (Florida, 2002). Skilled workers and creative population make creativity and diversity its strengths, becoming, in this way, a driving force for innovation, growth and development of urban areas. The development of a knowledge-based and creative economy shifted the attention to the need to attract qualified people, in order to increase the competitiveness of a territory, enriching its social and economic capital and producing a competitive advantage (Du et al., 2014; Florida, 2002). Cities and territories with a high concentration of skilled and creative people may well enhance competitive advantage, encouraging urban and economic growth. This determines the importance of soft factors instead of hard factors for the enhancement of urban competitiveness.

Productivity is of course essential, but not necessarily sufficient to make a territory more competitive. Software components of urban systems link to the needs, aspirations, and desires of the population. Quality of life, quality of place, culture, environment, and soft networks have taken on an essential role in attracting, not only investments, but also "talented migrants" (Malecki, 2002) who can support economic and technological advancements.

	1991-2000		2001-2010		2011-2020	
Rank	**Keyword**	**Frequency**	**Keyword**	**Frequency**	**Keyword**	**Frequency**
1	Competitiveness	22	Competitiveness	136	Competitiveness	297
2	Urban planning	15	Eurasia	77	Competition	156
3	Urban Economy	11	Europe	60	Urban Development	129
4	Competition	6	Urban Planning	59	Sustainable Development	104
5	Economic Development	6	Urban Economy	54	Urban Planning	103
6	Urban Renewal	6	Competition	53	Urban Growth	80
7	Europe	5	Urban development	41	China	80
8	Manufacturing	5	United Kingdom	30	Urban Area	66
9	United States	5	Asia	28	Sustainability	63
10	Urban Area	5	China	28	Urban economy	62
11	Developing Country	4	Governance Approach	28	Innovation	62
12	Regional Economy	4	Western Europe	23	Urban Competitiveness	57
13	Bus Transportation	3	Urban Area	22	Economics	56
14	China	3	Far East	21	Urban Policy	50
15	Costs	3	Sustainable development	21	Economic Development	48
16	Economic and social Effects	3	Economic Development	20	Governance Approach	43
17	Environmental impact	3	Globalization	20	Metropolitan Area	42
18	Environmental Protection	3	Innovation	20	Urban Transportation	42
19	Industrial development	3	Urban Policy	20	United States	41
20	Technology	3	Metropolitan area	19	Urban Transport	40

Table 3-1. Top ten of the most recurrent keywords from 1991 to 2020, from Scopus database (author's elaboration).

Cities achieve the increase in their competitiveness by providing jobs, income, cultural recreation amenities, social cohesion, and environmental benefits (Kresl, 2007). It follows that the key to urban competitiveness lies in different dimensions: investments in the tourism sector; research and innovation; the promotion of new opportunities for citizens and city users; the overcoming of social and economic disparities; the creation of urban identity that makes the city visible on the international level (Kresl & Ietri, 2017).

In this regard, it is worth mentioning the connection with tourism ("Tourism Development", "Tourist Destination"). Touristic attractiveness is fundamental especially in those cities where the cultural heritage and the intrinsic value of the settlement can be a driver for a culture-led development of the territory. "Accessibility" emerged as well in the word cloud processed by using ScientoPy. It can be intended as the level of connectivity among houses, services, facilities, and amenities but also as the number of opportunities available on the territory. Enhancing urban accessibility means improving the quality of life of citizens and city users and, therefore, the attractiveness of urban areas.
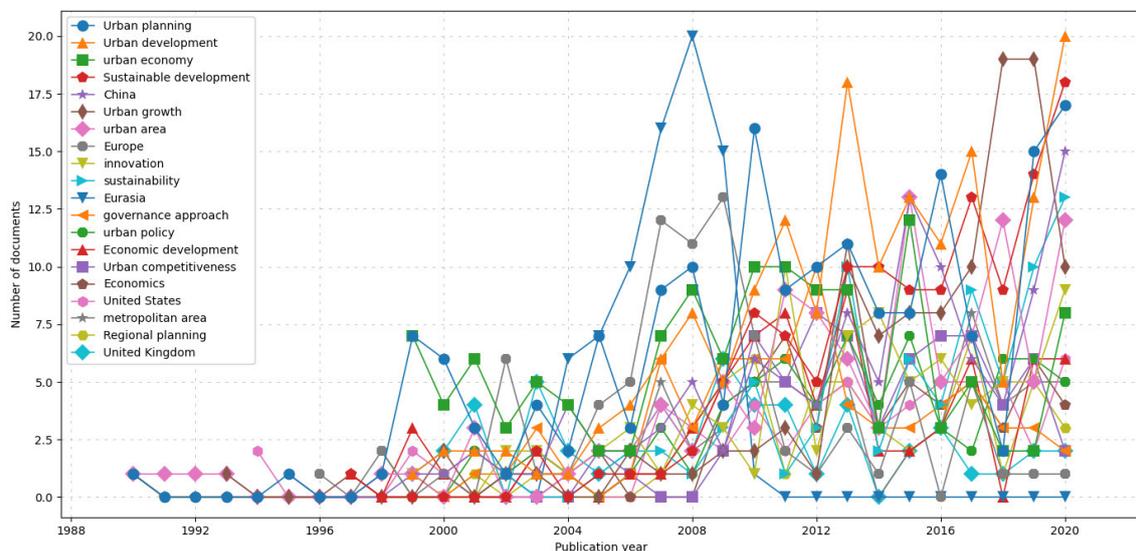
Figure 3-11. Timeline of the 20 most recurrent keywords in the sample of 1,631 articles retrieved from Scopus. We excluded the first two keywords "competition" and "competitiveness" (author's elaboration).

Climate change ("Climate Change", "Land Use") and urban design ("Urban Regeneration", "Spatial Planning", "Urban Design") are emerging topics, increasingly connected with urban competitiveness. They will therefore influence future

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competition between cities. The pace and extent of urban growth together with the environmental crisis are changing planning strategies, as cities are called upon to reduce the environmental impacts associated with their unprecedented growth. Cities have assumed a key role in the commitment to achieve environmental sustainability, climate resilience, the reduction of greenhouse emissions, developing paths for competitive and sustainable cities.

The graph in Figure 3-12 shows similar results, with additional information on the disciplinary field and the connection between items.

We identified many disciplinary fields: energy, transportation, environment, governance, society, urban phenomena – globalisation, urbanisation, sustainable development. The wide range of topics reveals the multidisciplinary nature of urban competitiveness and explains the systemic and multidimensional/integrated approach used by the academic community.

Figure 3-12. Network visualization of the keywords, from the Scopus Database, divided into different clusters. (author's elaboration).

In Figures 3-13, 3-14 and 3-15, there are represented the most recurrent keywords divided by regions, in a density display obtained by using VOSviewer. As the three engines of world economic development, I focused on China, the United States and the European Union: Europe continues to be a pivotal region, but, at the same

time, Asia and especially China, appears in the urban competitiveness panorama, due to the economic rise and the rapid urbanisation of Chinese cities.

In North America, urban competitiveness studies concern economic and social issues, departing from the multidimensional approach in some cases. Employment, economic activities and poverty rate alongside racial segregation and equality are elements for measuring competitiveness. Social or economic aspects drive regional competitiveness and development processes. Furthermore, it emerges that most of the developed studies concern US applications, almost as if the US concept of urban growth is closed in on itself, far from international competition.

China, in the last few decades, has become a leader in scientific production concerning cities and urban competitiveness. The growth of Chinese cities can be explained in terms of post-socialist pro-growth coalitions and reforms that led to the creation of new and more entrepreneurial local governments (Zhang et al., 2020). Following an extensive wave of industrialisation, during the 1990s, urban growth has become a preferred way for local governments to demonstrate local economic development and modernisation achievements.

Figure 3-13. Density visualization of most recurrent keywords in North America during the period 2011-2020. (author's elaboration).

Protection from financial losses against unprofitable urban investments generated a tendency for local governments to overspend and overdevelop (Xu & Yeh, 2005). In China, the increasing popularity of sustainable goals in urban planning is due to intense competition between cities (Song et al., 2020). The success of sustainable and innovative urban features such as eco-city, low-carbon city, smart city and knowledge city in China reflect the attempts of local governments to create global cities and boost their attractiveness. The density display shows the multidimensionality of urban competitiveness, ranging from transport to accessibility, from industry to urban development, etc. These topics make China's urban competitiveness approach close to the European approach. Quality of life, standard of living, space support, environment and social security are some of the factors correlated with urban competitiveness, according to both the Chinese and European scientific community.

Figure 3-14. Density visualization of most recurrent keywords in China during the period 2011-2020. (author's elaboration).

In Europe, the concept of competitiveness increasingly accompanies studies on the numerous challenges cities are facing. As shown in Figure 3-14, challenges refer to sustainable development and the circular economy, climate change, accessibility and transport demand, smart city, tourism, governance, and urban regenera-

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tion. In this context, urban competitiveness can be defined as the ability of an urban system to self-organise, to increase its competitive level, enhancing the intensity and quality of relations (EIU, 2013; Zenker et al., 2013) and, lastly, adapting to the external changes (Kakderi et al., 2021). After the 2008 economic crisis and the current COVID-19 health crisis, the success of the territorial economy does not rely only on the search for technological and economic advantage, but also on the ability of cities to adapt to changes and externalities (Rota et al., 2020). Furthermore, in European literature, the cultural economy is considered an essential resource, given that it is expected that cultural and creative sectors will play an important role in the future growth of advanced global economies (Montalto et al., 2021). It depends on the stratified structure of European cities, in which cultural and historic heritage constitute an opportunity to enhance them on an international level. Scholars agree in recognising cultural and creative industry as potential resources for new jobs and investments, economic growth, enhancement of property and better living standards (Moradi et al., 2019). Therefore, also tourism promotion is considered a viable solution.

Figure 3-15. Density visualization of most recurrent keywords in Europe during the period 2011-2020. (author's elaboration).

There are cities with unique attractions that distinguish themselves in the worldwide panorama. For this reason, urban regeneration and revitalisation measures

have become an important tool to enhance the "magnetism" of a city (Güzey, 2009; Sáez & Periáñez, 2015). Competitiveness, at the present stage, relates to the consolidation of innovative achievements, creative and intellectual potential and the promotion of creative urban centres, which are the key elements of creative and attractive cities (Perez et al., 2019). From the European point of view, urban competitiveness is also associated with cities' quality of life, due to the importance of attracting human capital to promote knowledge-economy (Esmaeilpoorarabi, 2016; Dima et al., 2018).

It is worth noting that many of the keywords in Figure 3-15 reflect the contents of the recent European program "NextGenerationEU", although the documents analysed chronologically precede it. NextGenerationEU is a temporary tool for recovery, which aims to repair the economic and social damage caused by the coronavirus pandemic to create a greener, digital and resilient Europe, ready to adapt to present and future challenges (EC, 2021). It is significant that some of the features that represent urban competitiveness, highlighted in the wordcloud, are also part of the main pillars of the plan. Among these:

− digital transformation (20% of the total budget of the plan);

− green transition (37% of the total budget of the plan);

− smart, sustainable and inclusive growth (job creation, competitiveness, research, development and innovation, strengthening of small and medium-sized enterprises);

− social and territorial cohesion (respect for social rights, gender equality);

− health and economic, social and institutional resilience;

Regarding the territorial scale of the research, most of the studies focus on metropolitan areas. They are vital centres of economic development due to their role in international trade and investment, the global mobility they can spark, the driving force of the technology and knowledge industry and the touristic attractiveness. This is true, particularly, for China and Europe, whilst in the US, a consistent scientific production still concerns regional competitiveness and large-scale metropolitan planning, due to the evolution of cities to polycentric systems (Grover Goswami & Lall, 2019). In addition, the European scientific community has recently

demonstrated its concern regarding the local scale, in an attempt to understand the relationship between local urban planning and the competitiveness of cities. Given these multiple aspects alongside the definition of the urban system and its attributes of complexity (Papa et al., 2009), the study of urban competitiveness requires a multidimensional approach. The next section describes the main paradigms, methodologies and statistical measures developed by different research groups.

3.4 Paradigms, methodologies, and techniques by the scientific community

Different paradigms, methodologies and criteria have been proposed to measure territorial competitiveness to date, to assess and rank territories and the competitive level of cities. There is not a paradigm that is universally recognised. The choice of the indicators along with the weighting of the variables, for example, may change according to the country in which the study has been developed. The reason is that, as observed in section 3.3, urban competitiveness takes on different implications according to the region the study comes from. Scientists and organisations consider different aspects – social, economic, physical, and environmental ones – on the basis of the territorial scale of the studies, the discernment of urban features and the selection of statistical methods. In addition, the differences between methodologies may depend on the strategic objective of the research (Mazziotta & Pareto, 2017). It is worth mentioning that, due to the lack of a universally recognised paradigm, the analysts' choices can affect the results of the research. For example, Jiang & Shen (2013) demonstrated how using different weighting methods – specifically PCA and Equal Weighting – leads to rankings of urban competitiveness that are significantly different.

The studies on urban competitiveness are all linked by a common factor: the consideration that urban competitiveness is multidimensional, made up of different dimensions and characteristics of cities that succeed in attracting investments, jobs and skilled people. Therefore, the first step for each study is to identify which urban features are most meaningful in order to define strategic actions to gain a competitive advantage, and which are the relative variables grouped in fields of intervention. Researchers, albeit to varying degrees, agree as to which dimensions improve

levels of urban competitiveness, referring to social and cultural capital, housing (Gargiulo et al., 2016), quality of life and quality of place (Esmaeilpoorarabi, 2016), public institution, infrastructures, accessibility, environment, economy, and employment (WBG, 2015; Gargiulo, 1995), city branding (Zenker et al., 2013), research and innovation (Institute for Urban Strategies, 2020). The fields of intervention comprise a flexible number of indicators, each of which has its own weighting, according to its meaningfulness. The relevance of an indicator hinges on the theoretical framework, so it is crucial to start with a systematic definition of the objectives and the context of the research. Indicators should be selected not only based on their meaningfulness but also in light of the availability, accessibility, measurability and country coverage of data (OECD, 2008). Once the overall structure of the competitiveness index has been defined, multivariate analysis is implemented to assess its suitability and appropriateness and guide subsequent methodological choices. Different analytics approaches exist, to explore whether the structure of the composite indicator is well-balanced – PCA, Cluster analysis, Factor analysis, expert opinions.

Normalisation is often necessary: it aims to make the indicators comparable, due to their different measurement units and ranges and floating polarity - positive/negative - as regards competitiveness (Mazziotta & Pareto, 2017). Choosing one method or another will produce different results for the composite index. Therefore, a previous systematic assessment of the pros and the cons is essential. The next step is, generally, the aggregation of indicators that is the combination of indicators to shape the composite index. It consists of two phases: the assignment of weightings and the identification of the statistical technique. As regards the first phase, the scientific literature relies on different weighting methods, which can be attributes-based weighting systems or expert-based ones. The choice of the weighting method must reflect the objectives of the research, the results of the theoretical framework, the significance of individual indicators and the statistical quality of the data. The second phase depends on the degree of compensability of indicators, that is the possibility to make up for a deficit in one dimension with the surplus in another.

Lastly, the validation of the method is required. It aims to verify the robustness of the composite index, using statistical methods, such as Uncertainty analysis and Sensitivity Analysis.

The table below summarises models developed by different research groups, examining the territorial scale of the study – regional, provincial, metropolitan, local –, the domains deemed significant, the indicator selection criteria, the statistical methods, or the procedures used to measure urban competitiveness, and the validation methods.

For example, Papa et al. have studied the impacts of the 2008-09 financial crisis on urban competitiveness in Italian provinces, finding that some provinces have been able to endure the consequences of the crisis preserving their level of competitiveness, whilst others have reacted by succeeding in increasing it. They implemented a multivariate statistical analysis and estimated a linear regression to assess the evolution of the urban competitiveness level.

Whereas, Sáez & Periáñez (2015) developed an Urban Competitiveness Index, focusing on the dimensions of efficiency and innovation. Weightings were assigned with Nash product a method taken from cooperative game theory, consisting of allocating to each city the product of the components of its vector characteristics $N(x\_1, x\_2, \ldots, x\_n) = x\_1 \cdot x\_2 \cdot \ldots \cdot x\_n$. The results were validated by studying the correlation between UCI and PPP per capita GDP.

Jiang and Shen (2010) take into account the economic, social, and environmental dimensions of urban competitiveness developing a four-level hierarchical indicator system (from indicators to subgroup, component and, finally, the urban competitiveness index) for 253 Chinese cities at the prefecture level. They use the Equal Weighting method to assign the weight to each indicator, according to its level. Then, they calculate the Spearman correlation coefficients of the ranks finding a positive correlation between environmental, social and economic components.

The Regional Competitiveness Index (Annoni & Dijkstra, 2019) is composed of 11 pillars that describe different aspects of competitiveness of European regions (NUTS-2 level). These pillars are classified into three groups (Basic, Efficiency and

Innovation) and contain a total of 84 indicators, which have been tested with uni-variate analysis (analysis of missing values, Box-Cox transformation). Weights are assigned considering the regions' population size and the z-score of each indicator.

Publication	Territorial scale	Macro-areas/domains	Indicators selection	Statistical method/ Procedure	Assessment and Validation
Papa et al. (2014)	Italy Province/NUTS-3	Transport/Population/Economy/Culture*	Review of previous studies	Multivariate statistical analysis (Min-max method+ EW + Euclidean distance)	Linear Regression
Sáez & Periáñez (2015)	Europe LUZ level	Demography/social aspects/ economic aspects/civil involvement/training and education/environment/ travel & transport/ information society/culture & recreation	PCA	Nash Product + Weighted aggregate of three sub-indicators	ANOVA, Kruskal Wallis, variance analysis
Jiang & Shen (2010)	China prefecture level	Economic competitiveness/social competitiveness/environmental competitiveness	Review of previous studies	EW+ Additivate averaging	Spearman correlation coefficients
Annoni & Dijkstra (2019)	Europe NUTS-2	Institution/Macroeconomic Stability/Infrastructures/ Health/ Basic Education	Univariate and multivariate analysis	Standardization or z-scores+ PCA	ANOVA
Kwon et al. (2012)	Korea urban level	Formation of cluster/human capital/ creative economy	Review of previous studies and statistical analysis/ correlation test PCA	Analytic Hierarchy Process+ Standardized T-score	/
Yuan et al., 2017	Municipal district China	Economic strength/ Living standard/space support/social security/Environmental governance	Review of previous studies, correlation test, PCA	Partial Least square / Structural Equation Model	Rank-size rule
Ni & Kamiya (2020)	Cities of different sizes	Eradicate poverty/ Protect the planet/Ensure peace and prosperity/ Sustainability	Review of a previous study	Comparison with sustainable development goals through matrix	/

Table 3-2. Summary of models, methodologies and techniques used by different research groups (author's elaboration).

Then, the authors examine the internal consistency within each pillars with multi-variate analysis, through the technique of Principal Components Analysis (PCA). Kwon et al. (2012) propose an index for Korean metropolitan areas based on three components of innovation (formation of cluster, human capital and creative economy), structured in factors and indicators. They use Analytic Hierarchy Process (AHP) to assign weights and standardized T-score to build the ranking of urban

competitiveness. The study aims to identify strength and weakness of six Korean cities, according to the final score.

Yuan et al. (2017) built a partial least squares structural equation model (PLS–SEM) considering socio-economic statistical data and urban flow data. They use Rank-size rule to assess the reliability of the model.

Lastly, The Chinese Academy of Social Sciences (CASS) and UN-Habitat have recently published the latest version of The Global Urban Competitiveness Report (GUCR), focusing on sustainable urban competitiveness (Ni & Kamiya, 2020). The report measures the economic competitiveness and sustainable competitiveness of more than 1,000 cities worldwide, through theoretical research and empirical investigation. However, what counts most in this study, is that it compares the goals of the UN 2030 agenda, related to the current challenges cities have to tackle, with their levels of competitiveness.

3.5 Conclusion

The review showed how urban competitiveness is linked to the evolutionary processes of cities, in time and space. Therefore, to understand the concept of urban competitiveness and its development, it is necessary to consider the variety of phenomena that weave strong relationships with it. What was found is a strong relationship between urban competitiveness and the challenges cities will face in the future. In other words, the ability of urban systems to deal with future issues, transforming threats into opportunities, will influence their competitive level.

The analysis highlighted the diachronic evolution of urban competitiveness and the main territorial characteristics that have defined it over time. The results described the change of perspective that led from competition between companies to competitiveness understood as an attribute of metropolitan areas. The study was conducted to understand the current definition of urban competitiveness and identify the urban features that are crucial to assess the competitive level of a territory.

Since the 1980s, globalisation has brought remarkable economic, cultural and political changes in those countries where governments had activated pro-growth policies. Technological advancement, the rising pervasiveness of new means of communication, the increasing mobility of people, information and goods have

reduced distances, facilitating international exchanges and economic and cultural convergence even in countries with different cultures and traditions (Gargiulo et al., 1997).

Even today, administrations, which had to redefine their role over time and verify the effectiveness of their actions, are looking for new tools and methods to manage these changes. The political classes in each country are replacing conservative and ideologized attitudes with the adoption of neoliberal policies that sometimes embrace populist tendencies. These transformations have had disparate effects in different geographical areas. In Europe, economic growth has slowed down dramatically with disastrous consequences, such as the crisis in the industrial sector, the relocation of production sites, the rise in unemployment and immigration. Nevertheless, the dizzying economic expansion in South-East Asia has given impetus to new markets and financial speculation.

From an urban perspective, this situation is reflected evidently in the increasing managing difficulties of settlements, along with the spread of large empty spaces, due to the decommissioning of industrial activities (Gargiulo, 2002).

On the other hand, the new scenario has determined powerfully competitive economic-cultural processes. The permanence and continuity of these processes produce alternate phases of growth and crisis, stimulating rivalries between cities and territories. The competition is certainly based on urban identity resources and physical endowments, administrative and entrepreneurial skills and functional organisation. However, it also depends on the ability to weave effective relations inside and outside of the socio-economic system (Papa et al., 2014b) the characterisation of the social system, the cultural and creative connotations, and identity values (Bianchini & Parkinson, 1993). In this regard, the work identified numerous disciplinary fields relating to urban competitiveness, including economy, demography, energy, mobility, tourism, environment, governance, social integration, sustainable development, etc. In Europe, as in China, urban competitiveness is no longer linked exclusively to economic performance, expressed by the relationship between income, employment rate and economic growth. Its meaning extends to culture, artistic and recreational facilities, urban identity, accessibility, and social

equity, as well as the physical environment. In Europe, in particular, there is growing attention to the relationship between urban regeneration measures, urban planning and competitiveness. The analysis of the keywords anticipates and reflects the contents of the recent European program Next Generation EU since some of the features that represent urban competitiveness – such as digitalization, adaptation to climate change, social inclusion, smart growth, resilience, governance – are also the main pillars of the plan. This affinity demonstrates the value provided by this research to understand the current direction of the research, since it highlights the elements of competitiveness, especially in the light of the road to recovery after the Covid-19 crisis.

However, it is possible to state that, everywhere, the improvement in quality of life and the achievement of sustainable development goals are the dominant objectives to increase the competitive advantage of a city. For this reason, the relationship with the paradigms of Smart city, eco-city, circular city and other models of urban functioning has increasingly aroused scientific interest.

As regards the methodologies developed by the scientific community, all the gathered articles take on a multidimensional approach, with the implementation of multivariate statistical analysis and the development of composite indices. It is the simplest way to represent urban competitiveness as it enables us to take into account the multifaceted structure of the topic. The results highlighted by the various publications show that the measurement of urban competitiveness depends mainly on the significance assigned to each dimension. The significance depends, in turn, on a wide variety of factors, including the period of publication, the scientific background, the statistical techniques and, lastly, the region from which the study originates. None of the articles analysed have yet investigated the interactions between different variables through statistical experiments.

The most interesting finding seems to be that the ability to cope with future challenges has gradually taken on an essential role in defining how competitive a city is on an international scale, especially following the global financial crisis of 2008 and the spread of Covid-19. During the current period of the Covid-19 health crisis, lockdowns and social distancing have disrupted the daily course of urban life. Numerous commentators claim that the co-existence and the post-covid phases will

be characterised by conspicuous changes in behaviours within urban areas. In this context, the success of the territorial economy does not lie only in a quest to gain a technological and economic advantage, but also in the development of resilience, the adaptation to external agents and the creative exploitation of changes (Rota et al., 2020). In other words, competitiveness represents the ability of a city to seize these changes as opportunities for growth. Cities rely on their internal organisation efficiency to create economic advantage, attract and transform resources, as well as provide benefits for their residents (Ni & Kamiya, 2020). We need to find new methods of development, that are more effective in periods of economic, environmental or health crises. Therefore, competitiveness is the ability of an urban system to self-organise, tackling and creatively exploiting external challenges (Kakderi et al., 2021). Covid-19 is not unique challenge cities have to tackle in the coming years. Cities have to face other global issues like climate change, an ageing population and poverty eradication, given that they have the resources to do so. Future research must question how current challenges could become an opportunity to increase the competitiveness of cities, by attracting people and improving their quality of life, as many scholars did. Boczy et al. (2020) discuss the opportunity to combine urban competitiveness goals with internationalisation and social inclusion goals. Montalto et al. study the impact of Brexit on the competitiveness of UK creative cities. Mutani & Todeschi (2019) identify the goal of energy efficiency as a chance to enhance the competitive level of European cities. Kresl (2010) focuses on the potential benefits of the ageing population on the competitiveness of cities. Kamal-Chaoui & Robert (2009) describes how climate-conscious management and planning can help to achieve national climate goals and minimise trade-offs between environmental and economic priorities, reaching competitive advantages.

On the basis of this scientific framework, this research project question which urban aspects should be promoted to achieve a competitive advantage and in which way a local intervention can influence the role of an urban system in the international competition. Another important question is which local strategies have to be implemented to improve the competitiveness of metropolitan areas, in the scenario of the challenges and important changes that will characterize future urban environments.

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CHAPTER 4. METHODOLOGY

4.1 Introduction

This chapter is dedicated to the illustration of the methodology developed for measuring urban competitiveness, which has been constructed on the basis of the theoretical insights exposed so far. It is worth emphasizing that the methodology has been designed to respond to the following research question: examine, from an operational and quantitative perspective, the role of territorial competitiveness in the development of an urban area with its own connotations and opportunities for growth. The methodology was designed according to three different scales of application: metropolitan, municipal, and sub-municipal scale. Also, it was constructed in the light of the scientific framework – and the identified scientific gaps – and compared with the objectives and resources of the Next Generation EU program, given its role of redefining the competitive balances in European territories in the post-covid recovery.

As highlighted in the previous chapter, different paradigms, methodologies and criteria have been proposed within the scientific community to assess and rank territories and cities according to their competitive level. This study can be framed in that strand of research that considers urban competitiveness as a multidimensional phenomenon since it sought to put into a system diverse urban dimensions considered fundamental for urban competitiveness.

With this vision in mind, a methodology made up of different and concatenated phases was built, combining techniques of statistical analysis with elaborations in a GIS environment, to obtain data at different scales. In particular, the analyses were conducted by using SPSS, Microsoft Excel, and QGIS. Every methodological phase responds to a specific objective. Whilst some objectives were hypothesised at the beginning of the research work, some others emerged during the elaborations and the subsequent advancements of the work.

The first phase of the methodology (§4.2) was intended to define the most relevant urban characteristics to urban competitiveness, and, for this reason, it is closely intertwined with the theoretical framework. As a matter of fact, the insights that emerged within the bibliometric analysis, along with the comparison with the NextGenerationEU program, were the key ingredients to define the most relevant

dimensions to urban competitiveness (named 'Macro-areas of Competitiveness') as the basis to develop the next methodological steps.

Secondly, multivariate statistical analysis (specifically Correlation Analysis, Principal Component Analysis, and Hierarchical Cluster Analysis) responded to the objective of examining, quantitatively, the relationship between urban phenomena and competitive processes at three different urban scales, as well as in the several Macro-areas proposed (§4.3). The application of this part of the methodology also allowed for the knowledge of the case studies for what concerns their potential and their distinctive competitive features.

The third methodological phase (§4.4) consists in systematizing the results of the previous phases by getting a single output, namely a benchmarking, that can synthesize the competitive behaviour of cities, also providing relevant insights into spatial relationships between different territorial competitors. This benchmarking is based on the calculation of a composite index named 'Potential of Urban Competitiveness' (P_{UC}) that, for its synthetic nature, might well facilitate the dialogue between the methodological technicalities and the needs of policymakers. This output is closely interlinked with another objective that descends from the contextualization of this research work in the NextGenerationEU program: comparing urban competitive potential – represented synthetically by the P_{UC} – with urban competitiveness for NGEU – represented, on the other hand, by an index I_{UC_NGEU} based on the actual distribution of resources as proposed by the NGEU program. This methodological step enables to visualize the gaps between the allocated resources and competitive potential for each analysed city, providing decision-makers a support tool to rebalance excessive disparities or incentivise the best-performing cases.

Finally, the fourth phase of the methodology (§4.5) was intended to highlight cities' distinctive vocations that define their competitive assets. To do so, it is proposed a correlation analysis between the Potential of Urban Competitiveness index (P_{UC}) and a partial index that considers the city's performance in just one Macro-area of Competitiveness. The representation of the two standardized indexes in a Cartesian chart allows to identify four quadrants, representative of the urban areas' performance: less dynamic areas with low Macro-area competitiveness; areas with

initiated transition in a Macro-area but low overall competitiveness potential; areas with high potential and high Macro-area competitiveness; and areas with high potential but low Macro-area competitiveness. This is the ultimate result of the methodology development, and the central element of the decision support tool, as it can support investment planning according to the position cities assume in the chart, i.e., their propensity to grow in a given Macro-area.

Based on contemporary notions of urban competitiveness and founded on the described objectives, this methodology aims to support public administration in putting in place the right lines of action in order to enhance urban competitiveness in diverse contexts and at different scales of interventions. The methodology can be of great interest to decision-makers to understand which are the most suitable measures to increase the competitive performances of territories.

4.2 Data matrix
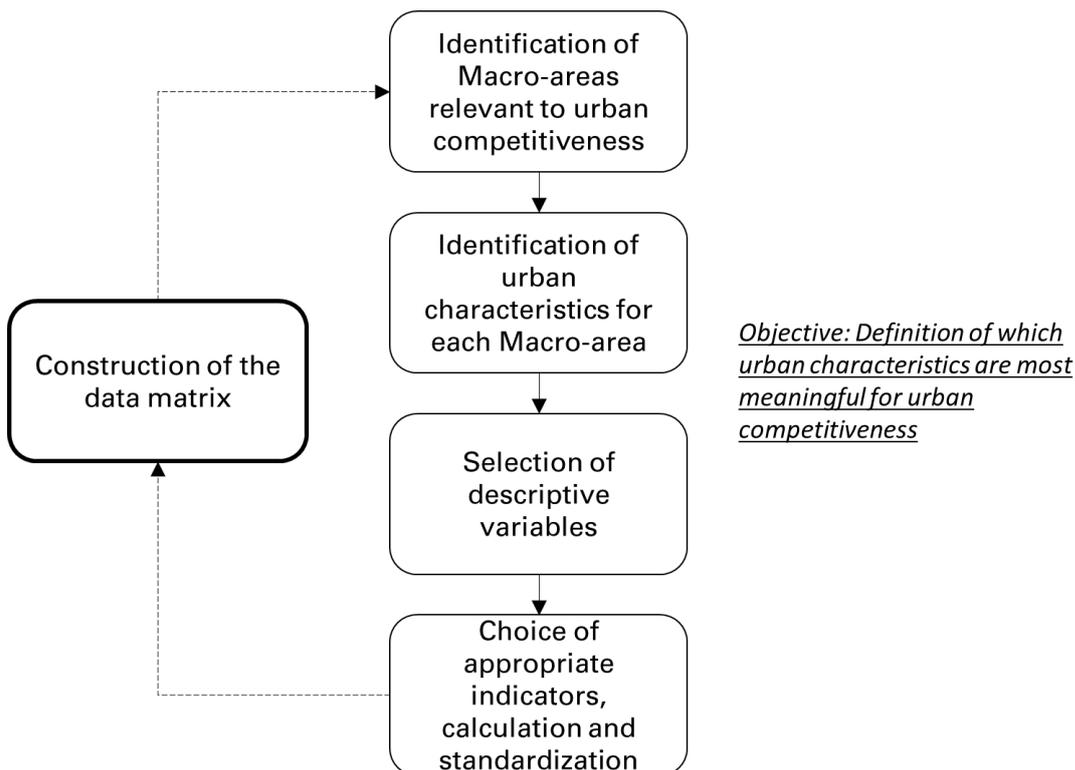
Figure 4-1. Workflow explicating the diverse steps of the first phase of the methodology, i.e. the construction of the data matrix.

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The first phase of the methodology consisted of the definition of the data matrix and started from the hypothesis, retrieved from the scientific literature, that the ability to handle future challenges has become a key factor for the definition and assessment of urban competitiveness. Given this assumption, the matrix was constructed by first defining the most relevant dimensions to urban competitiveness, named 'Macro-areas of Competitiveness' according to the results of the bibliometric analysis along with the comparison with key dimensions of current European economic recovery programs (NextGenerationEU). This comparison was quite meaningful because it revealed how the main challenges identified in the scientific literature can be found also within the areas of investment for the NGEU. Among the most recurrent challenges considered by the scientific literature are environmental sustainability, circular economy, sustainable mobility, and adaptation to climate change (resonating with the pillar of 'Green Transition' in the Next Generation EU program); innovation and the promotion of a digital economy (linked to the NGEU pillar 'Digital Transition'); and aspects related to the preparedness of cities to respond to economic and social challenges (which is a cross-cutting aspect in many parts of the aforementioned program).

Therefore, assuming as a main hypothesis that urban competitiveness is a multidimensional and complex phenomenon, we refer to the following Macro-Areas of Competitiveness:

− *Tourism and Culture*. Tourism is a fundamental sector for European cities and a substantial source of income for local economies (Corbisiero & La Rocca, 2020). The touristic attractiveness of each city depends on diverse factors, such as the presence of sites of historical and artistic interest, the diffusion of accommodation facilities, the geographical location, as well as the local commitment to tourism and valorization of culture. The scientific community recognizes that tourism is able to trigger competitive processes in urban areas thanks to the interaction between accommodation, leisure, and cultural activities (da Silva et al., 2019). In parallel, the promotion of culture can be the starting point for competitive growth in many urban realities (Li, 2020). Promoting cultural activities in urban areas has the positive side effect of attracting not only tourists but also new residents, skills, and knowledge that can enrich the

human capital of cities with increased competitiveness in the creative industry, know-how, and skilled economy (Hospers, 2003). All in all, fostering the tourism and culture sectors, according to the vocations of the city – e.g., artistic and cultural heritage, nature and landscape, multidimensional attractiveness – can lead to new occupations, a dynamic labor market, and continuous economic inflows, as well as a renovated urban image and increased livability.

– *Green transition*. Ecological transition aims at mitigating the effects of climate change through decarbonization and promoting sustainable development; in this sense, competitiveness and environmental sustainability are often intertwined in the scientific literature. The green transition would have the effect of increasing the competitiveness of the territories involved through the development of a green economy and the improvement of the quality of life (through, for example, the improvement of air quality, the reduction of energy consumption, diversification of energy resources, improvement of environmental quality, safety, and environmental management, etc.) with the consequent attraction of innovative companies and resources (Mazzeo, 2013). Furthermore, several studies have demonstrated that making cities more green and sustainable can effectively mitigate adverse environmental, social, and economic conditions, improve citizens' quality of life, and increase attractiveness and territorial competitiveness (Fan et al., 2023). The implementation of green transition strategies in cities can minimize energy consumption, waste production, and the use of unsustainable energy sources (Galderisi et al., 2016). This may bring the reduction of air pollution, the preservation of ecosystems, and the mitigation of climate change consequences (Pillogallo et al., 2019; Lai et al., 2021). Green transition contributes to creating healthier and safer living environments (Jiang & Shen, 2010; Hammer et al., 2011; Papa et al., 2016; Van Den Berg et al., 2016; Komasi et al., 2022; Cassinger and Thufvesson, 2023).

– *Digitalization/smartness*. The diffusion of innovative means of communication and new technologies triggered renewed competitive processes in cities that have evolved till today, generating new models of economic organisation and social interaction, and configuring a new field of competition, in which cities positioned themselves as attractive and highly competitive poles (Gargiulo et

al., 2022). As a result, cities have adapted to the new demands of digitalization as demonstrated by the growth of the information sector and the knowledge in the urban economy (Yigitcanlar et al., 2008), as well as the rise of paradigms such as that of the smart city (Aldegheishem, 2019). Regarding the diffusion of the knowledge economy as one of the main pillars of economic development, many soft factors of urban systems have flanked and, to a certain extent, prevailed over the infrastructural component that in the past influenced the establishment of industrial and production activities (Malecki, 2002). Among these soft factors, it may be cited the digitisation of institutional structures, as well as the availability of innovative technologies, the presence of qualified, educated and skilled workforce, and, finally, innovation in the academic and research centres. The promotion of digitalization can generate added value on multiple levels, such as economy, mobility, environment, governance, safety, competitiveness, and, in broad terms, the quality of life of citizens (Filo, 2007; Van Winden and Carvalho, 2008; Dmitrieva and Guseva, 2019; Penco et al., 2020).

− *Sustainable mobility*. Overall, the shift towards more sustainable mobility in the urban environment may result in much more opportunities for wide sections of the population and in sharing and shared well-being (Fenton, 2017). Sustainable mobility positively impacts urban areas' competitiveness, attracting people with more convenient and accessible transportation options. On the one hand, people may be attracted by cities that offer benefits in terms of time-commuting and accessibility – also intended as the opportunity for places and activities to be reached by walking or by using public transport – and quality of travel (Guida & Caglioni, 2020); on the other hand, the promotion of sustainable mobility brings new projects, resources, and investments to the city, boosting its economic attractiveness. In the most significant cases, sustainable mobility may encourage the establishment of cultural and commercial activities and boost the tourism and tertiary sectors.

− *Economic and Social Resilience*. Promoting social and economic resilience within a territory means ensuring equal access to resources and opportunities

for all residents and guaranteeing that level of accessibility to future generations. The redevelopment of the urban fabric, the promotion of culture and sport, and the bridging of territorial gaps (between the North and the South and between the centre and the suburbs) contribute both to sustainable development and to improving public welfare and significantly increasing the attractiveness of territories. The relationship of this Macro-area with urban competitiveness also regards affordable access to goods, services, employment, and education, in ways that promote healthy living and community cohesion, while reducing risks to personal safety. In brief, 'Economic and Social Resilience', includes dimensions related to the level of equity and inclusion, social provisions and salaries, employment, and safety (Williams et al., 2013; Martin & Sunley, 2017; Säumel et al., 2019; UNESCO & World Bank, 2021).

It is worth specifying that for each application these Macro-areas have been adapted according to the characteristics of the case studies and the contents of the recovery plans. For example, as shown in §5.3, for the application to Portuguese metropolitan cities just three out of five Macro-areas were analyzed, according to the fields of investment of the Portuguese Recovery Plan. Similarly, for each Macro-area, a set of urban characteristics was identified and declined differently for each scale of application (metropolitan, municipal and sub-municipal). Subsequently, the variables (v_i) describing the chosen urban characteristics were identified, as well as the correspondent indicators (i_i), which were standardized (with the z-score method) (Equation 4-1) to make them comparable with each other (see Figure 4-6).

$$n_i = \frac{x_i - \mu}{\sigma}$$

<div align="right">Equation 4-1</div>

Three indicator systems were developed, one for each territorial scale considered - metropolitan, municipal, and sub-municipal.

4.3 Multivariate statistical analyses

The use of multivariate statistical analysis techniques aimed to understand the structure of the urban areas examined. These techniques (Correlation Analysis,

Principal Components Analysis, and Hierarchical Cluster Analysis) enabled to identify the significant characteristics of the urban areas that establish their structural behaviour, functionality and foster their competitive development (Figure 4-2).
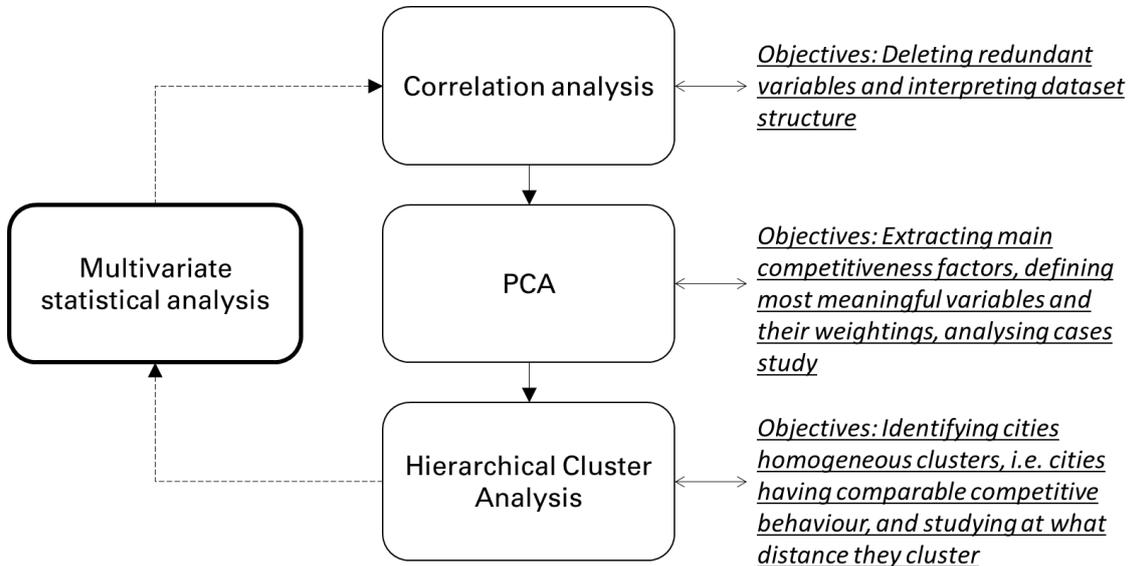
Figure 4-2. Workflow explicating the diverse steps of the second phase of the methodology, i.e. the multivariate statistical analysis.

4.3.1 Correlation analysis

In a territorial survey, it is common to find a strong correlation between variables, so it is necessary to eliminate indicators that, affected by strong correlations with primary variables, do not provide additional information to the set of significant data. Thus, for each Macro-area, upon considering different variables as operationalization devices, correlation analysis was used to exclude redundant variables. In the correlation matrix, intersections between variables belonging to the same Macro-area are highlighted, thus identifying 5 correlation sub-matrices. This is because the correlation relationship between variables belonging to the same Macro-area of competitiveness is considered significant. In the first step, correlation ratios (Pearson coefficient) equal to or higher than 0.75 are identified through highlighting rules in Excel (see Figure 4-3) and their visualization density is studied for each of the identified submatrices. Then, a comparison is made with the threshold value of the Pearson coefficient equal to or higher than 0.9, checking whether it can provide additional information to delete unreadable cases. Before proceeding with the exclusion of overly correlated variables, it was proposed a sorting of the indicators

that takes into account the reliability and relevance of the data, so as to favour the most reliable and significant indicators in the deleting of redundant variables.
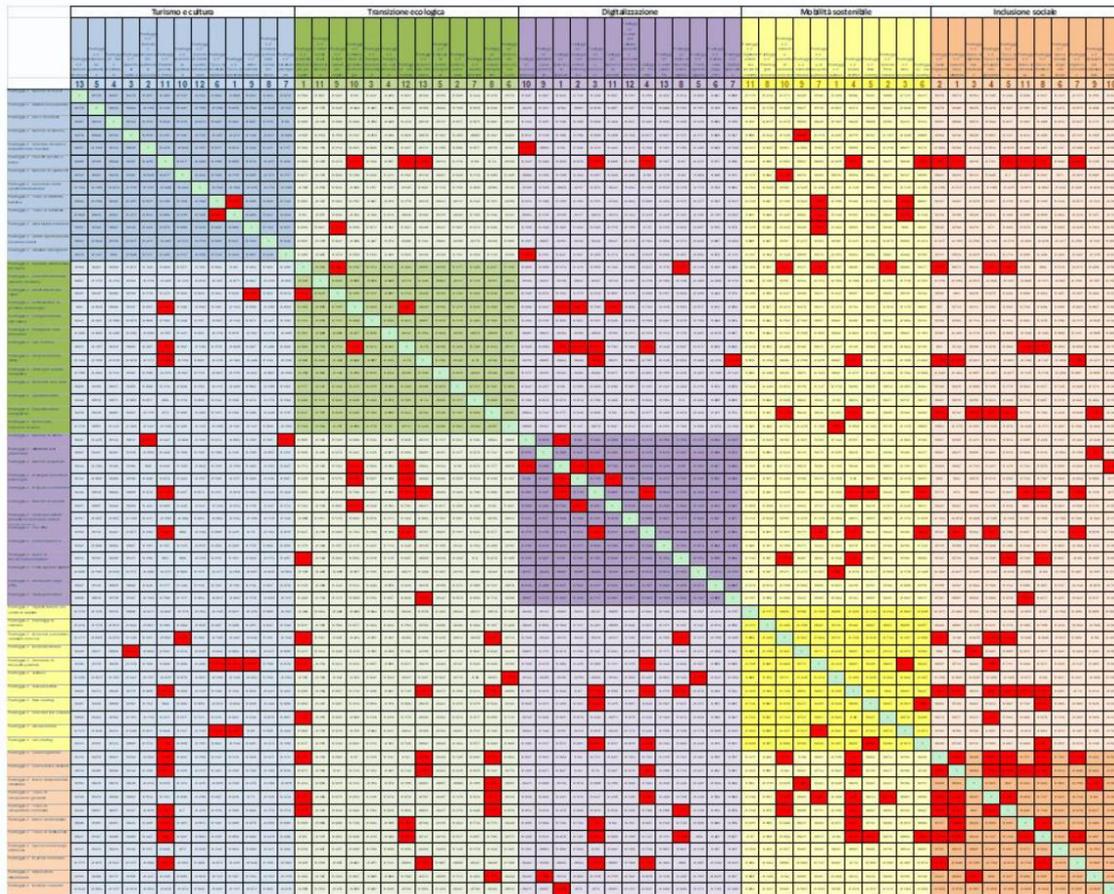
Figure 4-3. Screenshot from Excel of the correlation matrix of the data system in an application to metropolitan areas. The colours correspond to 5 macro-areas of competitiveness. The boxes corresponding to a correlation coefficient greater than 0.75 are highlighted in red.

4.3.2 Principal Component Analysis

The methodology then proceeds with Principal Component Analysis (PCA), which is made up of a set of statistical techniques that shed light, with little loss of information, on the intrinsic structure of a data set, reducing large amounts of data to a limited and reasonable number of indicators. Starting from a set of variables describing competitive behaviour, this part of the methodology was designed to obtain the matrix of factors, by means of a series of transformations of the matrix of indicators, which has a much smaller number of unobserved variables (principal

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components) but which achieves the same descriptive effectiveness as the initial data matrix.

PCA provides three types of output: the principal components, the coordinates of the characters (variables) and the coordinates of the objects (metropolitan areas, cities, or districts) on the new axes defined by the principal components. The vector of eigenvalues provides the shares of variance explained by each component of the system. The analysis of the outputs starts from the study of the vector of eigenvalues: by dividing each element of this vector by the number of objects, it can be obtained the shares of variance explained by each component. The mathematical objective is to identify the linear combinations pc_i of the normalized indicators n_i that make it possible to reduce the size of the initial dataset and at the same time maintain a medium-high proportion of explained variance, i.e. lose as little information as possible.

$$pc_i = L_{11} \cdot n_1 + L_{12} \cdot n_2 + \cdots + L_{1p} \cdot n_p$$

<div align="right">Equation 4-2</div>

The geometric objective is to identify, in a multi-dimensional space, a new system of axes (principal components) that cut the point cloud onto which to project the original point cloud (Figure 4-4).
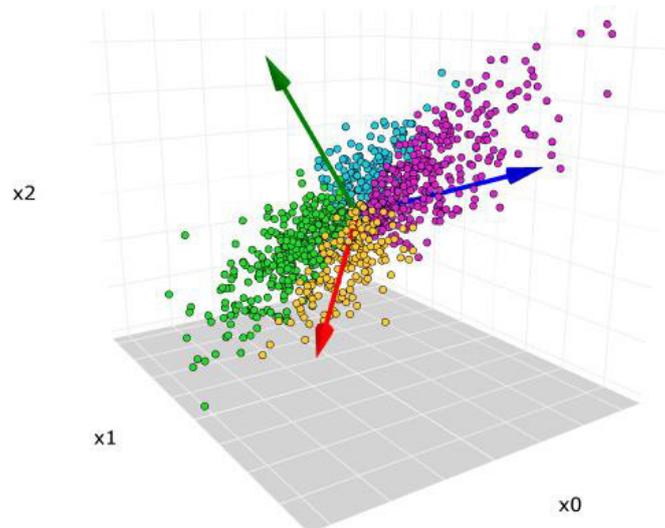
Figure 4-4. Geometric schematization of PCA (Source: Towards Data Science. Retrieved from: https://towardsdatascience.com/principal-component-analysis-pca-explained-visually-with-zero-math-1cbf392b9e7d)

To choose the number of principal components, it was decided to take the number of components that explains at least 60% of the total variance (Annoni & Kozovska, 2010). Subsequently, the matrix of rotated components (obtained through varimax rotation) provides the so-called 'loadings' (L_{ij}), which can be interpreted as correlation indices between the Principal Components (pc_i) and the variables (n_i). Rotation is used to minimise the number of individual indicators that have a high loading on the same principal component. The idea behind the transformation of the factorial axes is to obtain a 'simpler structure' of the principal components, a structure in which each indicator only has a relevant weight on one of the components, which makes it easier to interpret while leaving the analytical results unchanged. If the loadings L_i on a specific component are greater than 0.65, the variable is considered significant for that component. The significance of the variables is studied by also analysing the changes in the slope of the graph that represents the loadings associated with the variables. The study of which variables are more correlated with the components extracted is relevant to interpret the competitive assets of the urban areas analysed. For example, if a component has a very strong and positive correlation with income, employment and GDP, that component may be indicative of the economic well-being of a city. In the new reference system defined by the principal components, each city will have its own positive or negative coordinates.

The limits descending from the choice of this technique depend on the fact that PCA is an exploratory statistical technique that provides reliable results when the number of statistical units is much greater than the number of variables considered. However, in this case, considering that the method is applied to a territorial context, it seemed appropriate thanks to the interpretative opportunities it offers, especially in light of the large amount of data considered. In any case, to guarantee scientific rigor, the analysis was also repeated for individual Macro-areas of competitiveness, i.e. by referring to the sub-matrices of the starting matrix, obtaining information on the significance of the variables for the Macro-area to which they belong.

PCA has been used also to understand the propensity of the case studies to compete in a given Macro-area. This insight can be obtained by highlighting not only

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the most significant variables for each extracted component but also, and above all, the Macro-area to which these variables belong. This passage makes it possible to state that, for a given component, a percentage of the total variance can be attributed to a particular competitive predisposition, responding to the research objective of identifying the main competitive assets of urban areas to address their future development.

4.3.3 Hierarchical Cluster Analysis

The next step of this part of the methodology is Cluster Analysis, which comprises the set of algorithms and statistical methods aimed at subdividing a set of objects into groups or 'clusters' that can be defined as homogeneous on the basis of the measurements made. The classification of statistical units into homogeneous groups is a selective process that depends on the algorithm used. Generally, in spatial and urban settings, a hierarchical method that clusters statistical units gradually is preferred (Scaramuzzino et al., 2019) since it gives the opportunity to study at what 'distance' objects cluster. Therefore, Hierarchical Cluster Analysis is used to assess how urban areas can be grouped according to their level of competitiveness and if this clustering is coherent with the final score achieved (see §4.4). As a clustering method, the furthest neighbours method was chosen since it provides dendrograms in which the division into clusters is clearer. I set the interval to Euclidean squared distances, as all variables are quantitative and continuous, and ran the cluster analysis both for the whole dataset and for individual Macro-areas of indicators, obtaining several clusters. Finally, for the municipal (and sub-municipal scale), I represented the clusters on a map to verify if it does exist a spatial relationship between the municipalities (or the districts) belonging to the same cluster.

4.4 'Potential of Urban Competitiveness' vs 'Urban Competitiveness for NGEU'

This methodology stage aims at developing a ranking based on a new index named Potential of Urban Competitiveness (P_{UC}), drawing on the findings of the review on the evolution of the urban competitiveness concept (see Chapter 3), coupled with key dimensions of contemporary urban development.

The Potential of Urban Competitiveness (P_{UC}) is designed by taking into consideration a combination of multiple dimensions (Macro-areas) seen as driving forces for the competitiveness of cities – notably on the face of the challenges they are called to cope with to attract and retain people, economic activities, and other resources. In this sense, while drawing on an analysis of the current situation, it could also be seen as an index suggestive of 'prospective' urban competitiveness and place development.
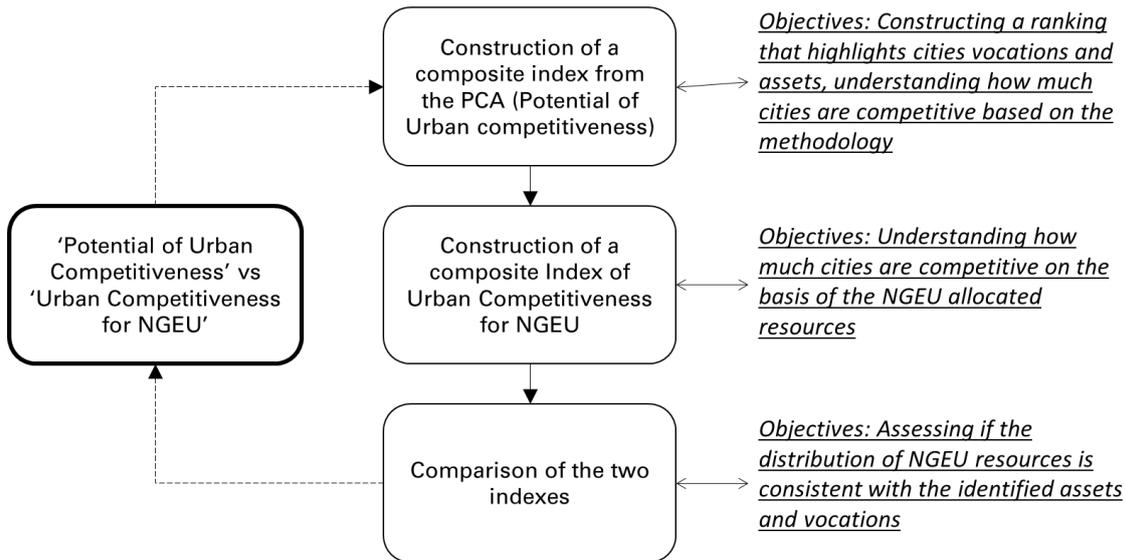
Figure 4-5. Workflow explicating the diverse steps of the third phase of the methodology, i.e. the construction and comparison of two composite indexes, respectively Potential of Urban Competitiveness and Urban Competitiveness for NGEU.

I assigned weights (I_j) proportional to the Principal Component analysis (PCA) loadings (L_{ij}) and then the indicators were aggregated into different intermediate indexes PC_j equal to the number p of principal components extracted from the model. I propose an approach similar to that used by Nicoletti et al., (2000) who group the individual indicators with the highest factor loadings into intermediate indices. In my case, for each indicator, I firstly considered on which of the components the indicator has the highest squared loading, and secondly calculated the proportional value I_i that considers the total variance ($\sum L_{ij}^2$) – as shown in Equation 4-3 –, and constructed an intermediate index PC_j for each component by doing the weighted sum of the selected indicators (see Equation in orange rectangle in Figure 4-6). This results in p synthetic intermediate indexes PC_j.

$$l_i = \frac{{L_{ij}}^2}{\sum {L_{ij}}^2}$$

Equation 4-3

The intermediate indexes are aggregated into the final index 'Potential of Urban Competitiveness' (P_{UC}) by assigning them a weight proportional to the explained variance of the model (wf_j) (See Equations in the purple rectangle in Figure 4-6). The P_{UC} was then normalized (P_{UC_st}) through the min-max method into a scale from 0 to 100:

$$P_{UC\_st} = \frac{P_{UCk} - P_{UCmin}}{P_{UCmax} - P_{UCmin}} \cdot 100$$

Equation 4-4

$$PC_j = l_1 \cdot n_1 + l_2 \cdot n_2 + \cdots + l_n \cdot n_n = \sum l_i \cdot n_i$$

$$wf_j = \frac{V_i}{\sum_{k=1}^{n} V_k}$$

$$P_{UC} = wf_1 \cdot PC_1 + wf_2 \cdot PC_2 + \cdots + wf_p \cdot PC_p$$
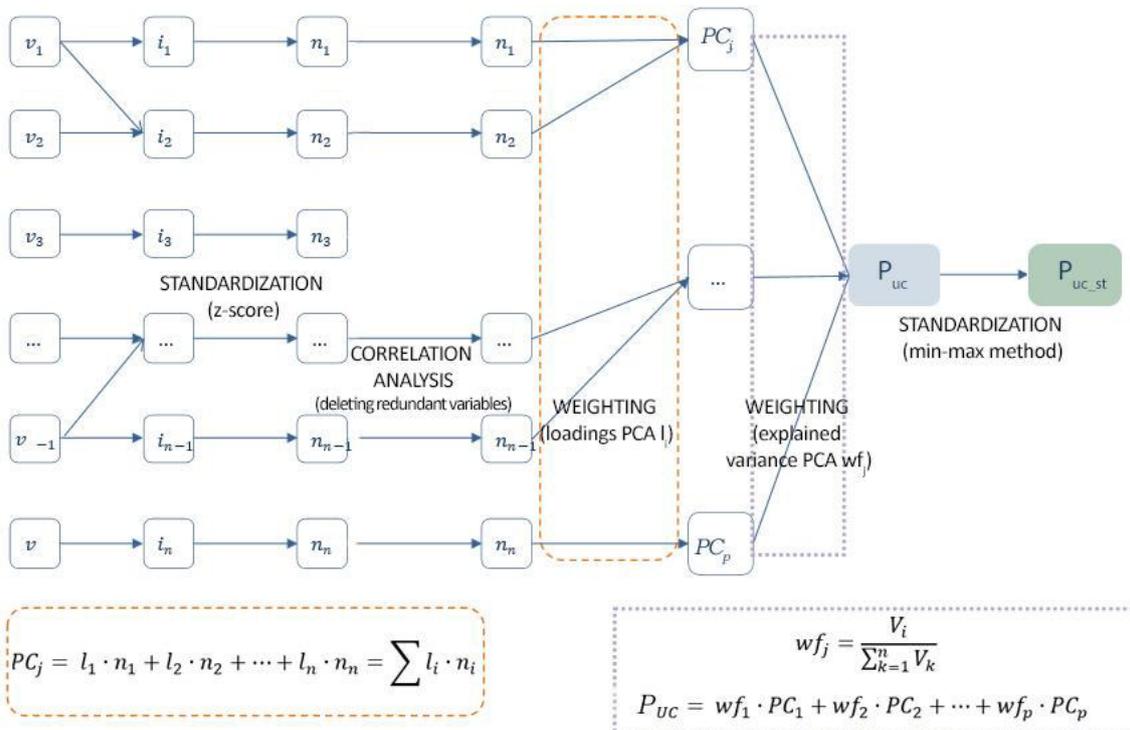
Figure 4-6. Structure of the index Potential of Urban Competitiveness

In order to obtain a comparison with the resources actually allocated by the NextGeneration EU program, a second composite index (I_{UC_NGEU}) was developed, assuming that the indicators within a Macro-Area had the same weight. In this case, the intermediate indexes M_k (with k=1,...5) are obtained through the non-weighted average of the indicators belonging to the same Macro-area. Secondly,

a weight was assigned to each intermediate index M_k, proportionate to the resources invested by the NGEU in that Macro-area (Tourism and Culture, Green Transition, Digitalization/smartness, Sustainable Mobility, or Economic and Social Resilience). In particular, the weight (w_{kNGEU}) was calculated as the ratio between the sum invested in that particular Macro-area (S_r) and the total economic resources allocated, calculated, in turn, as the sum of the R resources considered in this research (not all the resources in the plan).

$$w_{kPNRR} = \frac{S_r}{\sum_{r=1}^{R} S_r}$$

Equation 4-5

The composite index I_{UC_NGEU}, named 'Index of Urban Competitiveness for NGEU', is then obtained as the weighted sum of the intermediate indices M_k, where the weight assigned to each index is representative of the NGEU resources aimed at improving a given Macro-area of competitiveness.

$$I_{UC_{NGEU}} = \sum_{k=1}^{5} w_{kNGEU} \cdot M_k$$

Equation 4-6

This index is standardized on a scale from 0 to 100, as well:

$$I_{UC_{NGEU\_st}} = \frac{I_{UC_{NGEU}i} - I_{UC_{NGEU}min}}{I_{UC_{NGEU}max} - I_{UC_{NGEU}min}} \cdot 100$$

Equation 4-7

Subsequently, the two indexes P_{UC_st} and I_{UCNGEU_st} are compared in order to respond to the research question of whether the resources of the NGEU plan are distributed in accordance with the competitive potential of urban areas. To facilitate the comparison, the percentage delta between the two indexes is calculated. This methodological result constitutes the first pillar for a decision support tool allowing to visualize the delta between the actual competitive potential and resources for urban competitiveness. This methodological result is intended to support public administrations in bridging the gaps between investment choices and urban competitive potential, rebalancing the current disparities, or further incentivising urban areas with the greatest potential.

4.5 Correlation analysis to identify urban susceptibilities

This stage of the methodology was developed in parallel with the application to the urban scale, namely an application comparing the competitive performance of different municipalities within a larger metropolitan area. This methodological step is intended to find the main competitive assets of the analysed territorial units in order to address their future development, through the examination of existing correlations between the overall Potential of Urban Competitiveness index and the revealed conditions in each Macro-area (Figure 4-7). This operation intended to identify and measure the latent qualities and intrinsic features of a city that may be nurtured to steer competitiveness.
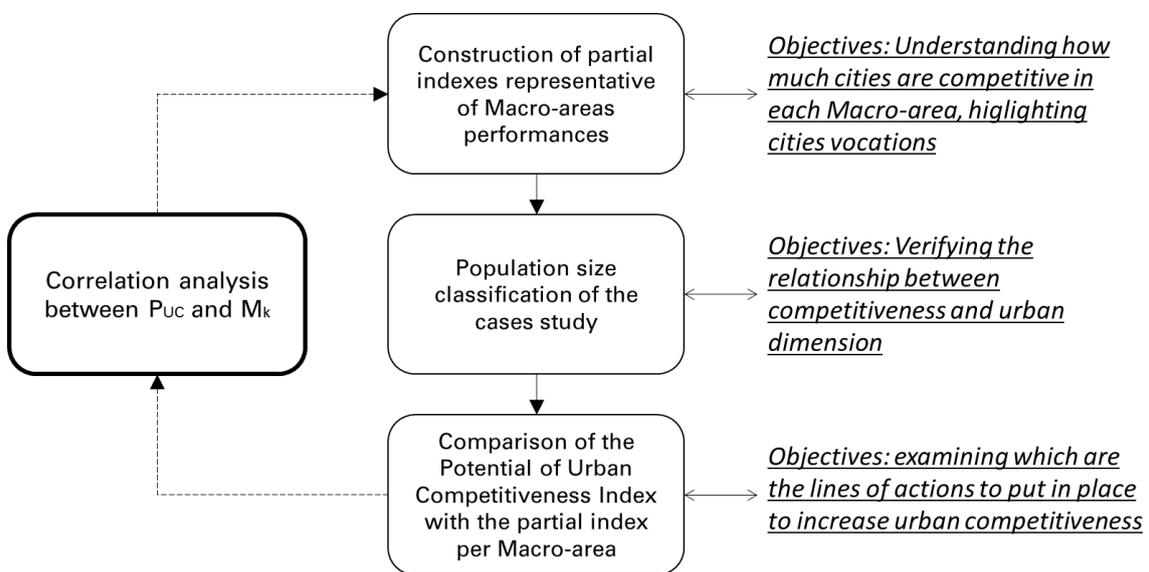
Figure 4-7. Workflow explicating the diverse steps of the fourth phase of the methodology, i.e. the correlation analysis between Potential of Urban Competitiveness and a partial index representative of the city performance in a given macro-area.

The first step aims at analysing the relationship between competitiveness and urban areas' population size. To this end, urban areas are classified according to population size, using a natural breaks method. This relationship is treated controversially in the literature: on the one hand, many studies have emphasized a positive link between urban economic growth and city's size (e.g., van Winden et al., 2007; Glaeser, 2013); on the other hand, it has been more recently demonstrated that such a link is non-linear (e.g., Frick & Rodríguez-Pose, 2018) and competitive performance may depend on multiple factors beyond dimension (Mel'Nikova, 2020). Yet, this relation has been much less analysed at the intra-metropolitan or

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sub-municipal level (e.g., Storper, 2013) and constitutes an important aspect to be evaluated before proceeding with an in-depth analysis of the main cities' competitive assets.

In order to proceed with this evaluation, I examined the correlation between the overall competitive potential and the performance of the case studies in each Macro-area (excluding extreme values). To this end, the P_{UC_st} is compared with a standardized index M_{k_st} resulting from the non-weighted average of the indicators belonging to just one Macro-area (Tourism and Culture Index, Green Transition Index, Digitalization/smartness Index, Sustainable Mobility index, and Economic and Social Resilience Index). The representation of P_{UC_st} and M_{k_st} on a Cartesian chart allowed to assess the contribution of one Macro-are in the overall competitive performance of urban areas, represented by the reciprocal position of the case studies within the chart. To this end, the regression line as well as regression coefficient are examined, too.

I proposed a distinction in four categories, that can be identified by four quadrants in the Cartesian chart:

- I quadrant is representative of low potential and less competitive areas (P_{UC_st} < 50 and low M_{k_st} < 50). Generally, the areas falling into this quadrant are characterized by degradation and scarce dynamism in all sectors, as well as low susceptibility to grow in that specific Macro-area.

- II quadrant includes urban areas with low potential but high sector competitiveness (P_{UC_st} < 50 and M_{k_st} > 50). These areas present an initiated transition in the specific Macro-area that, nevertheless, is not sufficient to boost the overall competitive potential because of scarce performance in other sectors.

- III quadrant embeds urban areas with high potential and high sector competitiveness (P_{UC_st} > 50 and M_{k_st} > 50). This quadrant is representative of the best-performing cases, those cities leading both the overall ranking and the partial ranking per Macro-areas.

- IV quadrant characterizes urban areas having high potential but low susceptibility to grow in that Macro-area (P_{UC_st} > 50 and M_{k_st} < 50). For these high-performing urban areas, this would mean either that the specific Macro-area

does not represent a competitive asset or that administrators should invest in that Macro-area to further increase the overall competitiveness.

This is the ultimate result of the methodology development, and the central element of the decision support tool, as it can support investment choices in urban environments according to the competitive potential of the areas and their distinctive vocations, given a set of sectors where to intervene.

4.6 Validation

The methodology validation took place in a framework of continuity with its development. The main validation is constituted by the application to three case studies that proved the reliability of the methodology and its replicability to different contexts and different territorial scales. It was also interesting to note that many of the obtained results, despite referring to different applications, lead to comparable considerations, converging into reasonable conclusions for this research work.

From a methodological perspective, several operational steps were run for the purpose of validating the research.

Firstly, for what concerns correlation analysis, both 0.75 and 0.9 were evaluated as threshold values of the Pearson coefficient. Regarding PCA, the Chronbach alpha test was used to test the reliability of the model. The test is repeated as many times as components are, each time considering different variables. The higher the Chronbach coefficient (a threshold value of 0.5 is considered), the higher the reliability. Finally, cluster analysis is repeated considering this time the loadings obtained with PCA instead of the values of indicators, and clustering both variables and cases (urban areas). This comparison between cluster analysis and PCA, while having precedents in the literature (Saha et al., 2019), is a methodological innovation useful to clean and confirm the interpretation of PCA results, which is subject to errors influenced by the subjectivity of interpretation. The resulting dendrogram can be cut to check whether there is a section that reflects the aggregation into components obtained by PCA. This operation has two objectives: on the one hand, to verify the conformity of the results of the two exploratory analyses, and on the other hand, to obtain further information on the clustering of variables that are not sufficiently correlated with the principal components identified. Furthermore, this

operation provides further insights into the homogeneity of the susceptibilities of the case studies.

For the last steps of the methodology, the correlation analysis between P_{UC_st} and population size, along with the study of regression parameters in the constructed regression models, represent another test site. The obtained rankings are compared with the results of other studies from the scientific literature and international benchmarking, in order to have a brief indication of the reliability of the rankings.

4.7 Methodology originality

By drawing on contemporary notions of urban competitiveness and consolidated scientific approaches and methods, this work proposes a revised method to evaluate competitiveness, latent qualities, and intrinsic features of urban areas, constituting an initial step to conceive suitable metropolitan development and investment strategies for economic recovery.

In detail, the purpose of this methodology was two-fold: on the one hand, it aimed at developing a new index of urban competitiveness, named Potential of Urban Competitiveness, based on key dimensions of urban development, by using multivariate statistical analysis; on the other hand, it intended to identify urban areas' main competitive assets, throughout the examination of the existing links between the overall competitive potential and relative urban conditions in each Macro-area considered. Another original result consisted of studying competitiveness on two dimensions (competitive potential vs susceptibilities in relation to available opportunities for growth), considering three different territorial scales, and introducing for the first time in the scientific literature the sub-municipal scale.

Operationally, the novelties introduced within the methodology regarded:

- the choice of competitive urban dimensions (Macro-areas) on the basis of a systematic literature review (bibliometric analysis) compared with contemporary challenges and tools (NGEU program);
- the confrontation of the main factors extracted through PCA with the initial Macro-areas;

- the comparison of two indexes, differently weighted, representing respectively urban areas' intrinsic competitive potential and competitive level in relation to an external source of investment;
- the contextualization of results in a spatial framework through the combination of statistical analysis tools and spatial analysis software;
- the study of competitive susceptibilities in urban areas through correlation analysis between overall index (representative of the competitive potential) and partial indexes (representative of partial performance in a Macro-area);
- the combination of Cluster Analysis and PCA to validate PCA results and give robustness to the following methodological steps.

Moreover, the continuous confrontation with the plan of investments NGEU constituted another element of originality and provided the opportunity to verify the scientific hypothesis as well as the applicability of the methodology to a real case. For what concerns policy implications, one of the main innovations of this study was the comparison of two competitiveness rankings that might reveal disparities or alignments between the resources allocated by the NGEU plan and the competitive potential of urban areas.

In conclusion, the innovative aspects proposed depended on the intention to consider together different urban phenomena and challenges, developing a method that, through a systemic, integrated, and holistic approach returns complementarity between the components of competitiveness, administrative levels, and territories, in order to ensure consistency between initiatives taken in different sectors and at different scales, in an unprecedented context of opportunities.

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CHAPTER 5. APPLICATIONS

5.1 Introduction

The way to arrive at an effective and robust methodology could not but pass through more than one phase of experimentation to achieve different objectives: first, the application of the methodology to examine urban competitiveness in different urban contexts and at different territorial scales; second, the validation of the method for different scenarios.

As regards the territorial scale, it is necessary to pay attention to the complementarity between competitiveness at the level of large urban and metropolitan agglomerations, intra-metropolitan municipalities, and at the sub-municipal level, in order to ensure consistency between wide-ranging strategies, with a broader impact on the territory, and local initiatives, which act at the neighbourhood level. The application phase is dedicated to verifying if the developed methodology is effective despite the differences between cities in terms of size, functional characteristics, technological development, cultural activities, economic and environmental resources, mobility, demographic and social context.

On the other hand, applying the methodology to different case studies highlighted its weaknesses, which were then taken into account for the subsequent implementation phase and methodology adjustments. Each of the following three sections is devoted to one of the three case studies: section 5.2 concerns the application to the 14 major Italian cities and constitutes the site test of the methodology at the metropolitan scale; section 5.3 studies the competitiveness of the municipalities embedded in the larger metropolitan areas of Porto and Lisbon (Portugal), deepening the research at the municipal scale and in a different context from the Italian one; finally, section 5.4 regards the application, at the sub-municipal scale, to the City of Naples (Italy), constituting unexplored ground in the scientific literature. The succession of sections follows the temporal evolution of the methodology, which got enriched step by step with new awareness and relevant analytical advancements. Weak points were gradually filed down, thanks to the introduction of new variables, functions, formulas, representation techniques, and outcomes.

5.2 Competitiveness of Italian metropolitan areas[6]

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). In the context of the post-covid recovery, the European Union has approved the Next Generation EU (NGEU) financial 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 a 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). Different local actors are involved in the implementation of the plan. Among them, metropolitan cities[7], by virtue of their strategic territorial and socio-economic role, have been called upon to present projects and programs, reaffirming their key role in the development of the country's competitiveness.

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 and 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

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[6] This paragraph was written on the basis of the following published scientific papers:

Gargiulo, C., Guida, N., & Sgambati, S. (2022). NextGenerationEU in major Italian cities. *TeMA-Journal of Land Use, Mobility and Environment, 15*(2), 287-305.

Sgambati S. (2023) Il PNRR per città più competitive? Una verifica della coerenza tra le scelte di intervento/investimento e la suscettività alla competizione delle aree metropolitane del nostro paese. *URBANISTICA INFORMAZIONI* (2023) Special Issue XIII Giornata di studio INU.)

Gargiulo, C., Guida, C., & Sgambati, S. (2023). Sustainable mobility as a factor of urban competitiveness. The scenario of major Italian cities. *Transportation Research Procedia*. ISSN 2352-1465

[7] The application exposed in this section refers specifically to the local entities known as "Città Metropolitane" – from now on in this chapter metropolitan cities – introduced by The Delrio law, enacted in Italy in 2014, coinciding with large urban areas with a high population density and a significant economic, cultural, and social role at the national level. The 14 cities object of this application are all considered metropolitan cities under this law, meaning that they have a higher level of autonomy and responsibility than other provinces in Italy. The cases study are: Bari, Bologna, Cagliari, Catania, Florence, Genoa, Messina, Milan, Naples, Palermo, Reggio Calabria, Rome, Turin, and Venice.

(susceptibilities and potential) 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 that correspond to a certain number of variables.

Given this frame, this application examines the competitiveness of the Italian metropolitan cities (Bari, Bologna, Cagliari, Catania, Florence, Genoa, Messina, Milan, Naples, Palermo, Reggio Calabria, Rome, Turin, and Venice) investigating the relationship between their characteristics and the competitive processes that are expected to occur with the implementation of the PNRR. Table 5-1 summarises some of the characteristics of metropolitan areas and their major municipalities.

Metropolitan area	Extension [km²]	Major municipality extension [km²]	Residential density in metropolitan area [inh/km²]	Residential density in major municipality [inh/km²]
Bari	3,825.0	116.2	319.8	2,718.6
Bologna	3,703.0	140.9	273.3	2,788.6
Cagliari	1,248.0	85.0	336.1	1,740.7
Catania	3,573.7	182.9	299.9	1,632.0
Florence	3,514.0	102.3	280.3	3,525.9
Genoa	1,839.2	240.3	442.3	2,325.0
Messina	3,266.1	213.7	183.3	1,021.8
Milan	1,575.6	181.7	2,045.8	7,473.3
Naples	1,171.0	117.3	2,535.9	7,789.4
Palermo	5,009.3	160.6	239.7	3,916.9
Reggio Calabria	3,183.0	239.0	162.5	714.5
Rome	5,352.0	1,287.4	787.8	2,133.9
Turin	6,827.0	130.0	322.2	6,452.2
Venice	2,472.9	415.9	336.9	601.1

Table 5-1. Territorial extension and residential densities of Italian metropolitan areas and their major municipalities.

Firstly, by taking a multidimensional approach and following the methodology procedure, five Macro-areas of Competitiveness were identified, namely Tourism and Culture, Ecological Transition, Digitalization/Smartness, Sustainable Mobility, and Economic and Social Resilience (as exposed in Chapter 4). 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 imple-

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mented 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 cities; 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 to date in the 14 metropolitan cities. 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.

Firstly, the construction of the dataset (Table 5-2) consisted 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 Economic and Social Resilience) 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. 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.

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
Green 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
Economic and Social Resilience	S1	Net migration	2019	Inh./1000 inh.	ISTAT
	S2	Foreigners	2019	%	ISTAT
	S3	Structural dependency ratio	2019	%	ISTAT

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S4	Youth employment ratio	2020	%	ISTAT
S5	Female employment ratio	2020	%	ISTAT
S6	Crime index	2019	n,/inh.	IlSole24ore
S7	Local expenditure for so-cial issues	2020	€	Istituto Tagliacarme
S8	Female enterprises	2020	%	Camera di Commercio
S9	Acquisitions of citizenship	2021	n./inh	IlSole24ore
S10	Accidents in the work-place	2021	n./n. employees	IlSole24ore

Table 5-2. The selected indicators, divided per Macro-area of Competitiveness for the metropolitan scale.

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 and 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 test was repeated 5 times, as many as the components are. The higher the Cronbach coefficient (considering a threshold value of 0.5) the greater the reliability is.

The third phase consists of the comparison of two indexes obtained from the elaboration of the previous two phases' output. The first index, namely the Potential of Urban Competitiveness (P_{UC}), is constructed by first 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, P_{UC}, standardised on a scale

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from 0 to 100. The second index I_{UCPNRR}, which is the Index of Urban Competitiveness according to PNRR, is calculated by aggregating indicators (weighted with the Equal Weighting Method) into five intermediate indexes corresponding to the Macro-areas of Competitiveness (see Table 5-3), then aggregated and weighted proportionally to the resources allocated by the PNRR in each Macro-area.

Macro-area	PNRR resources [billion €]	I_{UC_PNRR} Weightings
Tourism and Culture	6.68	0.05
Green Transition	42.31	0.30
Digitalization/Smartness	33.64	0.24
Sustainable Mobility	37.29	0.27
Economic and Social Resilience	19.81	0.14
TOT	139.73	1

Table 5-3. The weightings assigned to the Macro-areas of Competitiveness according to the PNRR resources.

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 Italian 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 Table 5-2) and the transformation of the dataset into a 53x14 matrix. It is worth emphasizing a strong correlation between the variables of the submatrix Economic and Social Resilience, which, however, 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 have a comparable weight for urban competitiveness. By analyzing the loadings of the first component, most variables have a positive correlation. Only 13 are inversely correlated.

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| | Significant indicators for the I | | | Coordinates in relation |
ID	component	Loading	Observed cases	to the I component
M7	Electric vehicles	0.922	Milan	2.068
S1	Net migration	0.912	Bologna	1.412
S5	Female employment ratio	0.884	Turin	0.733
S4	Youth employment rate	0.874	Florence	0.566
T6	Gyms, pools and spa	0.873	Genoa	0.444
D13	Innovative start-ups	0.855	Venice	0.357
E12	Energy requalification	0.852	Rome	-0.099
S6	Crime Index	0.831	Bari	-0.155
S2	Foreigners	0.824	Cagliari	-0.274
D10	Digital Transformation Index	0.789	Catania	-0.646
D8	POS services	0.752	Reggio Calabria	-0.921
M8	Bike sharing	0.745	Naples	-1.002
E1	Separate waste collection per capita	0.728	Palermo	-1.035
			Messina	-1.448
M3	Incidence of standard cars emissive	-0.743		
S8	Female enterprises	-0.805		
E8	Dispersion of the water network	-0.823		
	(a)			(b)

Table 5-4. (a) Significant variables for the first component; (b) Coordinates of the observed cases (Metropolitan cities) on the first component.

Considering the variables with higher loadings on the first component (Table 5-4a), 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 Economic and Social Resilience. 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 (Carta et al., 2018). Looking at the distribution of the cases on this component (Table 5-4b), it reflects the substantial disparities existing between the North and the South of the countries, with Milan in the first place, and southern cities arranged at the bottom of the ranking.

| | Significant indicators for the II | | | Coordinates in relation |
ID	component	Loading	Observed cases	to the II component
T1	Number of museums	0.904	Rome	2.848
T13	Hotel facilities	0.789	Naples	0.901
D12	Ultra-broadband	0.691	Turin	0.684
T5	Density and relevance of cultural heritage	0.666	Florence	0.542
			Palermo	-0.028
D3	Number of graduates	0.646	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
	(a)			(b)

Table 5-5. (a) Significant variables for the first component; (b) Coordinates of the observed cases (Metropolitan areas) on the first component.

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The second component (Table 5-5 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 separate aspects for urban competitiveness.

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

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

(a) (b)

Table 5-6. (a) Significant variables for the third component; (b) Coordinates of the observed cases (Metropolitan areas) on the third component.

The third component (Table 5-6 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.

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ID	Significant indicators for the IV component	Loading		Observed cases	Coordinates in relation to the IV component
M10	Pedestrian areas	0.974		Venice	3.333
T10	Tourists rate	0.963		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
(a)				(b)	

Table 5-7. Significant variables for the fourth component; (b) Coordinates of the observed cases (Metropolitan areas) on the fourth component.

The fourth component (Table 5-7 a and b) is highly correlated with the indicators 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 V component	Loading		Observed cases	Coordinates in relation to the V component
E6	Energy from renewable resources	0.868		Bari	2.163
M6	Public buses	0.777		Cagliari	2.018
D11	Digital Agenda Funds	0.730		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
(a)				(b)	

Table 5-8. 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 Table 5-8 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. In these dendrograms (Figures from 5-1 to 5-6) Northern cities were reported in blue, whilst Southern cities in red. The dendrogram obtained from the whole dataset (Figure 5-1) 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 (Figure 5-2) 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 (Figures 5-3 and 5-4), there is a significant homogeneity. The dendrogram relative to sustainable mobility (Figure 5-5) sees a subdivision between Bologna, Florence, Milan, and Venice with other cities. Finally, the dendrogram on Economic and Social Resilience (Figure 5-6) reflects the trend of the dendrogram relative to the whole dataset (Figure 5-1).
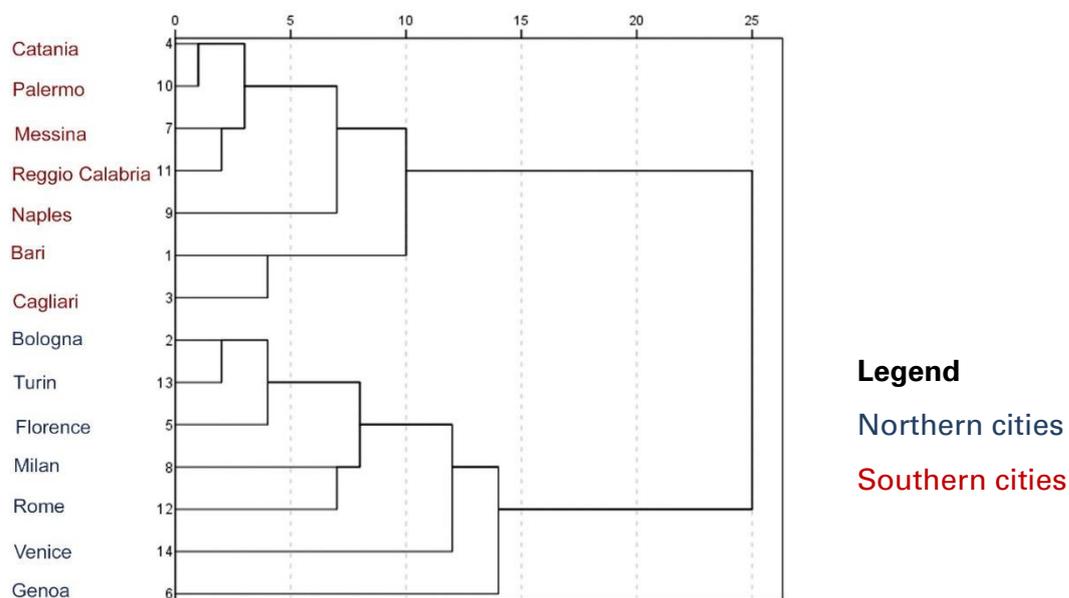
Figure 5-1. Dendrogram from the cluster analysis relative to the entire database
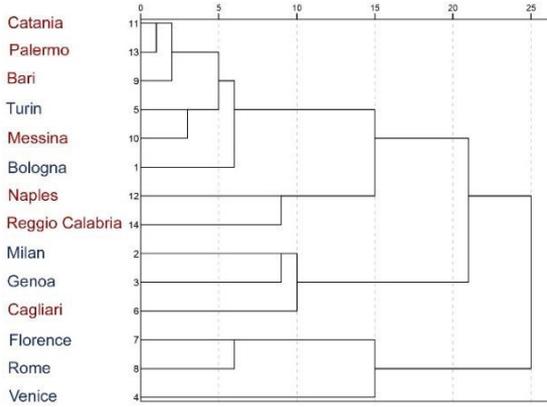
Figure 5-2. Dendrogram from the cluster analysis relative to the macro-area 'Tourism and culture'
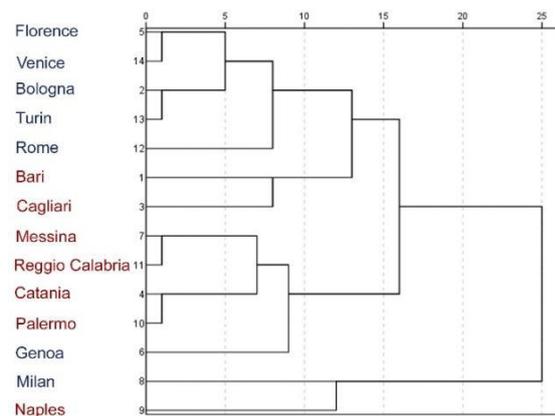
Figure 5-3. Dendrogram from the cluster analysis relative to the macro-area 'Green transition'
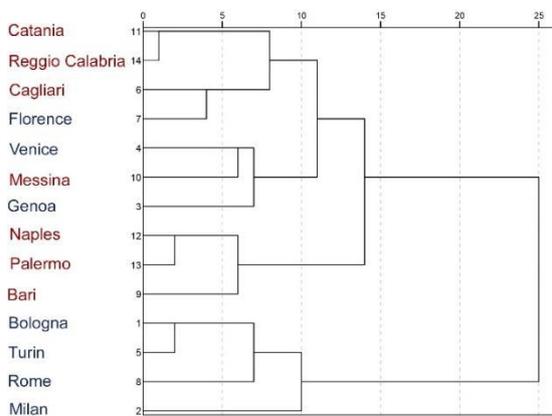
Figure 5-4. Dendrogram from the cluster analysis relative to the macro-area 'Digitalization / Smartness'
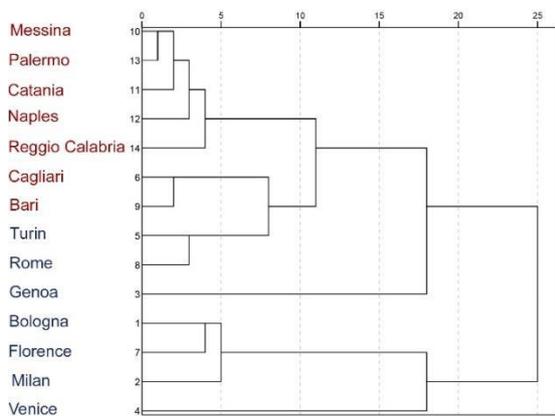
Figure 5-5. Dendrogram from the cluster analysis relative to the macro-area 'Sustainable Mobility'
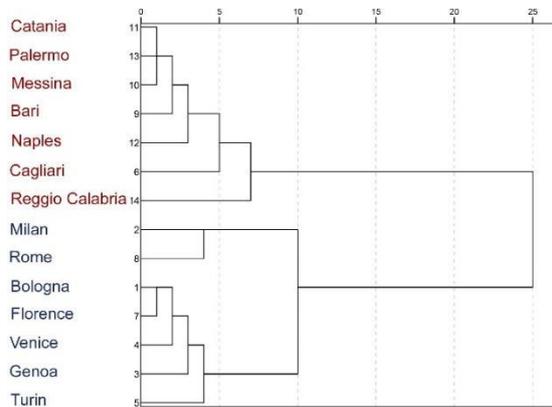
Figure 5-6. Dendrogram from the cluster analysis relative to the macro-area 'Economic and Social Resilience'

For the third part of the methodology, two indexes of competitiveness were built and compared. The first index P_{UC} is representative of the potential of competitive-

ness and is calibrated through the PCA, by utilizing the weight assumed by metropolitan cities' distinctive characteristics. On the other hand, the second index I_{UCPNRR} 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 (standardized on a scale from 0 to 100) 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.
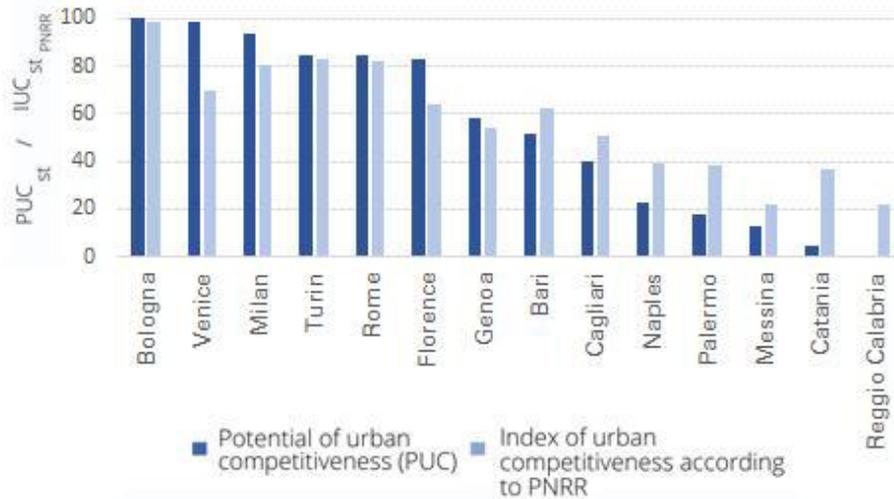
Figure 5-7. Comparison between the two standardized indexes of competitiveness, one (PUC) resulting from the application of the methodology and the second (IUC_PNRR) based on the PNRR resources distribution.
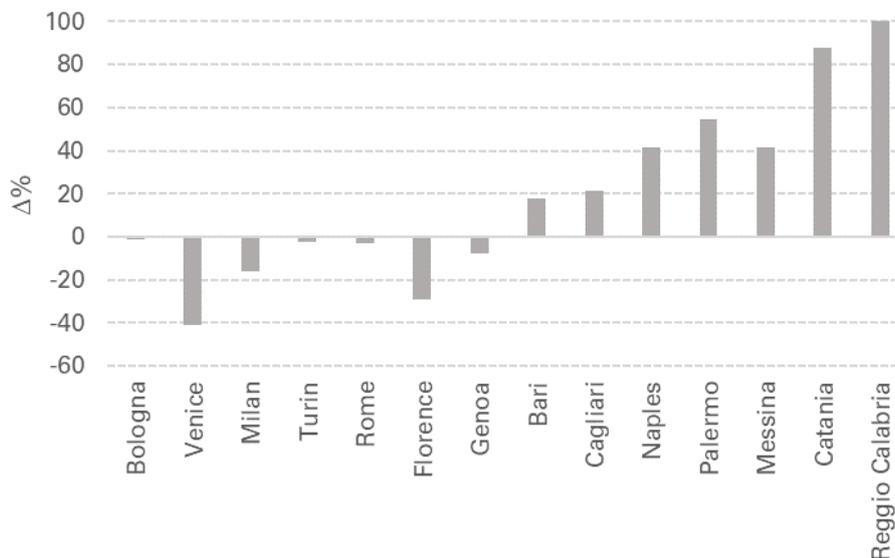
Figure 5-8. Difference between PUC and IUC$_{PNRR}$ expressed in percentage.

Figures 5-7 and 5-8 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 (Table 5-9). For the third component, only the variables positively correlated with the factor, namely, the structural dependency index and citizenship acquisitions, were considered.

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

Table 5-9. Cronbach alpha coefficient calculated for the 5 components obtained with the PCA.

Subsequently, a comparison between the results of the analyses and the interventions activated by the PNRR was developed. In particular, this section discusses relationships between metropolitan competitive assets, that emerged from explorative analyses, and the main strategies and projects promoted within the 14 Italian metropolitan areas. Table 5-10 facilitates this comparison by showing, for each metropolitan area, the objectives of the activated projects and the assets of competitiveness identified in this research.

By looking at the results of the analyses, the main factor that appears to influence most urban competitiveness of Italian metropolitan cities 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. All in all, 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 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.

Metropolitan City	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.	Economic and Social Resilience
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

Table 5-10. Comparison between PNRR projects' main objectives and the assets of competitiveness emerged from the analysis for the 14 Italian metropolitan areas.

By and large, 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 competencies. 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 the 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 the 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 to increase 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 (Veneri & Crociata, 2009). 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 (Rabbiosi, 2015). Also, promoting cultural activities in urban areas has the positive cross-cutting 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 for 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 services. The most significant cases for this component (see Table 5-6b) 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 together, 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 and Wang, 2019). Cities more suitable to grow in digital and green sectors are, according to the analysis, 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 unique southern city to have a privileged position in the field. Rome goes 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. Overall, the green transition has been much more driving than the 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 summary, 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 (e.g., 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.

Concluding, drawing up urban policies, starting from the cities' competitive assets, is fundamental to increase urban competitiveness. It is necessary to understand where to invest and what are the priorities of interventions.

The proposed comparison between the characteristics of 14 Italian metropolitan cities and the identified Macro-areas of Competitiveness, through multivariate statistical analysis, allows for verifying where it is worth investing to achieve a significant increase in metropolitan areas' competitiveness. Among the main findings, it emerged that quality of life has become the main driver for urban competitiveness in 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). Nevertheless, many cities are already improving along specific development trajectories, proposing solutions and projects to enhance urban resources while increasing resilience, especially in the most problematic urban contexts.

5.3 Municipalities' competitiveness in Porto and Lisbon metropolitan areas[8]

Once experimented on the metropolitan scale, the proposed methodology was secondly applied to the urban scale, examining the competitiveness of the municipalities embedded in the metropolitan areas of Porto and Lisbon. The experimentation was developed during a visiting period at the School of Economics of the University of Porto, with the support of Professor Luis Carvalho.

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[8] This section is a formal elaboration of a scientific paper published by the author in a class A scientific Journal. Sgambati, S., & Carvalho, L. (2023). Benchmarking urban competitiveness for economic recovery: an application to Porto and Lisbon. *Journal of Place Management and Development.* https://doi.org/10.1108/JPMD-03-2023-0019

This application meets two needs: firstly, to apply the methodology to the urban scale, comparing the competitive performance of different classes of municipalities within larger metropolitan areas; secondly, the application to the Portuguese context (and Southern European, in general) is also relevant from a policy perspective, considering the opportunities and investment volumes being provided by the European Commission program Next Generation EU to many countries following the Covid-19 pandemic (EC, 2021; Nieuwenhuijsen, 2021; Gargiulo et al., 2022); in countries like Portugal, the role of the metropolitan areas as recipients of these investments is pivotal, as they have been widely considered over time as national economic engines (Silva & Clarke, 2001; Chamusca et al., 2022).

The two case studies, namely the metropolitan areas of Porto and Lisbon, exemplify mid-sized cities that are comparable in terms of urban competitiveness, although they differ substantially in terms of spatial and developmental characteristics (van Winden & Carvalho, 2008; Puissant & Lacour, 2011). The Lisbon metropolitan area presents a mix of North Atlantic and South Mediterranean influences. Lisbon's urban model is characterised by rapid urban expansion, concentrated in the urban centres of Lisbon, Oeiras, Cascais, Setúbal and Almada, and intense urbanisation along the main road and railway lines (Amadora and Vila Franca de Xira) radiating from the main urban centres. The metropolitan area of Lisbon has 2.5 million inhabitants distributed over an area of 312 km^2, with a population density of 817 inhabitants/km^2. The city of Lisbon is the main nucleus of economic activity, mainly tertiary, flanked by emerging centres connected to the capital by motorways. The population is concentrated around the main railway axes, while low-density residential areas are spread over the remaining parts of the metropolitan territory.

The metropolitan area of Porto is characterised by an Atlantic coastal landscape and has a population of approximately 1.2 million inhabitants in an area of 817 km^2, with a population density of 1464.1 inhabitants/km^2. The urban pattern is concentrated between the main centres (Porto and Vila Nova de Gaia) and dispersed among many small towns and rural villages. The highest densities are found in the municipalities of Porto, Vila Nova de Gaia and Matosinhos. As in the Lisbon metropolitan area, the last 25 years have witnessed intense urbanisation. The 'Plano

de Melhoramento' of the city of Porto has favoured the provision of low-cost housing, making the municipality of Porto the largest 'landlord' in Portugal. Areas of intense urbanisation developed along the north-south transport axis, with the spread of industrial, tertiary and housing activities.

The methodology was recalibrated on the Portuguese context, considering, this time, just three Macro-areas of Competitiveness (comparable with the objectives and fields of investment of the Portuguese Recovery Plan) which were associated to contemporary policy objectives of fostering green and digital transition and to socio-economic resilience. The objective is to better understand which domains appear to correlate with metropolitan urban competitiveness more closely, assuming as hypothesis that the relationship between size (population) of metropolitan municipalities and their competitiveness is weak. This hypothesis has constituted a methodological advancement for this research and its verification has been a way to validate the initial assumptions. Subsequently, the index Potential of Urban Competitiveness (P_{UC}) was developed for each metropolitan municipality using Principal Component Analysis as a weighting method (JRC European Commission, 2008; Sáez & Periáñez, 2015; Akande et al., 2019). This index is intended as a measure of the competitive potential of a municipality since it puts together the latent qualities and intrinsic features – referring to pre-selected Macro-areas – that can be addressed to drive future increases in competitiveness. Also, by considering classes (or "clubs") of municipalities according to population dimension, it allows studying the relationship between the overall index and performance in each of the three Macro-areas.

Specifically, assuming as a main hypothesis that urban competitiveness is a multidimensional and complex phenomenon, the following three Macro-areas were considered: i) 'Green Transition', referring to the roadmap towards sustainable development, diversification of energy resources, improvement of environmental quality and safety, and the reinforcement of environmental management (Jiang & Shen, 2010; Hammer et al., 2011; Papa et al., 2016; Van Den Berg et al., 2016; Komasi et al., 2022); ii) 'Digital Transition' referring to digitalization across the economy and society (education, business, public sector) along with the spread of skills and the diffusion of technologies (Filo, 2007; Van Winden & Carvalho, 2008;

Dmitrieva & Guseva, 2019; Penco et al., 2020); and iii) 'Economic and Social Resilience', including dimensions related to the level of equity and inclusion, social provisions and salaries, employment, and touristic resources (Williams et al., 2013; Martin & Sunley, 2017; Säumel et al., 2019; UNESCO & World Bank, 2021).

As mentioned, the identification and systematization of these Macro-areas relied on the combination of the study of the scientific literature on urban competitiveness (see Chapter 3), structured along key dimensions of current European economic recovery programs (Next Generation EU). As stated in that phase, the ability to handle future challenges has become a key factor for the definition and assessment of urban competitiveness. Among the most recurrent challenges considered by the scientific studies, there are environmental sustainability, circular economy and adaptation to climate change (resonating with the Macro-area of 'Green Transition' in the Next Generation EU program); innovation and the promotion of a digital economy (linked to the Macro-area 'Digital Transition'); and aspects related to the preparedness of cities to respond to economic and social challenge (which converge into the third Macro-area 'Economic and Social Resilience' in the aforementioned program).

Macro-area	ID	Indicator	Date	Measurement unit	Source
Green Transition	G1	Wooded areas	2020	n.	SNIAmb
	G2	Urban waste	2020	kg/inh.	Ine.pt
	G3	Separate waste collection	2020	%	Ine.pt
	G4	Industrial electric energy consumption	2020	kWh/inh.	Ine.pt
	G5	Domestic electric energy consumption	2020	kWh/inh.	Pordata.pt
	G6	Gas consumption	2020	Nm3/inh.	Pordata.pt
	G7	Green urban areas	2018	mq	Copernicus
	G8	Environmental protection	2020	€	Pordata.pt
Digital Transition	D1	Expenditure for R&D	2021	€	Ine.pt
	D2	Employees with higher education	2021	%	Ine.pt
	D3	Knowledge-economy firms	2020	n.	Pordata.pt
	D4	New IT enterprises	2022	n.	Ine.pt
	D5	College Graduates	2021	%	Ine.pt
Economic and Social Resilience	E1	Cultural facilities	2019	n.	Pordata
	E2	Bed occupancy net rate	2020	%	Ine.pt
	E3	Disparity in the average monthly earnings	2020	%	Ine.pt
	E4	Unemployment rate	2021	%	Pordata.pt
	E5	Youth employment rate	2019	%	Ine.pt
	E6	Foreign residents	2021	%	Ine.pt
	E7	Net migration	2020	n.	Ine.pt
	E8	Female employment rate	2019	%	Pordata.pt
	E9	Crime	2020	n.	Pordata.pt
	E10	Average real estate value	2019	€	Pordata.pt
	E11	Recipients of unemployment benefits	2020	n.	Ine.pt
	E12	Average female salary	2019	€	Pordata.pt

Table 5-11. Selected indicators for each Macro-area for the application to Porto and Lisbon municipalities.

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For each Macro-area (Table 5-11), upon considering different variables as operationalization devices, correlation analysis was used to exclude redundant variables, with the result of streamlining the original matrix from 25 to 20 indicators. The excluded indicators are: 'Wooded areas' (G1), 'New IT enterprises' (D4), 'Number of cultural facilities' (E1), 'Foreign residents' (E6), 'Average female salary' (E12). Then, we extracted three components through Principal Components Analysis (PCA), with a total explained variance of 63%. The first component explains 42% of the total variance, the second 12%, and the third 8%. Table 5-2 reports the loadings registered on each component, with the variables ordered on the first component. The highest recorded loading for each indicator – that was used to weigh the indicator itself – are highlighted.

Indicator	Component		
	1	2	3
Recipients of unemployment benefits	0.945	0.094	-0.091
Knowledge-economy firms	0.939	0.302	0.060
Expenditure for environmental protection	0.869	0.262	0.207
Municipal expenditure for R&D	0.744	0.468	0.268
Net migration	0.640	0.467	-0.156
Average real estate value	0.541	0.658	0.340
Employees with higher education	0.442	0.804	0.157
College graduates	0.397	0.822	0.258
Industrial electric energy consumption	0.378	0.537	-0.016
Female employment rate	0.359	0.629	0.201
Crime	0.264	0.391	0.718
Separate waste collection	0.234	0.094	-0.118
Domestic electric energy consumption	0.212	0.081	0.775
Average female salary	0.050	0.900	0.081
Bed occupancy net rate	0.010	0.001	-0.028
Gas consumption	-0.002	0.025	-0.030
Green urban areas	-0.043	0.058	0.025
Urban waste	-0.161	0.140	0.843

Table 5-12. Loadings associated with indicators resulting from Principal Components Analysis, ordered on the first component.

By looking at the results of the PCA, the first component can be interpreted as closely linked to environmental quality and municipal investment thereof, which appears also associated to knowledge indicators and overall attractiveness; the second component is associated to the level of competencies and welfare of the population, while the third component can be interpreted as a composite measure of environmental degradation and social distress. By running a Hierarchical Cluster

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Analysis (Figures 5-9 and 5-10), we can see an aggregation of the most affluent and vibrant municipalities, with the capital cities constituting a separate cluster, as well as clear mosaics within both metropolitan areas, signalling (contiguous and non-contiguous) spaces with differentiated competitiveness profiles.
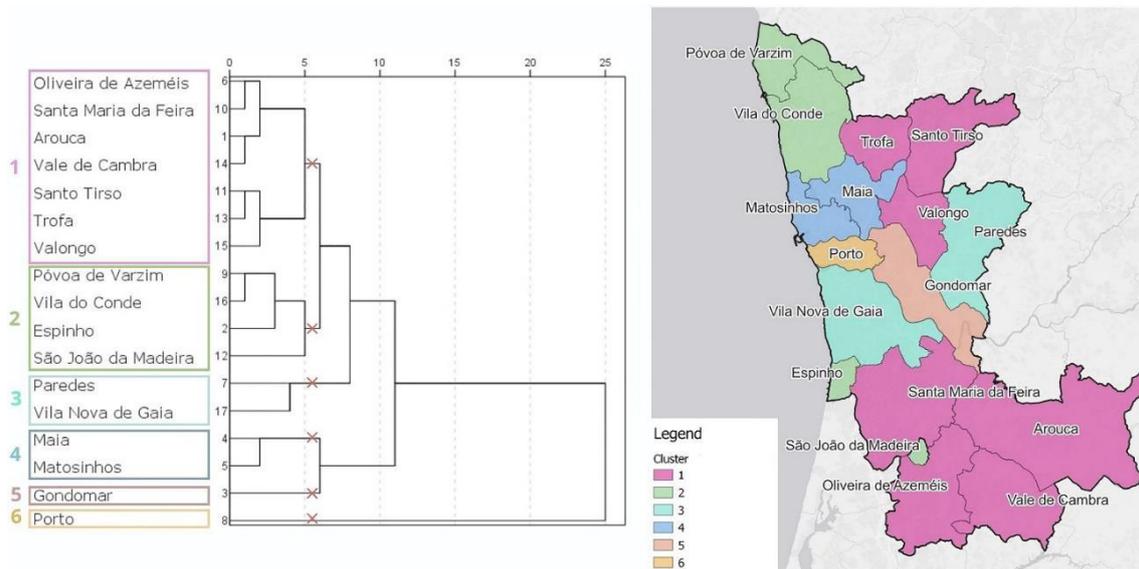
Figure 5-9. Results of the Hierarchical Cluster Analysis for the metropolitan area of Porto.
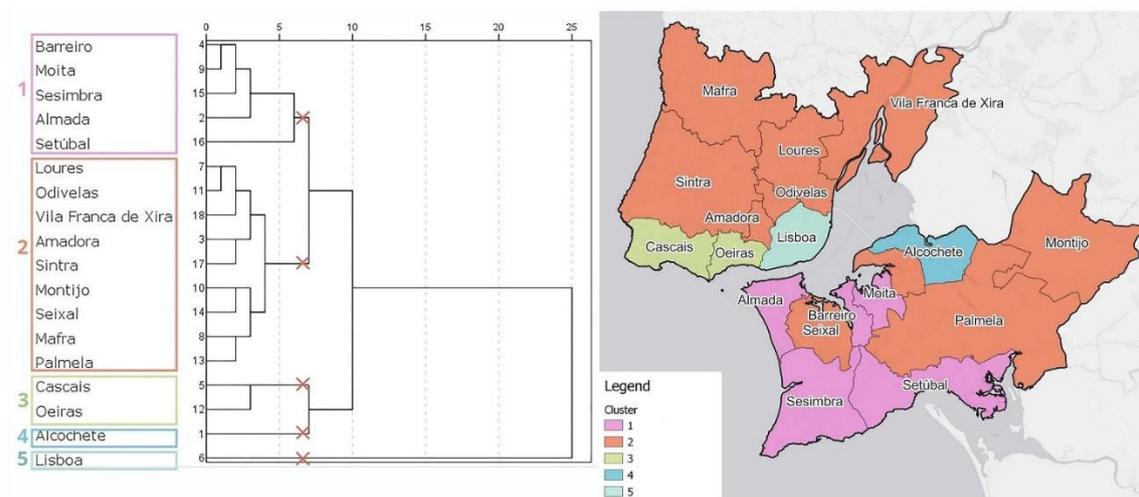
Figure 5-10. Results of the Hierarchical Cluster Analysis for the metropolitan area of Lisbon.

We assigned weights (l_i) proportional to the Principal Component Analysis (PCA) loadings and then the indicators were aggregated into different intermediate indexes PC_j equal to the number p of principal components extracted from the model. The intermediate indicators are aggregated into the final 'Potential of Urban

Competitiveness' index (P_{UC}) by assigning them a weight proportional to the explained variance of the model (w_{fj}). Hierarchical Cluster Analysis is used to assess how municipalities can be grouped according to their level of competitiveness and if this clustering is coherent with the final score achieved. The P_{UC} was then normalized (P_{UC_st}) through the min-max method into a scale from 0 to 100.

The composite index P_{UC_st} was built, as described in the methodology section, aggregating the indicators into intermediate indexes by assigning weightings proportional to the loadings of the PCA (see Table 5-12), and then assigning a weight to the intermediate indexes proportional to the variance explained by the three components. With this procedure, we obtained a ranking of the municipalities of both metropolitan areas, as shown in Figure 5-11. Without surprise, it can be noted that Lisbon, Porto and contiguous municipalities (which are important economic hubs and concentrate key amenities and infrastructure) lead the ranking. While, what is also revealing is a long tail of places with non-negligible competitiveness potentials, combining both industrialized and more rural municipalities. The second index I_{UCNGEU} was not calculated in this case because of the lack of data about the distribution of resources within the three Macro-area of competitiveness in Portugal at the moment of the analysis.
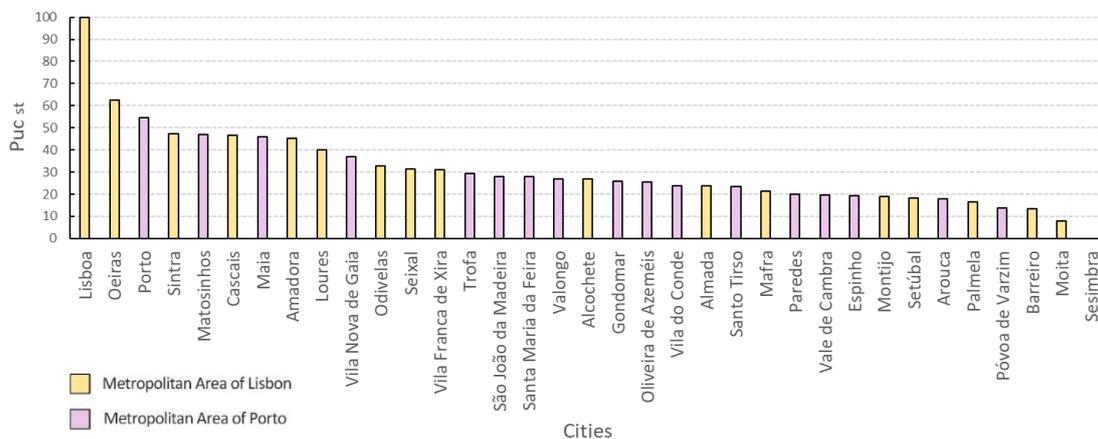
Figure 5-11. Ranking of the municipalities embedded in the metropolitan areas of Porto and Lisbon based on the results of the index Potential of Urban Competitiveness.

However, a methodological advancement was introduced within this experimentation that is the correlation analysis between P_{UC} and the partial indexes per

Macro-area. Firstly, municipalities are classified according to population size, using a natural breaks method. The first analysis aims at analysing the relationship between competitiveness and municipalities' population size. I have correlated the P_{UC_st} index with the standardized value of the municipalities' population size (Figure 5-12), removing the extreme values (Porto and Lisbon and Sesimbra). While there is a certain correlation between P_{UC_st} and normalized population size, the dispersion is also significant; hence, while a link between competitive potential and population size seems to exist, it is shown to be weak. We can also divide municipalities into classes based on population size. In this way, we can visualize how cities of different sizes distribute around the regression line. Figure 5-12 illustrates that, with equal population size, some municipalities have much higher competitive potential than others, thus the rather disaggregated scattered plot. This may depend on the different performances in the three Macro-areas considered, namely Green Transition, Digital Transition, and Economic and Social Resilience (see Figures 5-13, 5-14, and 5-15).

Figure 5-12. Regression analysis considering the Index of Urban Competitiveness as the dependent variable and Population size as the independent variable.

In order to deepen the reasons behind this result, I analysed three additional associations, keeping the classification according to the population size in Figure 5-12. Namely, considering the standardized indexes in Table 5-13, resulting from the non-weighted average of the indicators corresponding to the three Macro-areas of the study: Green Transition Index (GT_{I_st}), Digital Transition Index (DT_{I_st}), and Economic and Social Resilience Index (ESR_{I_st}).

City	GT_{I_st}	DT_{I_st}	ESR_{I_st}
Sintra	72.29	45.57	76.83
Vila Nova de Gaia	54.47	53.23	60.42
Cascais	62.41	64.54	77.28
Loures	55.80	30.91	69.67
Almada	56.36	45.00	38.91
Matosinhos	9.94	76.36	100.00
Oeiras	88.90	100.00	96.34
Amadora	68.14	50.67	81.23
Seixal	75.02	20.29	80.16
Gondomar	0.00	25.47	29.75
Odivelas	52.42	28.57	49.77
Vila Franca de Xira	41.67	22.77	46.43
Santa Maria da Feira	73.24	20.21	34.72
Maia	60.49	60.55	75.22
Setúbal	16.60	25.00	25.54
Valongo	63.05	21.54	60.08
Mafra	72.18	16.05	39.77
Paredes	46.76	5.44	34.59
Vila do Conde	25.48	27.51	62.36
Barreiro	45.02	20.13	0.00
Palmela	30.04	12.73	31.29
Santo Tirso	95.18	11.03	57.99
Moita	45.51	0.00	6.78
Oliveira de Azeméis	83.68	9.74	36.44
Póvoa de Varzim	5.68	22.69	43.71
Montijo	42.52	15.54	52.70
Trofa	86.28	18.08	55.60
Espinho	54.16	32.39	21.69
São João da Madeira	56.66	28.14	55.69
Vale de Cambra	59.32	17.21	25.09
Arouca	100.00	3.85	17.28
Alcochete	56.59	22.74	67.71

Table 5-13. Ranking based on the standardized indexes Green Transition Index (GT_{I_st}), Digital Transition Index (DT_{I_st}), and Economic and Social Resilience Index (ESR_{I_st}).

The relation between P_{UC_st} and GT_{I_st} (Figure 5-13) suggests that, in the constructed model, the overall competitive potential is not strongly correlated with the Green Transition dimension, not showing up yet as a clear indicator of how competitive a municipality is ought to be[9]. On the contrary, the correlation between P_{UC_st} and DT_{I_st} (Figure 5-14) shows that municipalities are arranged in relatively a uniform way around the regression line, suggesting that the two phenomena are more closely related. Lastly, the correlation between P_{UC_st} and ESR_{I_st} (Figure 5-15) presents a similar configuration to the one relative to Digital Transition, with higher levels of Economic and Social Resilience closely related to Urban competitiveness[10].
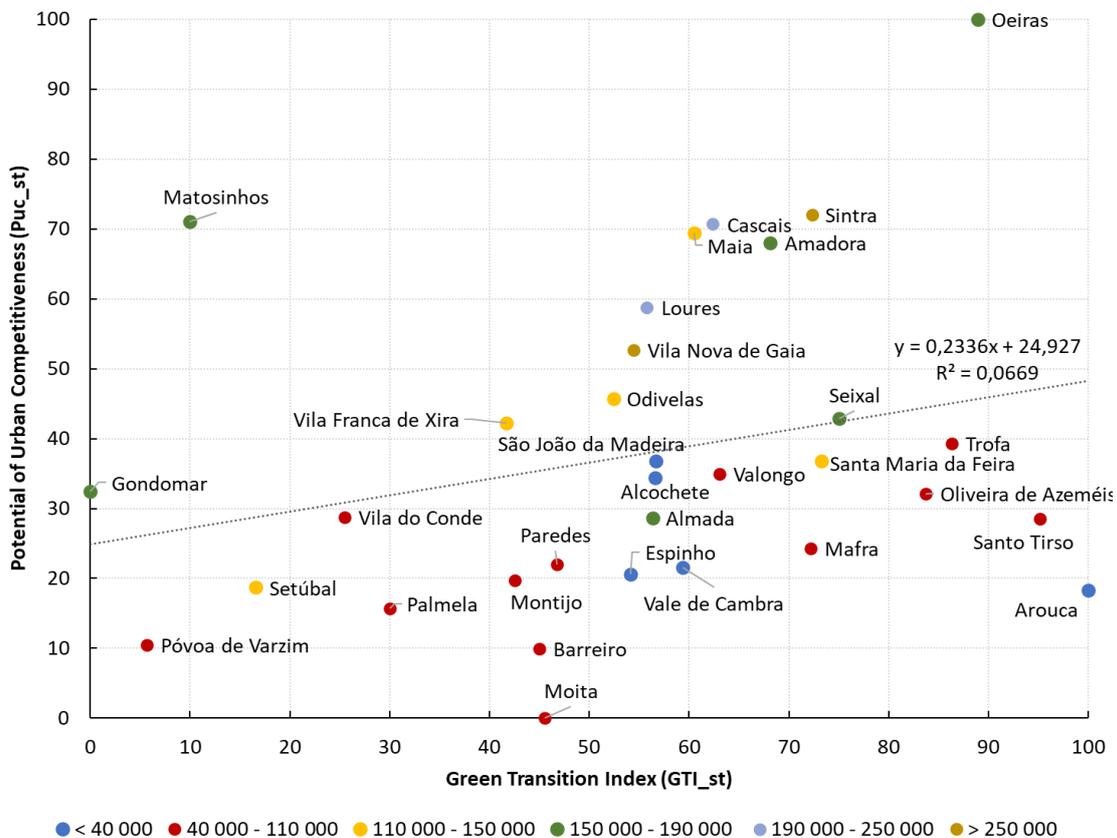
Figure 5-13. Regression analysis considering the Index of Urban Competitiveness as the dependent variable and the Green Transition Index as the independent variable.

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[9] In this interpretation, we should also consider the influence of the data quality, which (especially for the energy and waste collection sectors) may not be completely reliable, due to difficulties in data acquisition and the presence of projected values.

[10] In this case, the intercept assumes a negative value. This means that, according to the distribution of the data, only hypothetically negative values of the Economic and Social Resilience Index could associate to an Index of Urban Competitiveness equal to zero. This model may make sense if we consider that the interval of variance of both ESR_{I_st} and P_{UC_st} is [0,100], overlooking negative values. In this case, it is not relevant to predict outside the observed range of [0,100].
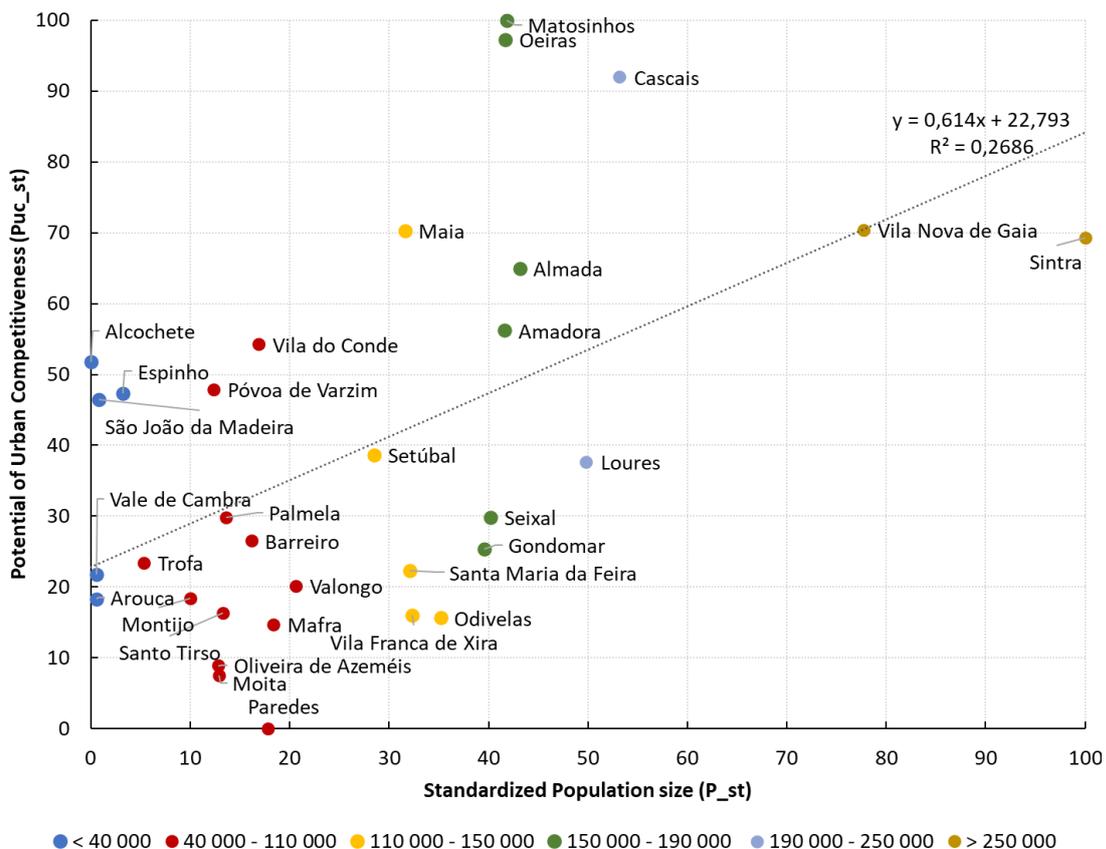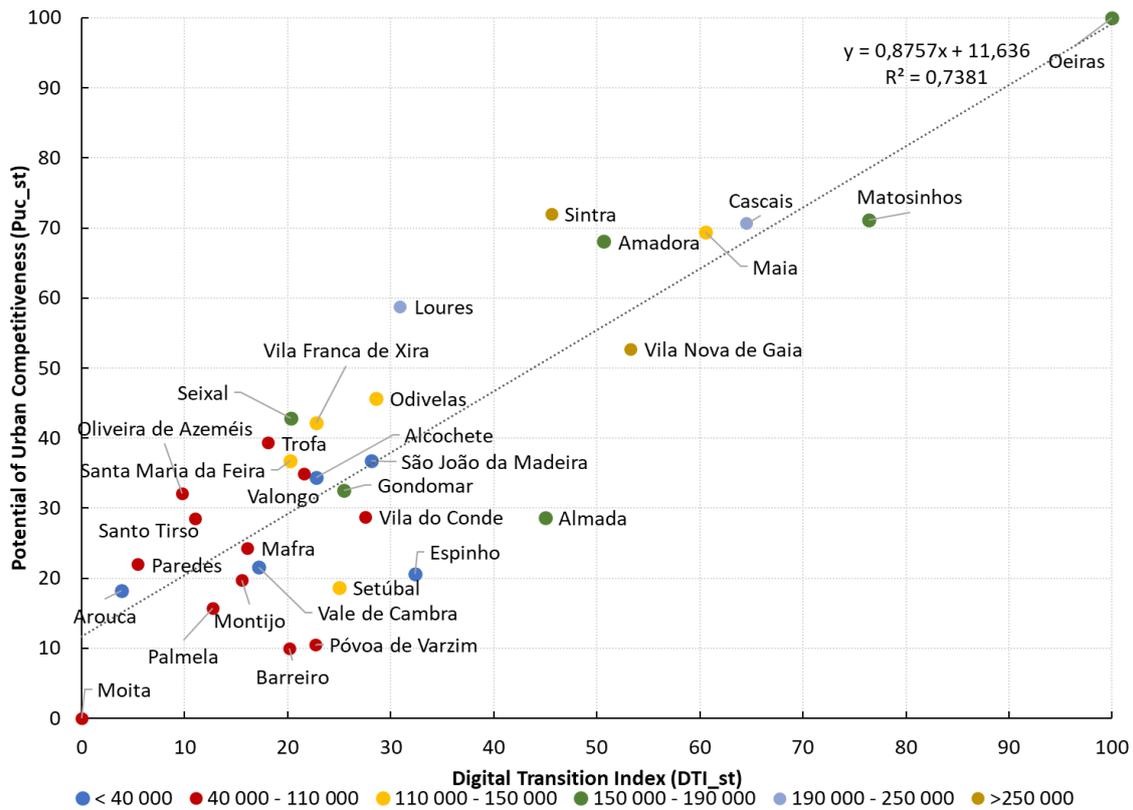
Figure 5-14. Regression analysis considering the Index of Urban Competitiveness as the dependent variable and the Digital Transition Index as the independent variable.

Discussing these results, the application of the first part of the methodology resulted in a ranking based on the score in P_{UC_st} achieved by each city. PCA was useful also to understand which variables contribute more closely for the competitive potential of municipalities within metropolitan areas, such as the ones related to the level of welfare, social equity, and economic performance in different sectors. The first component extracted can then be interpreted as an overall index of environmental quality and municipal investment thereof, which appears also associated to knowledge indicators and overall attractiveness, considering strongly correlated with variables such as: 'Recipients of unemployment benefits', 'Knowledge-economy firms', 'Municipal expenditure for environmental protection', 'Expenditure for R&D'. The second component, on the other hand, is an index of the level of competences and well-being of the population. It has a higher cor-

relation coefficient for the variables 'Average female salary', 'Graduated population', 'Employees with the highest level of education', and 'Average real estate value'.
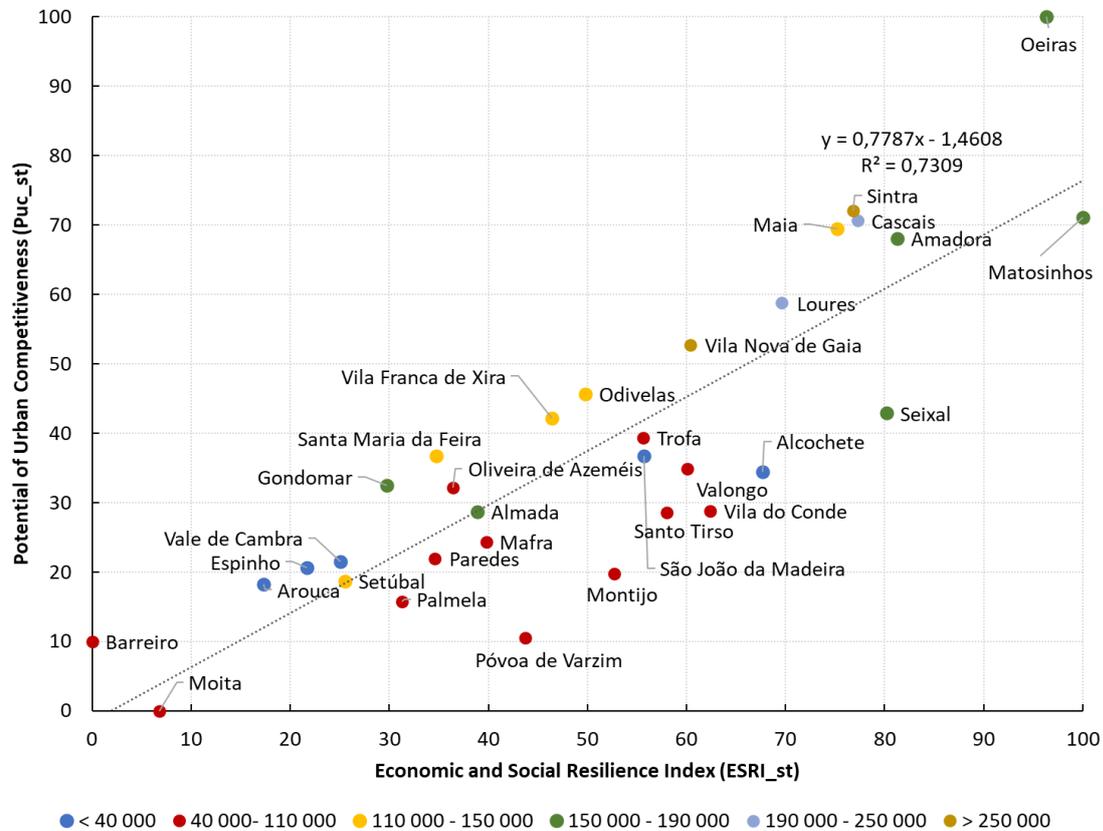
Figure 5-15. Regression analysis considering the Index of Urban Competitiveness as the dependent variable and the Economic and Social Resilience Index as the independent variable.

Looking at how the different municipalities are distributed on this component, at the top there are municipalities such as Porto, Oeiras, Matosinhos and Maia, at the spatial core of the metropolitan areas, that have recently blossomed in the knowledge-economy sector and are endowed with high-level infrastructure and amenities. The strong relationship with digital transition can be linked to the importance assumed in recent years by the IT sectors and the digital economy, also associated to relevant flows of international investment, in which both Lisbon and Porto are growing and investing significantly (Gama et al., 2014; Abrantes, 2020). The third and last component is instead related to the environmental and social degradation, as it presents high loadings for the variables 'Urban waste', 'Domestic electric energy consumption', and 'Crime'. All in all, the formation of components combining different variables of an economic, social, and environmental nature

suggest the heightened complexity and multiple interrelations among the contemporary determinants of urban competitiveness.

Regarding the distribution of the municipalities and the results of the Cluster Analysis, the latter is also clear showing, on the one hand, an aggregation of the most affluent and economically advanced municipalities; on the other hand, the dendrogram analyses (Figures 5-9 and 5-10) tends to cluster municipalities that instead present lower competitive performances considering the variables at stake, many of them forming contiguous sub-regions within metropolitan areas, whose characteristics are of being rural and urban-industrial belts, notwithstanding their still differentiated features within. However, as hypothesized, there is not a clear correlation between population size and the level of competitiveness. The results show that smaller municipalities (less than 40,000 inhabitants) have higher competitive potential than average (Figure 5-12), which suggests that different municipalities run with rather different competitive assets and attraction forces. This can be due to better levels of quality of life and proximity to amenities, the easier management of small territorial contexts or the reduced social disparities in comparison to big urban centres, but also by the fact that some highly populated municipalities in the metropolitan rings have "dormitory" features and limited direct access to goods, services and amenities, while metropolitan cores have lost residents over the decades. Most of the municipalities with a population between 40,000 and 150,000 inhabitants are below the regression line, while size between 150,000 and 190,000 reveal high scores in competitive potential. Regarding the classes 190,000-250,000 and more than 250,000 inhabitants, while there is high variability (e.g., between Loures and Cascais) the position of Vila Nova de Gaia and Sintra are comparable. Seen in combination, these results suggest that while there are signs of spatial fragmentation and competitiveness divides within both metropolitan areas, the great variability and heterogeneity in the behaviour of municipal size classes may be a symptom of the fact that there are different roads to urban competitiveness and its "levels" depend more on the city's intrinsic characteristics and vocations than on size.

Given these results, we sought to understand which dimensions are more closely associated to municipalities' competitiveness. In other words, we looked at the reasons why cities belonging to the same population class have different scores of P_{UC_st}, assessing performance in the selected Macro-areas. Regarding the Green Transition Macro-area, it is not possible to identify a pattern that relates population size, competitiveness and performance in green transition at the same time, judging by the large dispersion in Figure 5-13. Notwithstanding the presence of outliers, some municipalities are below the regression line although recording a high GT_{I_st}, while others have a high P_{UC_st} even if the GT_{I_st} is among the lowest scores. Oeiras is the only one recording high scores for both indexes. While the classes with 40,000-110,000 and 110,000-150,000 inhabitants scatter all over the plot, the class of small cities (less than 40,000 inhabitants) seems to be quite defined, positioning below the regression line and with a medium score in Green Transition. All in all, and while these assessments need to be read carefully, it suggests that the relation between environmental performance aspects does not relate directly to urban competitiveness, and the link is probably a non-linear one.

On the contrary, the relationship between the P_{UC_st} and Digital Transition (Figure 5-14), on the one hand, and Economic and Social Resilience Macro-areas (Figure 5-15), on the other hand, reveal more uniform and coherent patterns. On what concerns the Digital Transition Index, smaller and medium-small sized cities in the lower left part of the plot. On this side of the plot, we find more rural municipalities, landscape-culturally rich, some of them active in the agri-food economy, as well as regional sub-centres with industrial or service specializations, which have not actively attracted and anchored yet high echelons of the digital economy – in contrast to municipalities like Oeiras, Matosinhos, Cascais, and Maia, which are high-performing cities in the field of digital transition, forming a different 'club' in this dimension. On what concerns Economic and Resilience, this dimension seems to be rather linearly and closely associated with urban competitiveness and development overall; yet it also shows a major dispersion of municipalities within the same population class. Here again, the highest performing municipalities are, in general, the same high performing 'Digital Transition' municipalities, together with other

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places which have invested heavily in social cohesion initiatives over the last decades (like Seixal or Amadora). All in all, for the Portuguese metropolitan municipalities, it can be said that urban competitiveness, digitalization, and economic and social resilience are increasingly connected to one another.

Concluding, this application examined urban competitiveness as a complex and multidimensional phenomenon, analysing the relationship between competitive potential and the intrinsic resources of different 'clubs' of municipalities in the Portuguese context. The analysis – drawing on evidence from the metropolitan areas of Porto and Lisbon – confirms that size is not a good proxy for urban competitiveness, suggesting that solely concentrating investments in the larger municipalities will not necessarily lead to higher metropolitan competitiveness. On the contrary, it suggests that an approach taking into consideration different interventions for different 'clubs' of municipalities (instead of one-size-fits-all investment plans) would more likely contribute to expand territorial competitiveness within metropolitan areas, valorise territorial assets and reduce the apparent spatial divides observed. Yet, from a policy perspective, such a type of policy intervention would call for strong administrative and organising capacities, both at the municipal and metropolitan level (e.g., van den Berg et al., 2016; Carvalho et al., 2017).

The evidence from this experimentation also suggests that the link between environmental performance, green transition, and urban competitiveness is very likely non-linear within metropolitan areas. Further studies should embrace this question further, and a promising direction here would be to combine urban competitiveness studies with the well-established literature on the environmental Kuznets curve (e.g. Stern, 2004; Altintas & Kassouri, 2020). Also, from another angle, the analysis also suggests that it is hardly possible to decouple economic and social resilience, digitalization, and competitiveness from one another. This would mean that, despite the very different municipal profiles within metropolitan areas, investments in these dimensions are not mutually replaceable and cities need to invest in them all to enhance urban competitiveness, even if considering different types of digital and resilience-related investments.

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5.4 Competitiveness at sub-municipal level: the case of Naples

The last experimentation regards the sub-municipal scale, which represents a novelty in the scientific background since, generally, the studies on urban competitiveness focus on the competition between metropolises or, at least, cities. Evaluating the competitive potential of districts within a larger urban area means giving an insight into the actual vocations of different parts of a city. This insight is the core of the research: the application at the sub-municipal scale, in this sense, becomes a useful tool for policymakers to choose investments and projects that fit the context of intervention and respond to objectives of competitiveness.

The analysis of the sub-municipal dimension stems from the need, highlighted by the study of literature, to bring out the complementarity between competitiveness at the urban and metropolitan level and the neighbourhood scale (Perkmann, 2007; World Bank, 2015). Administrative boundaries no longer correspond to the physical, social, economic, cultural, or environmental reality of urban development, and new models are needed that take into account the specificities and intrinsic characteristics of urban areas due to their territorial dimension (Brenner, 2019; Cerreta & Daldanise, 2017). The aim is to orient local transformations and interventions towards development processes that arise from the specificities and susceptibility of a smaller area, intending susceptibility as the area's predisposition to grow in a given Macro-area of competitiveness, according to its characteristics and vocations. Competitiveness in the global economy must be complemented and supported by strong local economies that rely on their competencies and resources (Blair, 1995), and whose success is highly dependent on the ability of decision-makers to capitalise on their strengths and mitigate their weaknesses, due to their social, economic, cultural and environmental characteristics (Manjarrez et al., 2019).

The variables, in this case, were structured into four Macro-areas of competitiveness, the same ones of the application to the metropolitan cities with the difference of having merged 'Green Transition' and 'Digitalization/smartness' into the macro-area 'Green and Digital Transition'. This choice depended partly on the reduced availability of digitisation data for this application scale, partly on the results of the application to Porto and Lisbon, where digital and ecological transition seem to

move in parallel. Compared to the previous macro-area categorisation, some changes depended on the different territorial scale. For example, the indicator 'Number of graduates', which for the metropolitan and urban scale belonged to the Digitalization/smartness Macro-area, has been assigned to the Inclusion and Cohesion Macro-area for the sub-municipal scale. This is because at this scale the number of graduates represents an index of the social welfare of the population, rather than an index of the level of digitisation, since university graduates living in a neighbourhood do not necessarily work/operate in that neighbourhood, and therefore do not offer benefits in terms of digital transition. Similarly, the indicator 'Impermeabilized soil', in the area of the municipal perimeter, cannot be an index of a slowed-down ecological transition, especially since it would give distorted results for neighbourhoods belonging to the historical city.

Dimension	ID	Indicator	Date	Measurement unit	Source
Tourism and culture	TC1	Density of cultural facilities	2023	n./mq	OSM, Comune di Napoli
	TC2	Density of bars and restaurant	2023	n./mq	Google Maps
	TC3	UNESCO sites and archaeological sites	2023	mq	Comune di Napoli
	TC4	Areas with landscape value	2023	mq	Comune di Napoli
	TC5	Gyms, Pools and SPA	2023	n.	Googl Maps
	TC6	Sports facilites	2023	n.	Comune di Napoli, Campania Region
	TC7	Institutions for culture promotion	2019	n.	Campania Region
	TC8	Airbnb	2023	n./mq	Airbnb
	TC9	Impermeabilised soil	2018	%	Corine Land Cover
	TC10	Tourists accomodation facilities	2022	n.	Campania Region
Green and Digital Transition	TED1	Number of parks	2023	n.	Comune di Napoli
	TED2	PM2.5 concentration	2023	µg/m3	Breezometer
	TED3	NO_2 concentration	2023	ppb	Breezometer
	TED4	Green urban areas	2018	mq/inh.	Urban Atlas
	TED5	Sites that need environmental protection	2016	mq	Comune di Napoli
	TED6	Number of universities	2023	n.	Google Maps
Sustainable mobility	MS1	Density of bus stations	2021	n./mq	Comune di Napoli
	MS2	Density of metro network stations	2021	n./mq	Comune di Napoli, OSM
	MS3	Km cyclo-pedestrian network	2023	km	OSM
	MS4	Road deaths	2016	n./inh.	Comune di Napoli
Inclusion and cohesion	I&C1	Ratio of female to male labour force	2011	%	ISTAT
	I&C2	Foreign residents	2011	%	ISTAT
	I&C3	Average salary	2021	€/inh.	MEF
	I&C4	Unemployment rate	2011	%	ISTAT
	I&C5	Social structures	2022	n.	Campania Region
	I&C6	Number of property dwellings	2011	n.	ISTAT
	I&C7	Household with >6 people	2011	n.	ISTAT
	I&C8	Number of graduates	2011	n./inh.	ISTAT
	I&C9	Average real estate value	2022	€	Agenzia delle entrate

Table 5-14. The selected indicators divided per Macro-area of Competitiveness for the sub-municipal scale.

With these premises in mind, the third experimentation regarded the areas of the municipality of Naples (Italy) divided into districts. Regarding the scientific background and the contextualization of this application, we can refer to section 5.2. In fact, the context is that of the Italian PNRR, for which municipalities – at least until now – represent some of the main actors in the implementation of the plan at the local scale. The municipality of Naples has activated more than 2,500 projects, many of which are dedicated to the transformation of the city in a competitive key (OpenPNRR, 2023). The difficulties, if compared with the previous applications, were in the availability of data and their necessary elaboration in a GIS environment through geoprocessing and spatial analysis tools. Furthermore, the interpretation of the analyses must take into account that population data refer to 2011, due to the lack of updated data on official sites.

As shown in Table 5-14, I have selected a set of indicators describing the urban characteristics that are most relevant for urban competitiveness. The correlation analysis allowed to delete the redundant variables TC2, TC7, TC8, and I&C7.

Macro-area	Indicators	Loadings per component				
		1	Δ	2	3	4
I&C	Number of graduates	0.964		0.031	0.045	0.048
I&C	Unemployment rate	0.932	0.032	0.034	0.079	0.075
I&C	Ratio of female to male labour force	0.922	0.010	0.022	0.047	0.149
I&C	Average salary	0.902	0.020	-0.025	0.040	0.126
I&C	Average real estate value	0.874	0.028	0.115	0.095	0.188
MS	Density of bus stations	0.769	0.105	0.280	0.033	0.266
I&C	Foreign residents	0.746	0.023	0.390	-0.114	-0.212
TC	Gyms, Pools and SPA	0.708	0.038	-0.206	0.297	-0.060
TC	Density of cultural facilities	0.517	0.191	0.567	0.030	0.273
I&C	Social structures	0.471	0.046	-0.720	-0.016	0.199
TC	UNESCO sites and archaeological sites	0.454	0.018	0.505	-0.270	0.407
MS	Km cyclo-pedestrian network	0.420	0.033	0.138	0.659	0.356
MS	Density of metro network stations	0.355	0.066	0.541	-0.140	-0.190
TC	Tourists accomodation facilities	0.310	0.045	0.531	-0.099	0.673
I&C	Number of property dwellings	0.198	0.112	-0.058	-0.092	0.866
TC	Areas with landscape value	0.176	0.022	0.156	-0.140	0.074
TED	Sites that need environmental protection	0.141	0.035	0.297	-0.281	-0.032
TED	Number of universities	0.134	0.007	0.190	-0.058	0.149
MS	Road deaths	0.017	0.116	0.100	-0.117	0.198
TC	Sports facilites	0.008	0.010	-0.052	0.846	-0.172
TC	Impermeabilised soil	-0.043	0.050	0.788	0.004	0.191
TED	Green urban areas	-0.087	0.045	-0.314	0.190	-0.227
TED	NO$_2$ concentration	-0.106	0.019	0.085	-0.208	0.005
TED	Number of parks	-0.167	0.061	-0.783	0.029	0.001
TED	PM2.5 concentration	-0.170	0.003	0.107	-0.743	0.185

Table 5-15. Loading resulting from the PCA for each indicator of the data matrix. In this table indicators are ordered on the first component and the most significant indicators for this component are highlighted with a yellow rectangle. In the first column it is reported the macro-area of belonging.

The Principal Components Analysis is intended to study districts' competitive performance, this time with an extra step that was fundamental to complete the methodology. Once selected four components, corresponding to an explained variance of 63.2%, I highlighted not only the variables that are more significant for each component (loading >0.65) but also the Macro-areas of belonging (see first column in Table 5-15), using colors to make the results more easily interpretable. Table 5-15 reports the loadings resulting from PCA for the whole dataset but emphasizes the results on the first component. Delta (∆) between loadings was calculated to better identify discontinuities of the derivative function. Similarly, the objects' coordinates, as well as their deltas, are reported in Table 5-16, with a thicker line to emphasize discontinuities.

District	Component				
	1	∆	2	3	4
Chiaia	2.435		0.028	-0.536	0.887
Vomero	1.844	0.591	-0.219	0.968	-0.320
Posillipo	1.730	0.114	-0.811	0.221	-0.179
Arenella	1.697	0.033	-2.010	-1.272	0.167
San Giuseppe	1.588	0.109	1.907	-0.140	-1.771
San Ferdinando	0.660	0.928	1.444	1.742	1.049
Porto	0.595	0.065	1.336	-1.194	-0.355
Fuorigrotta	0.466	0.129	0.316	3.081	0.323
Avvocata	0.392	0.074	-0.281	-0.255	0.693
Montecalvario	0.295	0.097	0.920	-0.956	0.215
Soccavo	0.046	0.249	-1.240	-0.252	-0.514
San Carlo all'Arena	0.024	0.022	-1.924	0.568	0.917
Bagnoli	-0.022	0.046	0.122	1.635	-0.829
Vicaria	-0.086	0.064	0.906	-0.954	-0.129
Stella	-0.336	0.250	-0.138	-0.438	0.880
Chiaiano	-0.360	0.024	-1.392	0.296	-0.579
Poggioreale	-0.387	0.027	0.522	-0.537	-0.766
Zona Industriale	-0.457	0.070	1.047	-0.257	-0.627
Mercato	-0.515	0.058	0.996	-1.290	-0.472
Pianura	-0.535	0.020	-1.478	-0.908	0.233
Miano	-0.622	0.087	-0.662	-0.896	-1.002
Barra	-0.642	0.020	-0.158	-0.106	-0.561
San Lorenzo	-0.695	0.052	0.383	-0.216	3.743
Pendino	-0.701	0.007	1.364	-0.806	1.408
Piscinola	-0.804	0.102	-0.350	0.550	-1.001
Secondigliano	-0.860	0.056	-0.187	-0.311	-0.352
San Giovanni a Teduccio	-1.055	0.195	-0.641	0.292	-0.428
Ponticelli	-1.126	0.070	0.041	1.307	-0.276
San Pietro a Patierno	-1.149	0.023	-0.130	0.068	-0.419
Scampia	-1.418	0.269	0.287	0.596	0.062

Table 5-16. Coordinates resulting from the PCA for each object (district). In this table districts are ordered on the first component and the representative districts for this component are separated with a thicker line.

Thanks to the analysis of the Macro-areas in Table 5-15, it can be stated that, for the first component, 32% of the total variance can be attributed to a high predisposition to social inclusion and cohesion.

This predisposition characterizes the districts, highlighted in Table 5-16, Vomero, Chiaia, Vomero, Posillipo, and Arenella that, as a matter of fact, are notably the wealthier districts of the city.

On the opposite side, there are some districts distinguishing for their attitude to ecological transition (see bottom of Table 5-15), that are, specifically, the districts of northern and eastern suburbs, thanks to their availability of green areas and spaces that, however, could be improved in terms of quality. These results are reported in maps to obtain additional considerations on their spatial as well as urban relationships.
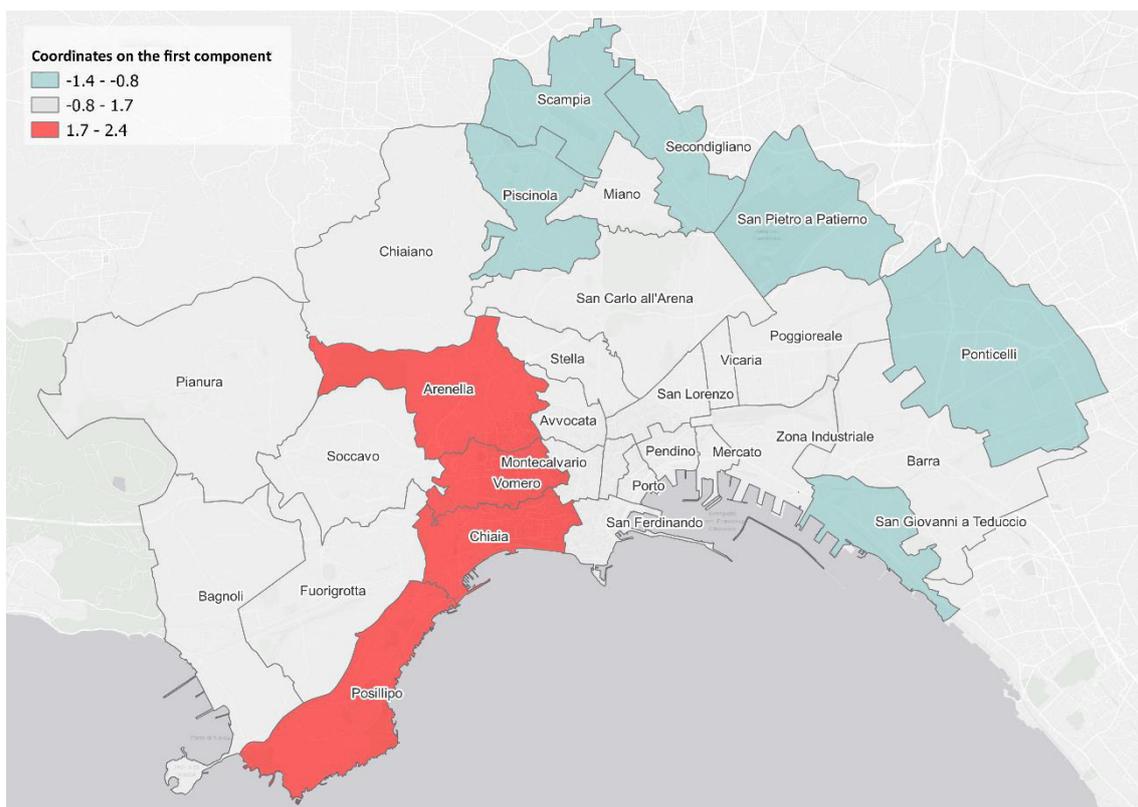
Figure 5-16. Map reporting the most significant districts for the first component (those highlighted in Table 5-16). In red the districts having a high predisposition to social inclusion and cohesion, in light blue the districts predisposed to green transition.

For simplicity, I do not report the tables ordered on the second, the third and the fourth components, but only the most significant variables (Tables 5-17, 5-18, 5-19). Suffice it to say that the same procedure was repeated to evaluate the meaning

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of each component and obtain the representative districts, namely the most competitive districts in a certain Macro-area. I hereby report just the most relevant variables and the maps resulting from this procedure.

Therefore, by assigning the Macro-areas of interventions to the variables, it can be stated that the second component can be attributed on the one side to high competitiveness in the tourism and culture Macro-area since the most correlated variables are: 'Impermeabilized soil' (a sign of the profoundly transformed and consolidate urban fabric), 'Density of cultural facilities', 'Density of metro network stations', 'Accommodation facilities', and 'UNESCO and archaeological sites'. These variables denote a particular predisposition to compete both in the cultural sector (thanks to the rich cultural supply) and the tourism sector (due to the presence of accommodation facilities and services for tourists) (see Table 5-17).

Macro-area	Indicators	Loadings on the second component
TC	Impermeabilised soil	0.788
TC	Density of cultural facilities	0.567
MS	Density of metro network stations	0.541
TC	Tourists accomodation facilities	0.531
TC	UNESCO sites and archaeological sites	0.505
TED	Green urban areas	-0.314
I&C	Social structures	-0.720
TED	Number of parks	-0.783

Table 5-17. The most significant variables for the second component. The dotted red line separates the variables with plus sign loading from the variables with minus sign. In the first column it is reported the macro-area of belonging.

The characterizing districts are those of the ancient nucleus of the city, namely Pendino, Porto, San Giuseppe, and San Ferdinando. On the other side, with the minus sign, the case studies distinguish themselves for the availability of green areas and social structures (see Figure 5-17).

These districts are, specifically, those of the north-western periphery, characterized by high availability of public spaces and service structures that, however, are currently in a state of decay. Given the high predisposition to the green and social transition of these districts, the improvement of the available services might well improve their overall level of competitiveness, as well as guarantee better levels of liveability.
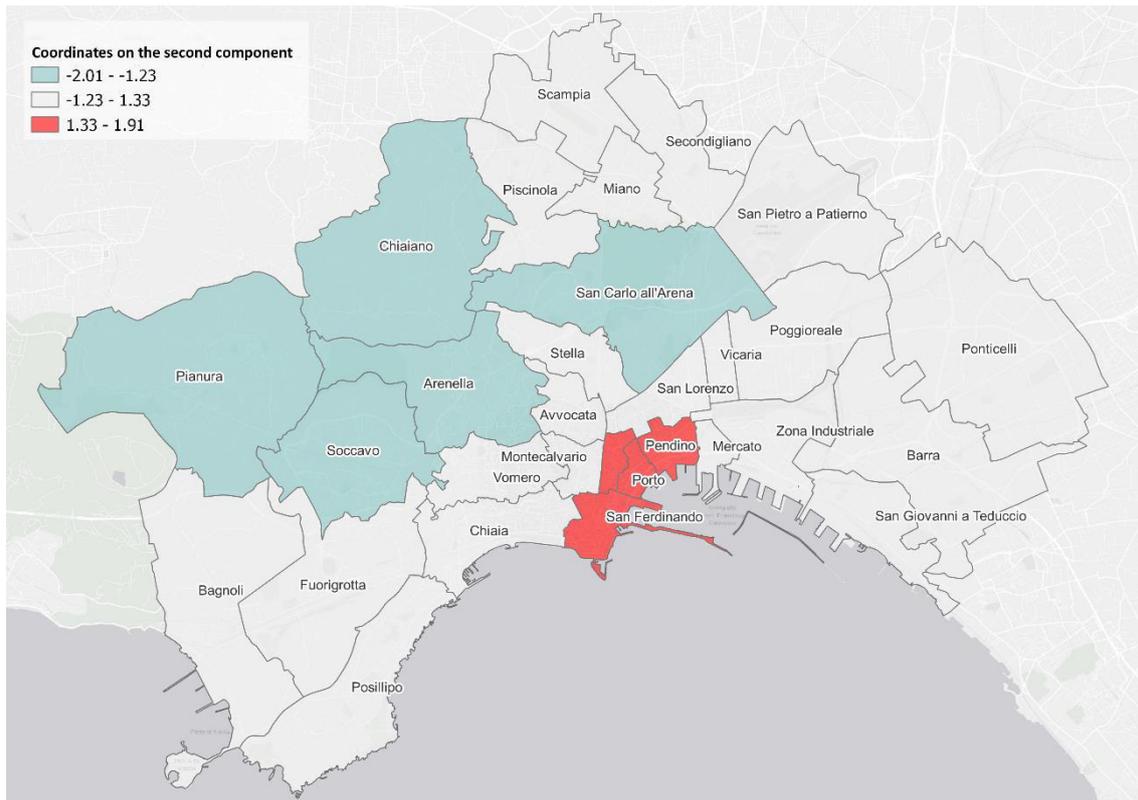
Figure 5-17. Map reporting the most significant districts for the second component. The red districts are those having a high predisposition to compete in the tourism and culture Macro-area, while the light blue districts are those predisposed to green transition and social cohesion.

Looking at the third component (Table 5-18), the positively correlated variables define the areas where the promotion of sport, sustainable mobility, and youth facilities can constitute an element of competitiveness, in brief, the 'sprint city'. This name has been assigned referring to a PNRR project presented by the city of Venice to promote sport and leisure as factors to relaunch the competitiveness of the city.

Macro-area	Indicators	Loadings on the third component
TC	Sports facilites	0.846
MS	Km cyclo-pedestrian network	0.659
TC	Gyms, Pools and SPA	0.297
TC	Green urban areas	0.190
TED	NO_2 concentration	-0.208
TC	UNESCO sites and archaeological sites	-0.270
TED	Sites that need environmental protection	-0.281
TED	PM2.5 concentration	-0.743

Table 5-18. The most significant variables for the third component. The dotted red line separates the variables with plus sign loading from the variables with minus sign. In the first column it is reported the macro-area of belonging.

The districts with an already strong transition in this direction are Bagnoli, Fuorigrotta and San Ferdinando (see Figure 5-18), that, in fact, for their structure

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and the services they offer, distinguish them as youth attractors. The variables with the minus sign on this component define a predisposition to ecological and digital transition, in a framework of sustainability, due to the significant relationship with air quality, sustainable mobility and environmental performance. The most significant districts, called to improve these aspects for the benefit of their competitive performance, are the districts of Arenella, Porto and Mercato.
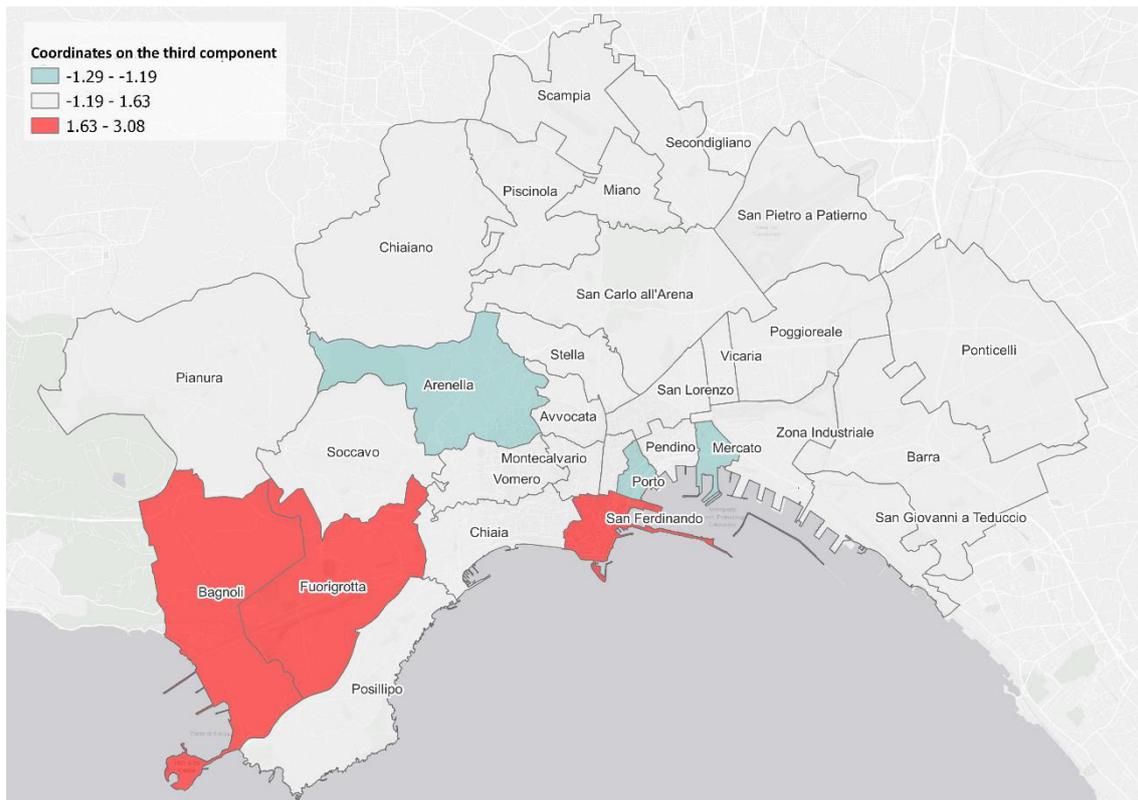
Figure 5-18. Map reporting the most significant districts for the third component. The red districts are those denoting the 'sprint city', while the light blue districts are those predisposed to ecological and digital transition.

Finally, for the fourth component I evaluated as significant only the variables with the plus sign, both for the higher loadings and for the negligible variation in the Δ between loadings.

This component can be again attributed to a predisposition to tourist development, thanks to the high correlation with variables denoting tourist services and cultural amenities, this time enlarging the area of influence and embedding also districts out of the ancient centre of the city.

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Macro-area	Indicators	Loadings on the fourth component
I&C	Number of property dwellings	0.866
TC	Tourists accomodation facilities	0.673
TC	UNESCO sites and archaeological sites	0.407
MS	Km cyclo-pedestrian network	0.356
TC	Density of cultural facilities	0.273

Table 5-19. The most significant variables for the fourth component. There are reported only the variables with plus sign loading. In the first column it is reported the macro-area of belonging.

In particular, as shown in Figure 5-19, districts characterized by this component, having a more variegated tourist and cultural offer, are Chiaia, San Ferdinando, Pendino, San Lorenzo, Stella, and San Carlo all'Arena.
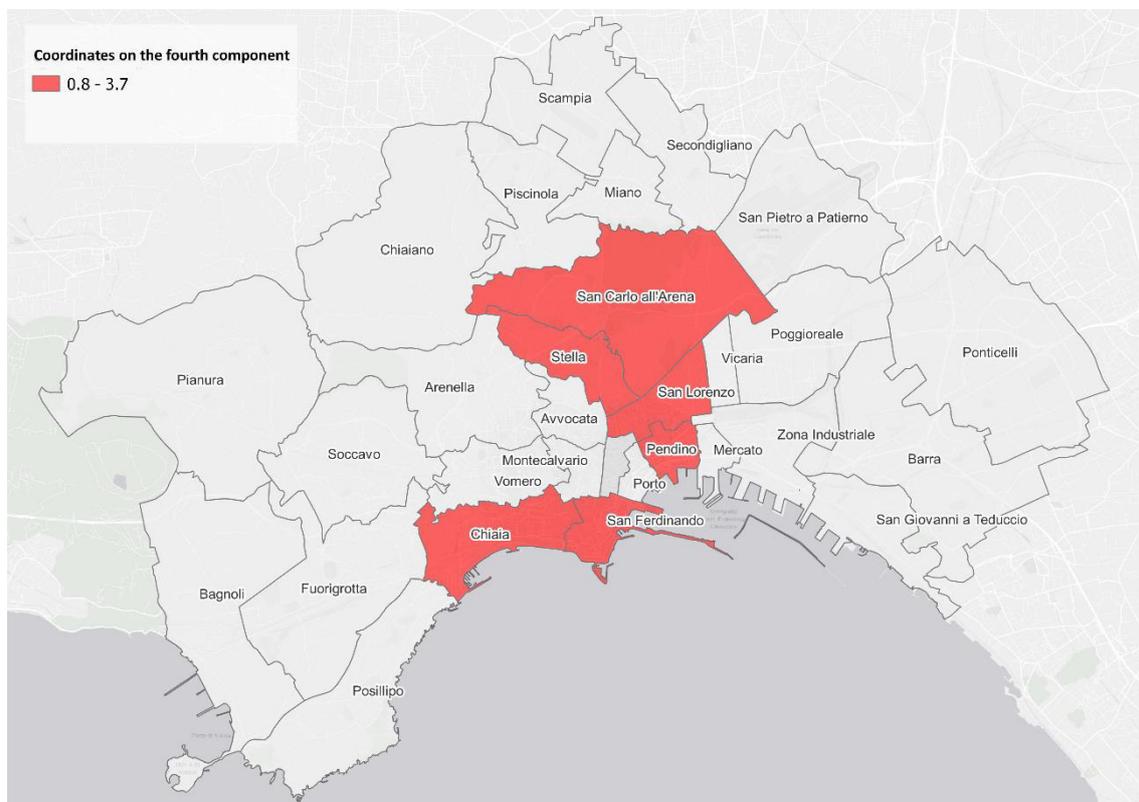
Figure 5-19. Map reporting the most significant districts for the fourth component. Only the variables with the plus sign were considered as significant. The districts highlighted in red are characterized by a predisposition to tourist development.

To support and validate the results of the PCA, a hierarchical cluster analysis was held to study the overall competitiveness of the districts analysed, their homogeneities, and spatial implications. By cutting the dendrogram in Figure 5-20 at a distance of about 14, it is possible to identify districts with a homogeneous competitive behaviour, suggesting a grouping of districts that has also spatial implications.
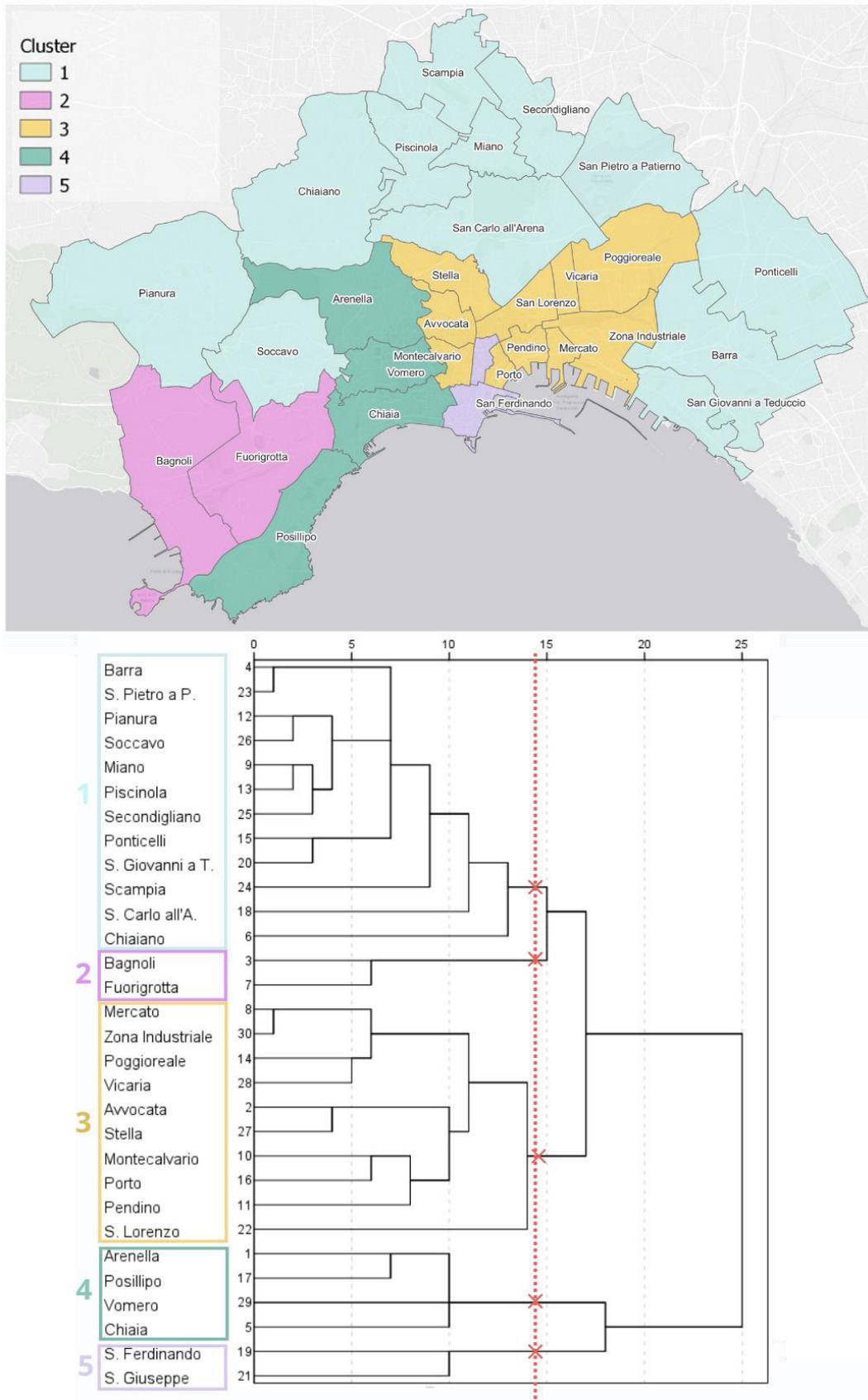
Figure 5-20. the results of the Hierarchical Cluster Analysis reported both in a dendrogram and in map.

In fact, in yellow there are the districts with high tourist competitiveness, in green those more consolidated in the field of social inclusion and cohesion, in pink the 'sprint districts', in light blue the suburban ones that, despite lacking in many sectors, are the districts with the highest potential in ecological transition, thanks to their morphological, settlement, and environmental characteristics. Finally, there are the districts of San Ferdinando and San Giuseppe that, although distinguishing for tourism and culture, present variegated assets of competitiveness like the high availability of services and leisure facilities, predisposition to digitalization, high levels of inclusion, and so on.

After the application of this first part of the method, I sought to answer another research question, namely, whether the distribution of the resources by the PNRR is consistent with the areas' competitive potential. The results constitute an interesting insight into the gap between strategies for competitiveness on a national scale and the actual competitive state of local realities. To this end, two indices were constructed: as exposed in the methodology chapter, the first index, called Potential of Urban Competitiveness (P_{UC}), takes into account the results achieved by the first phase of analysis and is thus a function of the results of the PCA. It represents the intrinsic potential of Naples' districts according to their competitive assets. The second index is called Index of Urban Competitiveness for the PNRR (I_{UCPNRR}) and is instead a function of the resources allocated by the PNRR in the four Macro-areas of investment considered.

By comparing the two indexes (Figure 5-21), it is possible to observe that while for some districts the difference between the two indexes is minimal, for others the distribution of resources as thought by the PNRR does not conform to the areas' actual competitive potential. This result might support the public administration in defining strategies for the city's competitive development, as well as address future investment choices in the frame of the PNRR implementation. The comparison of the two indexes, indeed, allows for the visualization of the gap between competitive potential and resources as distributed by the PNRR, giving decision-makers a two-fold perspective. On the one hand, the graph in Figure 5-21 highlights the cases that have been most penalized by the PNRR, although presenting a certain competitive potential.
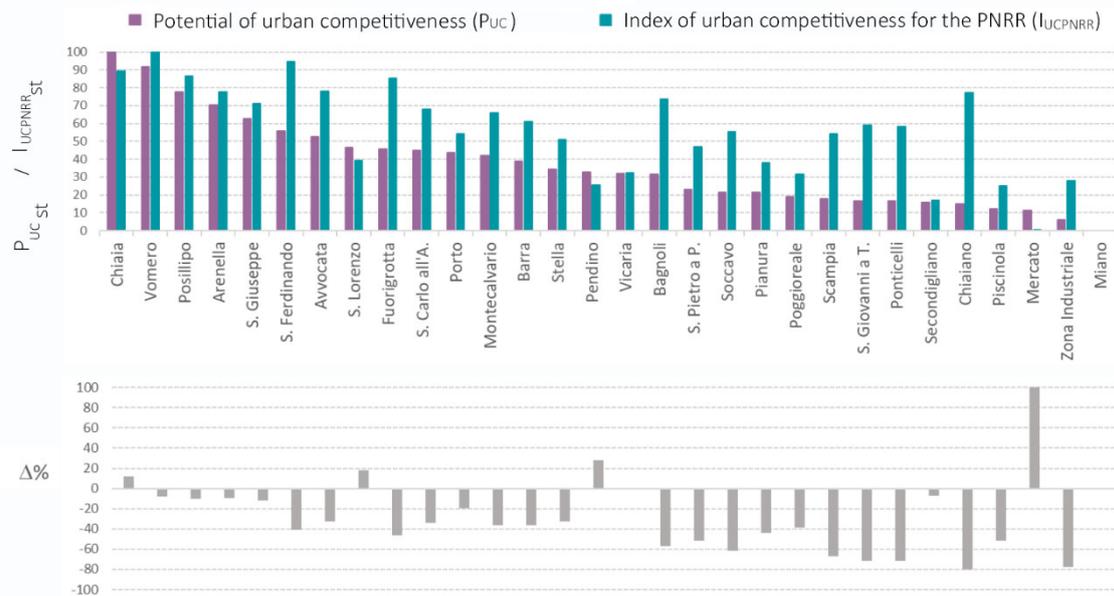
Figure 5-21. Comparison between the two indexes 'Potential of urban competitiveness' (in violet) and 'Index of urban competitiveness for PNRR' representative, respectively, of the actual level of competitiveness and the competitiveness according to PNRR distribution of resources of Naples' districts.

This is the case of the districts Mercato, Pendino, and San Lorenzo, that, perhaps, pay the price of the limited amount of resources assigned to the Macro-area 'Tourism and culture' (that, as shown in Table 5-3, has a weighting of 0.05 in the I_{UCPNRR}) which is instead their leading sector.

But the graph also highlights those districts that have been boosted by the PNRR although having a scarce competitive potential, for example, all the districts of the northern and eastern periphery that, in fact, resulted to be competitive in the field of green transition which is the 'heaviest' Macro-area in the I_{UCPNRR} model. On the other hand, the comparison between P_{UC} and I_{UCPNRR} allows for identifying the best-performing cases, i.e. those districts with high potential of urban competitiveness and verifying the correspondence with the competitiveness for PNRR. This insight gives the opportunity to further incentivize the best districts, boosting the competitiveness of the entire municipality.

Although meaningful, this result was not exhaustive since it is not comprehensive of the identification of districts' vocations in the Macro-areas considered. Hence the last part of the application was dedicated to the comparison between the overall index 'Potential of urban competitiveness' and a partial index indicating the performance in just one Macro-area, both standardized on a scale from 0 to 100,

throughout a correlation analysis. Compared to the experimentation to the municipal scale, this application takes a step forward by identifying the most dynamic as well as the worst cases in each Macro-area and proposing a scheme to intervene in each case. In the graph in Figure 5-22 this schematization is exemplified. Specifically, on the x-axis it is represented a partial competitiveness index for one of the Macro-areas (Mk), while on the y-axis the Potential of urban competitiveness index is represented. In this graph, I have identified 4 quadrants that allow decision-makers to make strategic investment choices based on the susceptibility and potential of the districts at the time of planning interventions.

Figure 5-22. Correlation analysis between the two indexes 'Potential of urban competitiveness' (on the y-axis) and a partial Index of a generic Macro-area (on the x-axis), both standardized from 0 to 100. In the graph it is represented also the regression line and the division in quadrants proposed. The bar graph on the right-hand side represents the numerosity of quadrants in each Macro-area.

In the first quadrant, we can find the districts with low potential and low Macro-area competitiveness.

The districts falling into this quadrant are characterized by degradation and scarce performance in all Macro-areas, and, particularly in the Macro-area represented by Mk. In the second quadrant, there are those districts where the sector is competitive but not sufficient to push the overall competitive potential of the districts. In other words, these areas present an initiated transition in the Macro-area Mk that, nevertheless, is not sufficient for urban competitiveness because of scarce performance in other sectors. In the third quadrant, we find the high-potential districts with high competitiveness.

This quadrant is representative of the best-performing cases, those districts leading both the overall ranking and the partial ranking per Macro-area. In the fourth quadrant, we can find districts with low sector competitiveness but high overall potential.

This means that the specific Macro-area Mk does not represent a competitive asset for those districts or that administrators should invest in that Macro-area to bridge the gap with other Macro-areas and further increase the districts' overall competitiveness. As we can see in the bar graph in Figure 5-22, the results show, for all Macro areas, a high number of districts falling in the I quadrant, i.e. districts with low potential and low sector competitiveness, showing a diffused state of degradation around the entire urban area.

It is meaningful, to the aims of the research, visualize the results of this application stage on a map, as shown in the figures below.

By deepening the Macro-area 'Tourism and culture', firstly, it emerges, from the regression line, that it is enough significant for defining the competitive potential of districts ($R^2 = 0.53$ and regression coefficient equal to 0.68). Regarding the case studies, it can be noted a difference between the suburbs and the inner-city districts, where the development of the tourism sector, along with the cultural offer, have been representing, especially in the last decade, a driving sector for the competitiveness of the entire city.

Nevertheless, the development of the tourism and culture sectors is not enough to guarantee a high level of competitiveness, and in fact these districts (indicated in yellow in Figure 5-23) although having high Macro-area competitiveness, present a low P_{UC}.

The outer ring constituted by the suburbs is, instead disadvantaged because of the lack of cultural facilities and tourism attractors. On the other hand, in the third quadrant, there are the notably wealthiest districts of the historical centre (e.g., Vomero, Chiaia, Posillipo, and San Ferdinando) accompanied by other historical districts that present favourable conditions in all the Macro-areas.

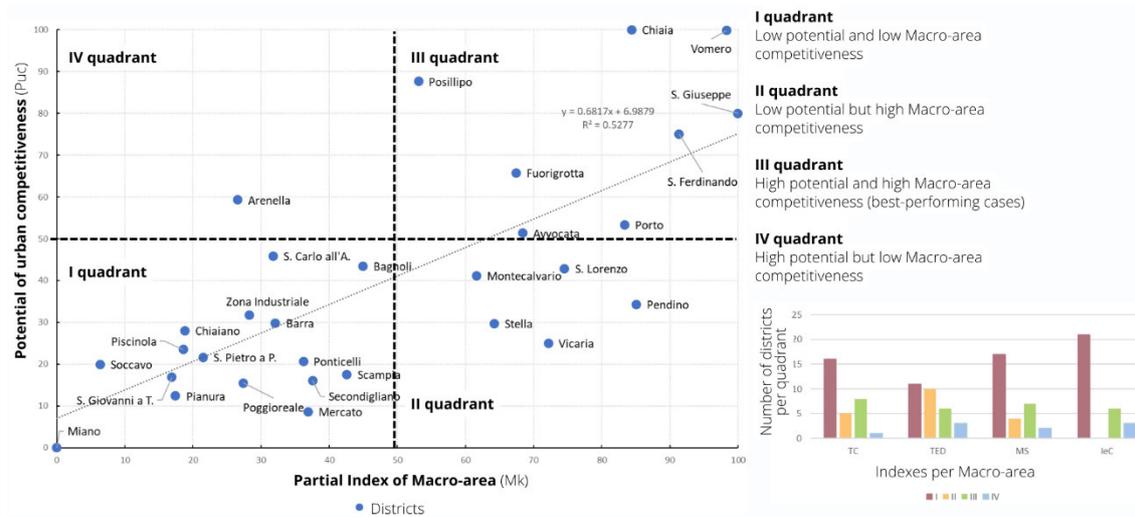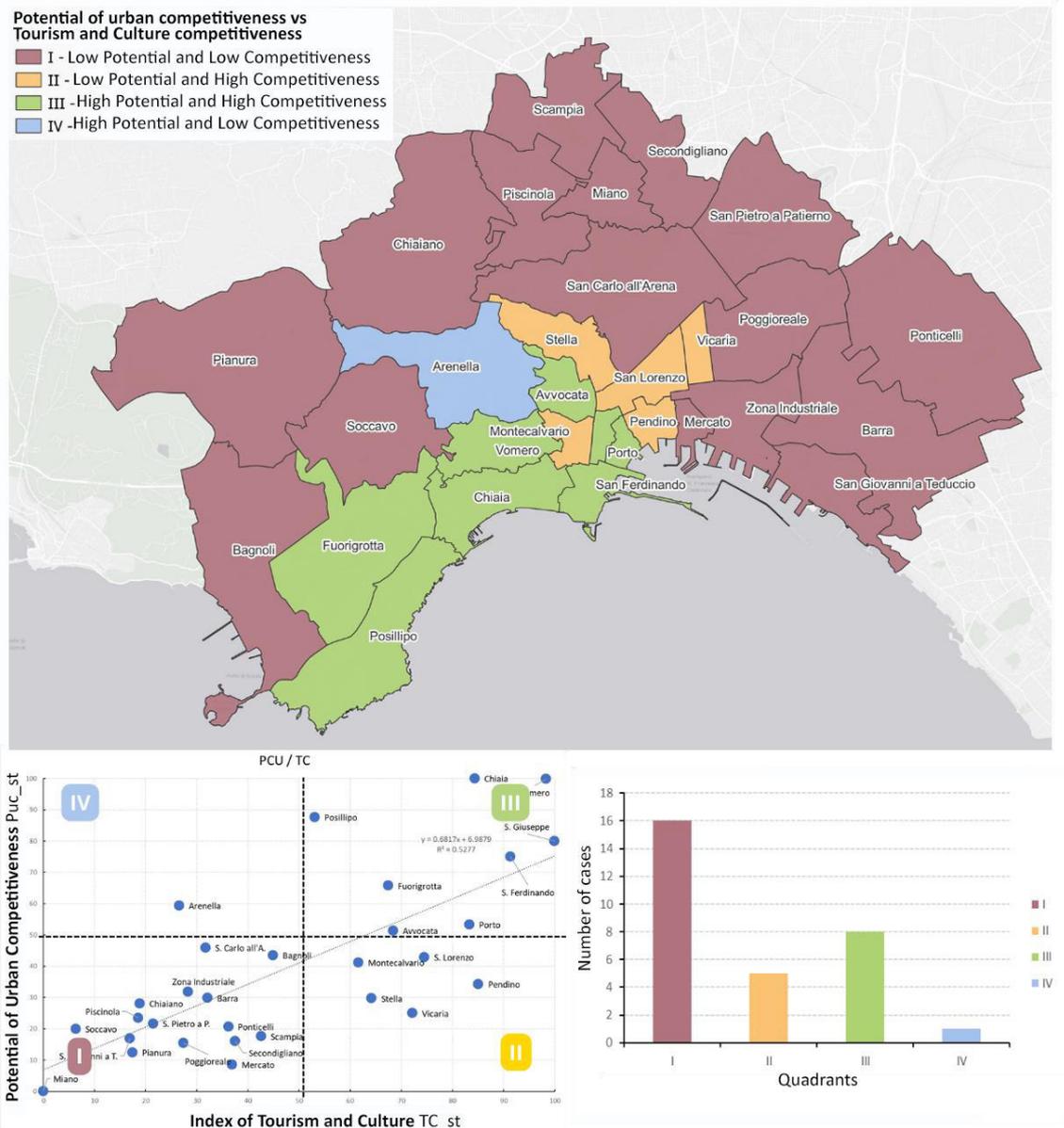Figure 5-23. Results (map, scatter plot and bar graph) of the correlation analysis between the two indexes 'Potential of urban competitiveness' and the partial Index of the Macro-area Tourism and culture, both standardized from 0 to 100. In the map districts belonging to each quadrant are represented in different colors. In the scatter plot it is represented also the regression line and the division in quadrants proposed. The bar graph on the right-hand side represents the numerosity of quadrants.

The presence of Fuorigrotta in this quadrant comes as a surprise since it is not particularly known for its tourist attractiveness. However, thanks to its proximity to the historical centre and the high level of connectivity, as well as the presence of elements of identity like the Stadium or Mostra d'Oltremare, Fuorigrotta appears to be competitive in the field of Tourism and Culture. Therefore, the promotion of measures aimed at incentivising this vocation might have positive impacts on its competitiveness involving also other sectors.

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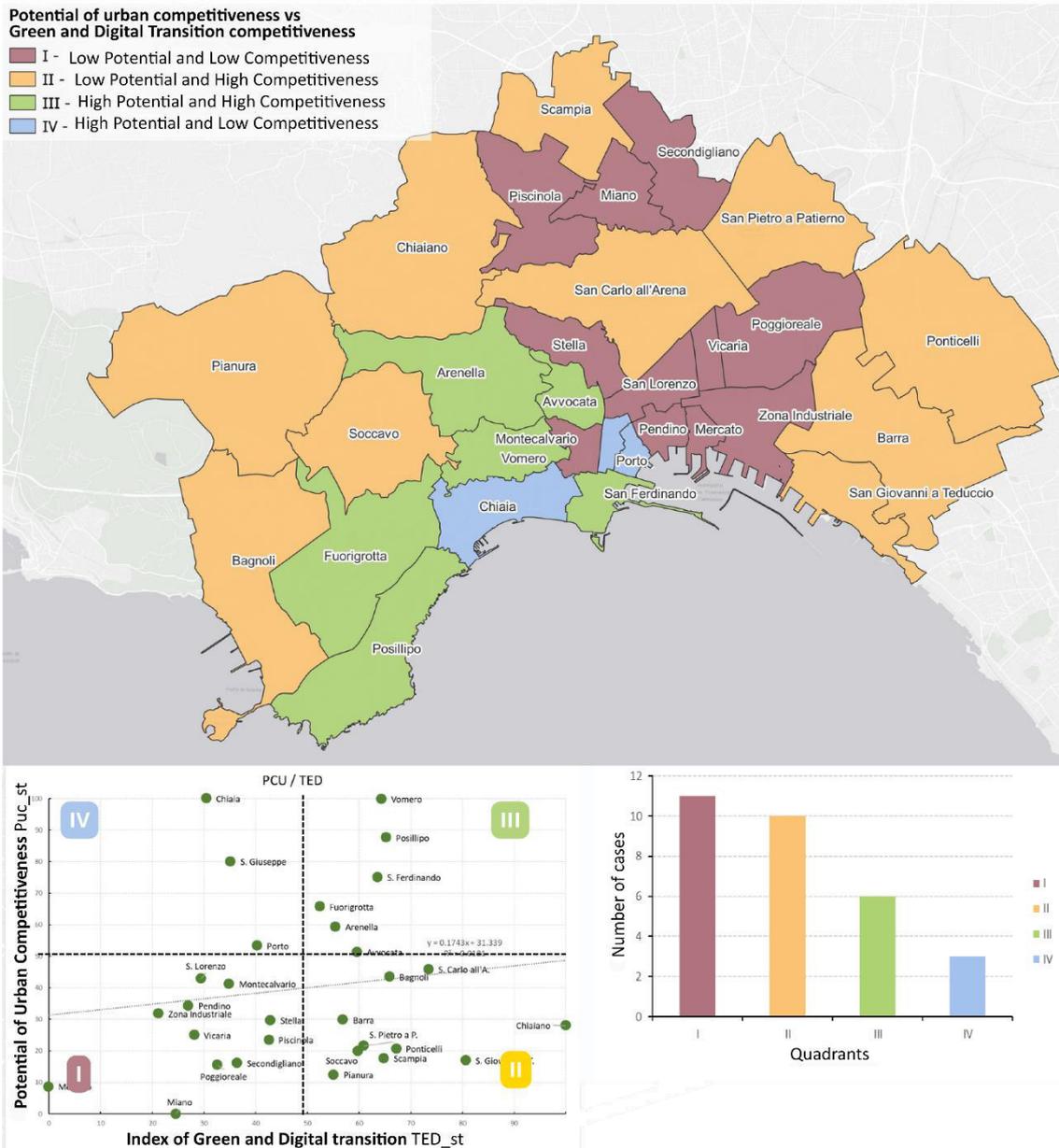
Figure 5-24. Results (map, scatter plot and bar graph) of the correlation analysis between the two indexes 'Potential of urban competitiveness' and the partial Index of the Macro-area Green and Digital Transition, both standardized from 0 to 100. In the map districts belonging to each quadrant are represented in different colors. In the scatter plot it is represented also the regression line and the division in quadrants proposed. The bar graph on the right-hand side represents the numerosity of quadrants.

This pattern changes completely for the Green and Digital transition Macro-area. Firstly, it can be observed that the relationship between the partial index TED_st and Puc_st is not as strong as the other Macro-areas (R^2=0.02 and regression coefficient equal to 0.17). This weak relationship also emerged in the other applications,

suggesting that, although ecological transition is the spearhead of the NGEU programme, its promotion would not necessarily result in an increase of competitiveness of our territories.

Figure 5-25. Results (map, scatter plot and bar graph) of the correlation analysis between the two indexes 'Potential of urban competitiveness' and the partial Index of the Macro-area Sustainable Mobility, both standardized from 0 to 100. In the map districts belonging to each quadrant are represented in different colors. In the scatter plot it is represented also the regression line and the division in quadrants proposed. The bar graph on the right-hand side represents the numerosity of quadrants.

Looking at the distribution of the cases, it can be noted something already emerged in the principal component analysis: the suburban areas have a high predisposition to grow in the Green and Digital sectors. Boosting the 'dual' transition for these districts would probably increase their competitiveness in the context of the PNRR

but would not be enough to boost their overall potential. The numerosity of each quadrant is more balanced than for other Macro-areas. The most disadvantaged districts are those of the historical centre because of the lack of green areas, the high levels of pollution and the scarce environmental quality depending on the urban fabric and the consolidated structure of these districts. On the contrary, peripheral districts, notwithstanding their low levels of social and economic well-being and equality, have a high susceptibility to ecological and digital transition, due to their physical, environmental, and functional characteristics.

For what concerns Sustainable mobility, the regression parameters show a fairly solid relationship with the potential of urban competitiveness (R^2= 0.56 and regression coefficient equal to 0.80). In the sustainable mobility Macro-area, Posillipo and Porto are cut off from the highly competitive districts in the sector due to their marginality with respect to the metro, public transportation and bicycle/pedestrian mobility networks. On the opposite side we can find Bagnoli, Zona Industriale and Barra where sustainable mobility helps to raise the level of competitiveness but is not sufficient due to deficiencies in other Macro-areas. The disadvantaged districts are located in the peripheral areas as well as in the ancient nucleus of the city. This might be due, *inter alia*, to the morphological conformation of the sub-urban areas (often developing on different elevations, due to the hilly landscape) and the dense urban fabric of the historic centre that hinder the diffusion of sustainable modes of transport. Arenella, Avvocata, Vomero and Chiaia confirm their leading role also in this Macro-area, accompanied by Fuorigrotta, San Giuseppe and San Ferdinando thanks to the density of public transport and the pedestrian-cylcing networks that, however, need to be improved in terms of quality and functionality.

The relationship with competitiveness is even more accentuated for the inclusion and cohesion Macro-area for which R^2= 0.81 and the regression coefficient is equal to 0.91. This suggests that the social sphere is much more impactful than the other Macro-areas. Figure 5-26 shows the great disparity between those districts that are experiencing an already advanced transition in this sphere (e.g., Posillipo, Arenella, Vomero, Chiaia, Avvocata and San Giuseppe) and the rest of the city which is in a state of marginality and social decay (see the diffusion of red districts in Figure 5-

26). The II quadrant is empty, while the IV quadrant counts Fuorigrotta, San Ferdi-nando and Porto, where a high competitive potential does not correspond to an equal performance in the social inclusion and cohesion sector. The I quadrant is the most populated, counting a lot of districts that are lagging in the field of social inclusion. This result can be an interesting input to address resources for urban regeneration, that is one of the fields of investment of the PNRR, and can trigger competitive processes.
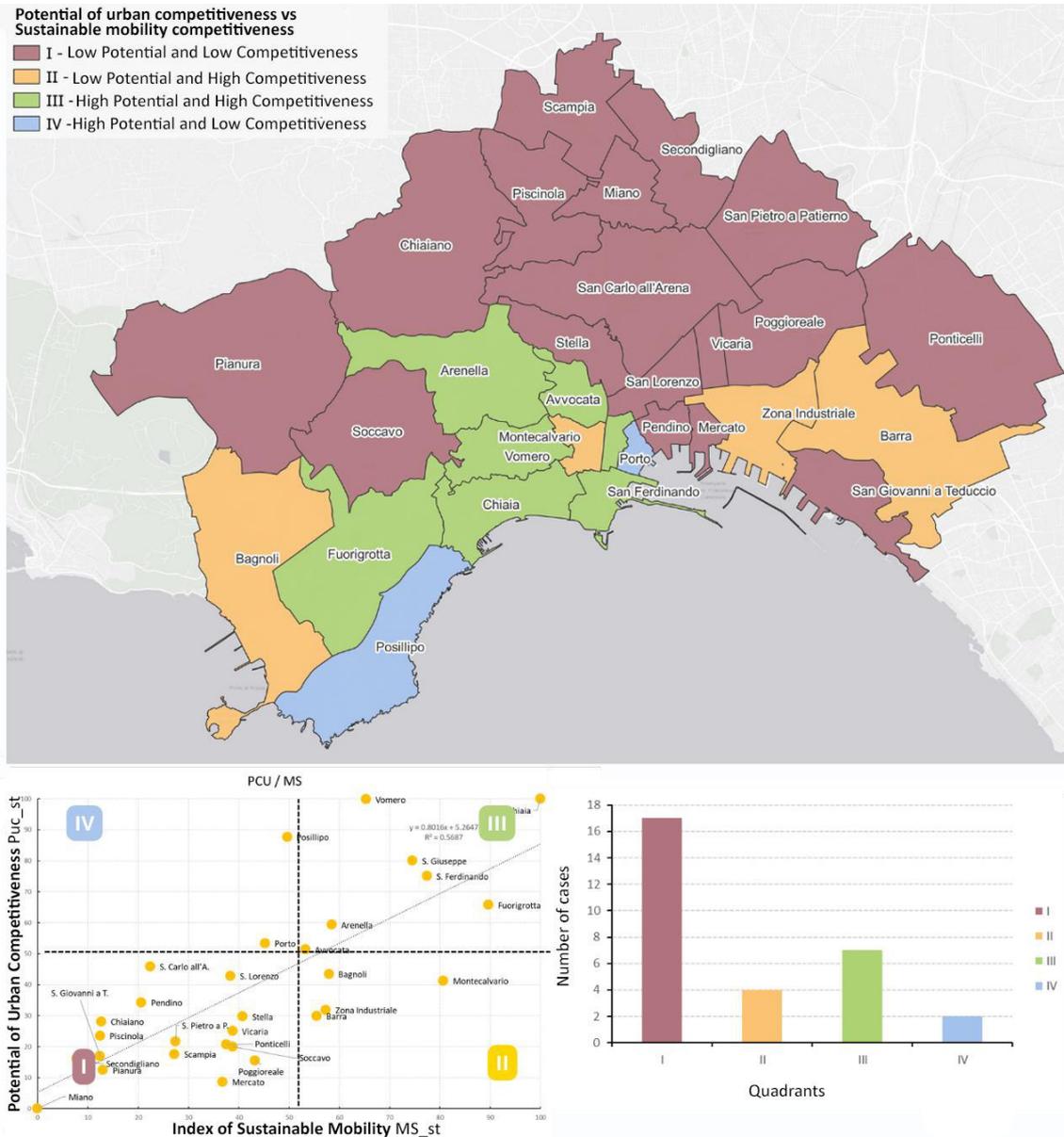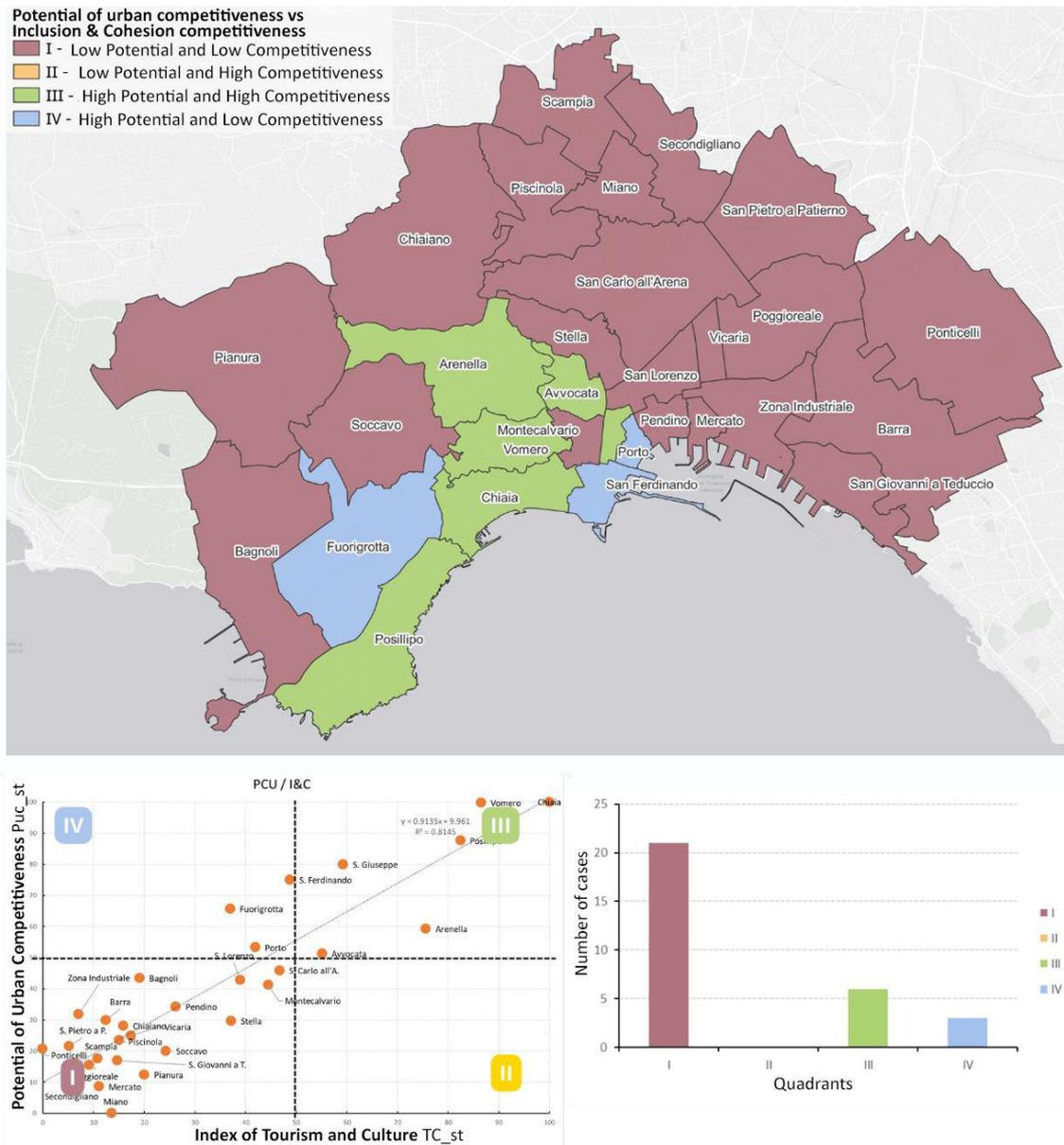

Figure 5-26. Results (map, scatter plot and bar graph) of the correlation analysis between the two indexes 'Potential of urban competitiveness' and the partial Index of the Macro-area Inclusion & Cohesion, both standardized from 0 to 100. In the map districts belonging to each quadrant are represented in different colors. In the scatter plot it is represented also the regression line and the division in quadrants proposed. The bar graph on the right-hand side represents the numerosity of quadrants.

In conclusion, the results of this application can be of great relevance for the distribution of PNRR resources by the public administration at the sub-municipal scale, and the associated findings might be interesting inputs to address transformation strategies of the city of Naples in a competitive key – both in general as well in the context of the PNRR. Based on these findings, the public administration can work in a double way: on the one hand, it can further enhance the existing potential and assets by tapping into districts' vocations as reservoirs of competitive growth; on the other hand, it can balance the existing disparities between the various districts, especially for the macro-areas where intervening is more urgently needed, such as social inclusion.

The originality of the work, in general, and of this application, in particular, lies in studying urban competitiveness in relation to cities' potential and vocations along with casting the research in a context of real resources that is the NextGenerationEU (and the PNRR for the Italian case). The verification of the methodology at a sub-municipal scale is an innovative element in scientific literature and makes the developed methodology a tool to support the choice of current and future investments at the local level, according to the in-depth knowledge of cities 'competitive potential.

5.5 Conclusions

As repeatedly highlighted in the previous chapters, the aim of this research was to develop a model to investigate the relations between urban characteristics and competitive phenomena, especially in the framework defined by the NGEU. The model should have been versatile so as to be applied in different contexts and at different scales. Finally, it should have given the opportunity to support the development of urban transformation strategies aimed at increasing territorial competitiveness on the basis of cities' potential and vocations.

The proposed applications were intended to test the methodology in this view. The three applications considered the resources provided by the European Union in the post-Covid recovery era as a likely pool for urban competitiveness, comparing the main sectors of investment with the vocations and competitive potential of metropolitan areas, municipalities, and districts, respectively.

The first application concerned the case study of Italian metropolitan cities, comparing competitiveness and susceptibility, within the frame of the Italian Plan of Recovery and Resilience (PNRR), and considering 5 Macro-areas of Competitiveness. One of the meaningful results of this study was a comparison of two competitiveness rankings that revealed a certain disparity between the resources allocated by the PNRR and the competitive potential of metropolitan cities, especially for southern cities.

Secondly, the methodology was tested at the scale of the urban perimeter with an application to the municipalities embraced within the metropolitan areas of Porto and Lisbon, in Portugal. Among the results of this application was a sorting of cities on the basis of their urban competitiveness potential. This case study was the experimental laboratory to test the part of the methodology aimed at identifying the susceptibilities of the territories, i.e. those intrinsic aspects that if increased can lead to increases in the level of competitiveness. The first step consisted of verifying the existing relationship between competitive potential and the number of inhabitants, which, although existing, is not strong enough to state that the more people there are, the more competitive the city is, since the relationship is not linear, and the cases are scattered. This result confirmed one of the assumptions of the research, namely that competitiveness does not depend on 'quantity', but on the susceptibilities of the territories. The novelty that I introduced with this experimentation consists in studying these susceptibilities in the context of the implementation of the NGEU, relating potential competitiveness and a performance index of one of the Macro-area of competitiveness.

The methodology was then tested at the sub-municipal scale, which represents a scientific novelty and the core of the research since at this scale it represents a decision support tool to assist the public administration in the choice of interventions and projects to be presented in a city in response to competitiveness objectives. Specifically, the case study for this territorial scale was the city of Naples, subdivided into districts. The study of the reciprocal position of the districts in the correlation plot allowed to make a distinction – valid for each Macro-area – between: less dynamic areas with low Macro-area competitiveness, areas with initiated transition but low potential, areas with high potential and high Macro-area

competitiveness and areas with high potential but low Macro-area competitiveness.

In the three cases, the analytical results have been interpreted with the aim of verifying if the strategies of development activated, within the NGEU framework, are consistent with the intrinsic potential of urban areas, and, thus, if they are able to increase their urban competitiveness. Although the NGEU does not operate directly at the territorial and urban scale, 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.

The ultimate result of the applications, and the central element of the decision support tool, is the comparison between the overall competitive potential and the performance of the case studies in each macro-area, as it can support wise investment choices and urban planning, in a competitive key.

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CHAPTER 6. A TOOLKIT TO INCREASE URBAN
COMPETITIVENESS

6.1 Introduction

As already declared at the beginning of this thesis, the aim of this research work was to examine, in quantitative and operational terms, the role of territorial competitiveness in the development of an urban area with its own connotations and opportunities for growth (susceptibility), also in the light of the objectives and resources of the European program Next Generation EU (NGEU), designed to recover from the pandemic and enhance the competitiveness of European countries and regions (EC, 2021). Within this research work, I achieved several results that have been illustrated so far. Among these, I have deepened the existing relations between urban phenomena and competitive processes, at three different urban scales (metropolitan areas, municipalities, and districts). Furthermore, I have proposed a paradigm to define and examine, with a quantitative approach, the relations between urban characteristics and territorial competition (competitive phenomena), founded on the novel notions of 'susceptibility' and 'competitive potential'. Moreover, I have sought to cast this paradigm in the NGEU context, given the role that this program will play in the coming years to redefine competitive equilibria between territories, due to the large number of financial resources it offers. This operation provided the opportunity to define the fields in which the NGEU territories compete (namely Macro-areas of Competitiveness – see Chapter 4), on the basis of which the 'competitive potential' of urban areas can be measured. All this has contributed to the elaboration of an interpretative model of the relations between urban areas and competitiveness in different contexts and at different scales, whose ultimate result was a methodology to identify cities' distinctive vocations that define their competitive assets.

The further development, that this research work proposes, concerns the development of a support toolkit for public decision-makers aimed at detecting the most suitable and effective (cost/benefit) interventions - to be envisaged in strategic plans - to increase or balance the competitive potential of urban areas. The aim is to provide policymakers with a user-friendly tool to, firstly, determine areas of the territory presenting crucial conditions in terms of competitiveness where it is a priority to intervene, and, secondly, suggest which kind of intervention is needed.

In practice, this last part of the research is intended to detect the most suitable interventions to improve competitive conditions of metropolises, cities, and districts based on the developed methodology. Indeed, the toolkit is made up of the combination of the results of the methodology application with a matrix of interventions suitable to meet the characteristics of competitiveness of the urban areas analysed (Figure 6-1).
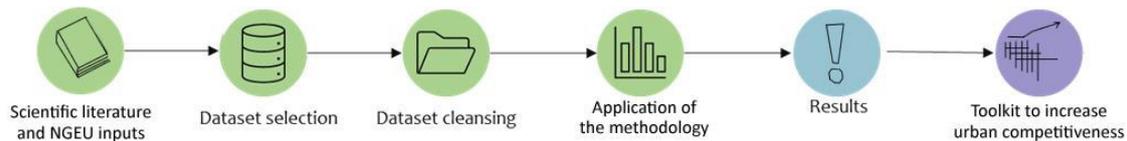
Figure 6-1. The workflow that led to the construction of the toolkit to increase urban competitiveness.

The matrix of interventions is set up as a tool to raise competitive edge in light of the relationship between the urban areas' potential of competitiveness and their susceptibility to grow in a specific 'Macro-area of Competitiveness' (see Chapter 4), which emerges through the application of the proposed methodology. Besides, the methodology was thought of as composed of different phases. While the first (§4.2) and the second (§4.3) phases aimed to define the most relevant urban characteristics to urban competitiveness through multivariate statistical analysis, the third phase (§4.4) materialises in a benchmarking basing on the composite index 'Potential of Urban Competitiveness' (P_{UC}) that synthesize the competitive behaviour of cities. This methodological step is flanked by the comparison with the NGEU allocated resources, providing decision-makers a first support tool to visualise the existing gaps, rebalance excessive disparities, and incentivise the best-performing cases. Finally, the fourth phase of the methodology (§4.5), intended to highlight cities' distinctive vocations vis-à-vis their overall competitive potential, consisted of a correlation analysis between the Potential of Urban Competitiveness index (P_{UC}) and a partial index that considers the city performance in just one Macro-area of Competitiveness. This correlation analysis allowed to pinpoint, for each Macro-area, four 'clubs' of urban areas with different competitive character: less dynamic areas with low Macro-area competitiveness; areas with initiated transition in a Macro-area but low overall competitiveness potential; areas with high potential and high Macro-area competitiveness; and areas with high potential but low Macro-area competitiveness.

The division into four 'clubs' proposed in the last phase of the methodology, along with the structure in Macro-areas, constitutes the main input for the construction of a matrix of intervention. The matrix is, therefore, configured as a tool to increase the competitive level of an area by intervening at three territorial scales, in five Macro-areas of Competitiveness, and in four 'clubs' of urban areas with a homogeneous competitive character.

6.2 Matrix of interventions

In the elaboration of the set of actions aimed at increasing urban competitiveness, it was fundamental to consider and give value to the inputs of the scientific literature. Recently, the scientific community has started deepening the topic of urban competitiveness by relating it to the numerous challenges that the city is called upon to face in the future (Papa et al., 2015; Papa et al., 2017). Furthermore, the complexity of urban systems implies that the competitiveness of an urban area must be assessed by taking into account a great multiplicity of factors interpenetrated with the governance of the territory (Xia et al., 2022), in summary, by taking a multidimensional approach.

These two inputs led to the decision to compare this research with the challenge of post-Covid recovery and to examine different Macro-areas of Competitiveness that, *de facto*, refer to a tool of great importance for economic recovery in Europe, that is Next Generation EU. As exposed in Chapter 4, the selected five Macro-areas are, respectively, Tourism and Culture, Green Transition, Digitalization/smartness, Sustainable Mobility, and Economic and Social Resilience. Tourism plays a crucial role in the growth and development of European cities, serving as a significant contributor to local economies (Li & Du, 2021), especially in those territories with high cultural value and unique heritage (Alberti & Giusti, 2012), as highlighted by some of the results of this Ph.D. work (see Chapters 2 and 3). Similarly, a vibrant cultural sector attracts not only tourists, but also new residents, talented migrants, skills, and knowledge that nurture the city's competitiveness (Chiu et al., 2019). Green transition is the flagship area of the NGEU plan (EC, 2021), due to its links to climate change mitigation, decarbonization of economies, and sustainable development (Nassar & Tvaronavičienė, 2021). Yet, the analyses conducted within this research have shown a weak bond with urban competitiveness (see Chapter 5). On

the contrary, green transition seems to be linked to digital transition, that, on its own, can trigger competitive processes generating new models of urban organization and added value in multiple sectors (Guseva & Dmitrieva, 2020; Tiwari, 2022). Therefore, the research results suggest that proposing joint actions to accelerate the 'dual transition' (both green and digital) could be much more effective than fostering compartmentalised actions. The work also highlighted the relevance of the sustainable mobility sector (Bebber et al., 2021), emphasizing the role of soft/active mobility (pedestrian and cycling mobility) for the quality of life and competitiveness of cities of different sizes (Tennøy et al., 2022). This is not a novelty since the role of active mobility in guaranteeing high standards of well-being is widely recognized by the scientific literature (Garau et al., 2016; Guida & Carpentieri, 2021) and international organizations. However, the study results suggest that dedicating a specific section of the NGEU to active mobility in cities would have had significant impacts on competitiveness in the long-term, for residents and visitors' benefits alike. Finally, Economic and Social Resilience was revealed to be the most incisive sector for urban competitiveness since promoting economic preparedness, social inclusion, and community cohesion are fundamental ingredients to make a territory, firstly, liveable for its inhabitants and, secondly, competitive on an international scale (Martin & Sunley, 2020; Sharp et al., 2020).

All these considerations converged into the construction of a matrix of interventions that, by embracing a multidimensional and systemic approach, holds the different Macro-areas together, treating them not by compartmentalisation but by considering their transversality (Baldissara & Fasano, 2016). Besides, intervening in each Macro-area might have positive side effects that regard other sectors. In this sense, it is important to bear in mind that the assignment of an intervention (action) to a particular Macro-area is not absolute: there are several measures or categories of intervention which, although associated with just one of the five Macro-areas, may also relate to the others.

The interventions vary according to the territorial scale, be it metropolitan, municipal, or sub-municipal. However, at the current state, I have proposed and systematized only interventions at the sub-municipal since it seemed to be the most interesting scale to be deepened, thanks to the useful input it can provide to decision

makers called to intervene in their territories to respond to the NGEU cry. Future development of the research will regard the enlargement of the matrix to the other territorial scales, as well. The interventions to be put in place to increase the competitive level of an area have been selected and explored focusing on the most recurrent dimensions, categories, and variables in the scientific studies on urban competitiveness. The identification of the most influential actions and measures was carried out not only through a careful study of scientific papers but also in the light of best practices in Europe and worldwide, – i.e. interventions at the urban scale that have led to an actual increase in the attractiveness of cities – by consulting several databases of practices (Covenant of Mayors, UN-Habitat, Urbact, EIT Urban Mobility, …).

ID	T01	E01	...		
Macro-Area	Tourism and Culture (T)	Green Transition (E)	Digitalization/ Smartness (D)	Sustainable Mobility (M)	Economic and Social Resilience (R)
Quadrant	I- Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)	
Action	Description/title of the proposed intervention				
Objective	The objective of the intervention linked to the increase in territorial competitiveness				
Sub-system	Socio-economic and anthropic	Functional	Physical	Systemic/ territorial	
Type of action	GREEN	GREY	SOFT		
Impacts	Eventual negative effects due to the action implementation				
Transversal Macro-areas	Tourism and culture	Green Transition	Digitalization/ smartness	Sustainable mobility	Economic and Social Resilience
Monitoring indicators	Indicators selected among the ones proposed in the methodology to monitor the increase in competitiveness associated with the action implementation				
Time frame	Brief-term	Mid-term	Long-term		
Territorial scale	Metropolitan	Municipal	Sub-municipal		
Normative reference	Regulations associated with the action				
Costs	Estimated costs				

Table 6-1. The structure of the matrix of interventions proposed. The items (columns) of the matrix are reported in the first column of this table, therefore this table should be read horizontally, from the left-hand side to the right-hand side, with a description of the items in each arrow.

Given the choice of deepening only the sub-municipal scale, the good practices analysed have the objectives to increase the competitiveness and attractiveness of

small urban realities, with policies focusing on social cohesion, the dissemination of knowledge, sustainable development, and the enhancement of tourism and local production.

The matrix structure (Table 6-1) resumes the structure of the strategic plans. In particular, it was constructed and developed taking inspiration from the abacus developed by the Italian Ministry of the Environment and Land and Sea Protection as part of the National Strategy for Adaptation to Climate Change (Ministero dell'ambiente, 2017), for what concerns the structure. It has been structured in Excel in a way that makes it consultable throughout filters. Currently, it recollects 40 actions divided into five Macro-areas, but it is expected to be expanded in the near future.
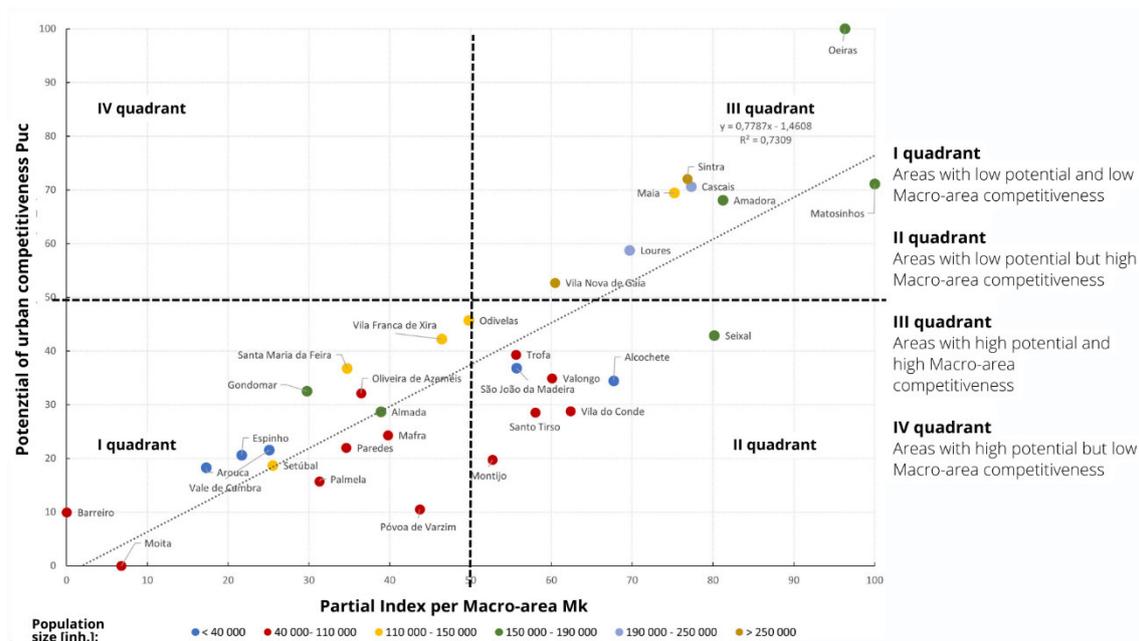
Figure 6-2. Scheme representing the correlation analysis between the two indexes 'Potential of urban competitiveness' (on the y-axis) and a partial Index of a generic Macro-area (on the x-axis), both standardized from 0 to 100 and the division in quadrants proposed.

The first column of Table 6-1 shows the items in which the matrix is articulated. Each action can be identified by an ID code, based on the Macro-area identifier letter and a cardinal number. The item 'Quadrant' refers to the 'club' to which the single territorial unit falls according to the correlation analysis between the index 'Potential of Urban Competitiveness' (P_{UC}) and a partial index indicative of the Macro-area performance (Mk). This 'club' can be determined by looking at the position of the territorial unit in a Cartesian chart representing P_{UC} on the y-axis and

Mk on the x-axis, both standardized on a scale from 0 to 100. As shown in the previous chapters, in this chart it is possible to visualize four quadrants exemplifying four different competitive behaviours with respect to the phenomena analysed (Figure 6-2).

The following items are 'Action' – which synthetically describes the intervention proposed – and 'Objective' – which highlights the aim of the intervention. Thus, the matrix can be filtered by Macro-area, but also by objective. Several measures can be addressed to the same objective, therefore the filtered visualization by objective is important to identify actions with a greater positive impact on competitiveness. Furthermore, it is important to note that the Macro-areas are interlinked: an intervention in the Economic and Social Resilience Macro-area is not close in itself but can also affect other Macro-areas. That is why the item 'Transversal Macro-area' has been introduced. The column 'Sub-system' reports the subsystems involved in the intervention, assuming the definition of cities as complex systems made up of several sub-systems in relation to each other. According to Gargiulo & Papa (2021), these subsystems are the following:

− Socio-economic and anthropic sub-system: it includes the complex of people, socioeconomic characteristics, behaviour, and soft networks that compose a city.

− Functional sub-system: it includes the system of activities that take place in a territory, including mobility and communication.

− Physical subsystem: it is the material component of an urban system, made up of the group of adapted spaces and channels where the activities take place.

− Systemic/territorial subsystem: it refers to the broader physical matrix where relationships between different subsystems develop and includes hard networks.

The item 'Type of action' refers to a classification proposed within the SNAC (2017) between green, grey, and soft actions. SOFT actions are those interventions that do not require direct structural and material measures, concerning mainly governance and information processes along with the consultation and participation of public administration, population, and stakeholders. The GREEN and GREY actions both have a materiality component. The GREEN actions do not require substantial

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economic resources and can be implemented through greenery interventions, such as the provision of green spaces, permeable paved surfaces, sustainable management of natural services, and so on. GREY actions refer to the built heritage, and concern plants, infrastructures, the building envelope, structures, and roads, with proper engineering interventions (SNAC, 2017). Evidently, GREY interventions are the most expensive, and this provides input for the choice of the right interventions, favouring, for instance, 'cheaper', despite effective, actions.

The column 'impacts' reports the expected negative effects due to the implementation of interventions.

By following the SNAC pattern, the matrix proposes indicators to monitor the increase in competitiveness associated with the implementation of the interventions. The monitoring indicators are those indicators proposed in the methodology (Chapter 4). The change in the value of indicators allows to evaluate their impacts on the overall competitive performance of territorial units. They can be useful also to simulate scenario analysis that can support the choice of the most suitable actions in a specific territory.

The column 'Time frame' refers to the period necessary to intervene, dividing the matrix into brief-term, mid-term, and long-term actions. Finally, whilst the item 'Normative references' refers to the regulations to which actions should comply (national, regional, municipal, and local), the column 'Costs' reports the estimated costs associated with the action proposed.

This toolkit, based on scientific studies and good practices, and if linked to the specificities, shortcomings, and strengths of the territorial units, allows for the identification of measures that, acting on different sectors, would be able to determine a significant increase in competitiveness of specific urban areas.

To understand the applicability and the relevance of the toolkit, an application hypothesis is proposed. Let us imagine that the proposed model has been applied by a public administration technician to a sub-municipal case, specifically to a municipality made up of 8 districts (see Figure 6-3), in order to understand where and how to primarily intervene to increase urban competitiveness, given the availability of the NGEU resources. Once all the phases of the methodology have been applied and the susceptibilities/potential highlighted, the administrator/technician

will obtain a 'competitiveness profile' for each district, with a precise performance in each Macro-area displayed by its position in one of the four quadrants shown in Figure 6-2. According to this information (Macro-area and relative Quadrant) the technician can enter the matrix to visualize the actions of interests and, subsequently, use the other instruments of filtering (Impacts, Objectives etc.) to obtain appropriate actions to transform the districts in a competitive key, according to the single cases characteristics and needs. The expected result is a table modeled on the one shown in Figure 6-3, reporting for each district and for each Macro-area the identifiers (ID) of the selected actions.

	Tourism and culture				Green Transition				Digitalization/smartness				Sustainable Mobility				Economic and Social Resilience			
Quadrants **Districts**	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
District 1	T01, T02...				E08, E09				D09							M17...			R16	
District 2		T04, T09				E10, E18			D02						M12		R01, R02...			
District 3		T05, T06...				E23			D01, D04...						M12				R17, R18	
District 4								E33			D25, D27...	M01							R15, R18...	
District 5			T11, T12			E12, E25					D15			M04						R25, R33
District 6				T20		E10, E18...			D10, D11					M04, M05						R26, R34...
District 7			T10, T17	T20, T21	E01				D08, D09...					M07				R08		
District 8		T08			E01, E02				D01, D03...						M13, M14		R02, R05			

Figure 6-3. Scheme representing, in a hypothetical application of the toolkit, the expected result consisting of a table with all the actions proposed for each district.

20 of the actions that compose the matrix are reported in the section ANNEX I in the shape of action sheets. In particular, I chose the most significant actions representative of at least one Macro-area/quadrant intersection to illustrate how the matrix is structured. It is worth noting that for districts falling in the I quadrant – which are supposed to be the most degraded – the interventions are mostly linked to recovery, redevelopment, and regeneration. On the other hand, for districts falling in the II quadrant, having low potential but high Macro-area competitiveness, there are, mainly, interventions of maintenance and monitoring in order to preserve the value of the Macro-area of interest. For the III quadrant, which recollects the best-performing urban areas, I propose interventions to further boost the competitiveness on an international scale, by focusing on the main vocations and assets of the

districts, going beyond the system of variables proposed. Finally, the districts belonging to the IV quadrant, characterised by a high competitive potential but low Macro-area competitiveness, are, generally, those where it is necessary to invest to overcome the disparities with other Macro-areas and achieve higher competitive advantage in all sectors.

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CHAPTER 7. CONCLUSIONS

7.1 Conclusions

This dissertation is the final result of a research project carried out as part of the Ph.D. course in Civil Systems Engineering at the Department of Civil, Architectural and Environmental Engineering of the University of Naples Federico II, within the group of research TeMALab – Laboratory of Land Use, Mobility, and Environment, and in collaboration with the School of Economics at the University of Porto.

The activities carried out and summarised in this thesis are based on various conceptual and methodological assumptions, which are based on sound scientific ground and an integrated approach to urban and territorial systems, and which, in turn, have constituted the basis for the development of a decision support tool to increase urban competitiveness.

The research activities were designed, carried out, and validated, with the supervision of my tutor, Prof. Arch. Carmela Gargiulo, in order to achieve theoretical-methodological objectives to fill the gaps of the scientific literature, as well as applicative results that could be of interest to public decision-makers, administrations, and stakeholders.

The problem underlying this research derives, first of all, from the fact that during the past 30 years, since the burden of managing economic policy for competitiveness has devolved to urban areas, cities possess a means to bolster their competitiveness and actively strive to foster the desired economic environment for their residents, entrepreneurs, as well as public and private actors (Boschetto & Bove, 2012; Kresl & Ietri, 2014). Yet, cities are facing challenging times that continuously test their ability to attract and retain both resources and people capable of sustaining their competitive advantage (Ruggero et al., 2020).

For instance, many cities are tackling an increasing shortage of labour in key sectors of the urban economy, causing brain drain and depopulation of urban centres (Wichowska, 2021). This exodus is exacerbated by the lack of affordable housing, in the city centre – because of excessive location costs and incompatibility between cost of living and wages –, and of adequate dwellings in the suburbs, often populated by lower-income, non-educated, and low-skilled immigrants groups (Giacherini et al., 2021; Jing et al., 2022). This is resulting in the decline of the urban environment and the closure or failure of many services and activities.

The increasing physical vulnerability of the urban environment to external agents such as climate change and natural disasters does not improve the situation (Kitchin & Dodge, 2020). The consequences of global warming threaten the liveability of urban areas due to phenomena such as heat islands, floods, and storms, undermining people's safety and endangering the urban system functions (Guida, 2021; Gargiulo & Zucaro, 2023). In addition, poor environmental quality, air and noise pollution, and the scarcity of green areas all together reduce the attractiveness of cities as places where to invest and live, leading to a decline in the quality of life and economic vibrancy (Wang et al., 2021). The current trajectory results in a downturn in the economy, a widening social gap, the alienation of certain social groups based on class, race, and ethnicity, and increased tension between different generations (Aceska et al., 2019).

There is no denying that these developments are alarming the future of our cities that, still, are the main engine of global development and feed on competitiveness. Thus, the research question stems from the necessity to interpret these challenges not only as threats but also, and above all, as opportunities to enhance the competitiveness of urban areas (Rota et al., 2020). Therefore, this Ph.D. research puts a dowel to respond to how to measure and enhance the competitiveness of cities in relation to these challenges.

Yet, from the study of the scientific literature, it emerges that the evaluation of a city's relative competitiveness is a controversial matter, involving different aspects and issues (Jiang & Shen, 2013; Rosa et al., 2020). For this reason, this study examined urban competitiveness as a complex and multidimensional phenomenon, analysing the relationship between competitive potential and the intrinsic resources and place-based attributes of different-sized urban areas. In this research, urban competitiveness takes on several meanings, first as the ability of a city to self-organise in order to increase its competitive level; secondly, as its suitability to attract people, investments and activities due to its susceptibilities (intrinsic and distinctive characteristics). Finally, by virtue of the numerous challenges that cities are called upon to face in the years to come, urban competitiveness is the predisposition to adapt to these challenges, taking advantage of the opportunities offered by change. In light of these definitions, the purpose of the research was to examine

the role of territorial competitiveness in the development of an area considering its connotations and opportunities for growth, in other words relating its potential of competitiveness with its susceptibilities.

The fact that the research started in parallel with the promotion of the Nextgeneration EU program gave me the opportunity to compare it with a real case, which provides concrete resources for coping with a period of economic crisis, as well as increasing the competitiveness of the territories involved (EC, 2021; Gargiulo et al., 2022). One of the main results of the research was the identification of the existing relations between urban characteristics and competitive processes at three different urban scales, referring to the Plan's investment sectors for which cities play a prevailing role and comparing these investments with the actual competitive potential of the territories.

Secondly, the Ph.D. work resulted in an interpretative model of these phenomena in order to support public decision-makers in identifying, in different contexts and at different scales, urban transformation interventions aimed at increasing territorial competitiveness, by tapping into the resources of the plan.

Specifically, grounded on contemporary notions of urban competitiveness (Sgambati & Gargiulo, 2022), one contribution of this study was a revised method to measure the urban competitiveness of metropolitan areas, municipalities, and districts and the identification of which factors and specific dimensions show a stronger relation to competitiveness – opening new ways of thinking about urban policy and place management interventions. Another important result consists in the development of two competitiveness 'rankings' that allowed for the comparison between the actual urban competitiveness potential of the territories and the distribution of NGEU resources in the various investment sectors. This comparison is the central element of the research since it enables to visualise the differences between the current distribution of the NGEU resources and the actual competitiveness and susceptibilities of the territorial units, so as to support future investment planning.

While being well-aware of the limitations of this research (e.g., the limited number of indicators, the limitations in using indexes and rankings, and the necessity to experiment on other case studies), to the best of my knowledge, the methodology

proposed in this Ph.D. work goes one step beyond by, on the one hand, drawing on contemporary notions of competitiveness and, on the other hand, by addressing the link between such an overall performance index and key policy dimensions in a time of on-going (post-pandemic) economic recovery investments in Europe and beyond – focusing on fostering Tourism and Culture, the so-called "Dual Transition" (Green and Digital), Economic and Social Resilience along with Sustainable Mobility (European Commission, 2021).

I believe the methodology can be applied to other territorial contexts and may constitute an initial step to conceive more nuanced urban development and investment strategies, in which place vocations and their distinctiveness can be taken into closer consideration. Therefore, this study can be seen as building on previous urban competitiveness measurement approaches (e.g., Sáez et al., 2017), proposing a new measurement methodology that investigates urban competitiveness beyond economic, innovation and efficiency dimensions, in a context of new societal and crisis recovery challenges.

The methodology was tested at three territorial scales. The first experimentation regarded the 14 Italian major cities and referred to the metropolitan scale. This application revealed a certain disparity between the resources allocated by the plan and the competitive potential of Italian metropolitan areas, especially for southern cities that have been advantaged despite their scarce level of competitiveness. This disparity, however, depends on one of the main objectives of the NGEU and of the Italian Recovery Plan, namely, to overcome the territorial gaps between the north and south of the country.

The second experimentation regarded the municipalities in the metropolitan areas of Porto and Lisbon in Portugal, with the vision of comparing the model developed with a non-Italian case, notwithstanding being involved in the NextGenerationEU recovery program. The results of this application included a ranking of cities based on their urban competitiveness potential and the study of the correlation between competitiveness and city size.

The model was then tested at the sub-municipal scale, which represents a novelty in the scientific literature and the core of the research since, at this scale, the results of the research are oriented to support the public administration in the choice of

interventions and projects that meet the competitiveness objectives of the NGEU while meeting the potential of local realities. I carried out the experiment on the districts of the City of Naples, in Italy, which revealed to be a significant case study for several reasons. First of all, for the internationally competitive potential that characterises the city, due to its geographical location and cultural attractiveness, in contrast to the stagnant state of several districts. Secondly, because of the heterogeneity of the districts, which makes the study of competitive susceptibilities even more interesting. Finally, because Naples is a city in southern Italy, to which many NGEU resources are destined, and because the results that such research provide might well support the planning of the interventions within the European program.

Like in other recent studies (e.g. Rodríguez-Pose and Griffiths, 2021), the applications of this Ph.D. work – drawing on evidence, respectively, from the Italian metropolitan cities, the metropolitan areas of Porto and Lisbon, and the city of Naples – confirm that population size is not a good proxy for urban competitiveness, suggesting that solely concentrating investments in the larger urban areas – such as the so-called global cities – will not necessarily lead to higher metropolitan competitiveness. On the contrary, as also argued for other European contexts (Pino et al., 2018), it suggests that an approach taking into consideration different interventions for different "clubs" of urban areas (instead of one-size-fits-all investment plans) would more likely contribute to expanding urban competitiveness, valorising territorial assets (susceptibilities), and reducing the apparent spatial divides observed. These interventions might be proposed according to the relationship potential/susceptibility in each of the investment sectors, distinguishing among:

− underperforming urban areas, with low potential and low sector competitiveness;

− areas where the high susceptibility in one sector is not able to boost the overall competitive level;

− top-performing areas, with high potential and highly competitive in one investment sector;

− and, finally, areas with low sector competitiveness but high overall potential.

Chapter 7 - Conclusions

Within this framework, public administrations have two possibilities: on the one hand, they might work on the existing susceptibilities exploiting them as reservoirs of competitive growth for the entire city (or even the whole region/country); on the other hand, they might balance the existing differences by investing in more disadvantaged urban realities, paying more attention to the most urgent sectors for the benefits and the overall well-being of citizens.

From a policy and place management perspective, this would be a plea to focus on shared metropolitan and urban strategies, as well as common projects, that valorise the competitive potential and distinctiveness of each urban area "club" (instead of copycatting projects and investments), widening metropolitan competitiveness potentials, notwithstanding the fact that such a type of intervention would call for strong administrative and organising capacities, both at the metropolitan, municipal and sub-municipal level (e.g., van den Berg et al., 2016; Carvalho et al., 2017)

The evidence from this research´s analyses also suggests that the link between environmental performance, green transition, and urban competitiveness is very likely non-linear within metropolitan areas. Also, from another angle, the analysis also suggest that it is hardly possible to decouple economic and social resilience, digitalization, and competitiveness from one another.

This would mean that, despite the very different urban profiles, investments in these dimensions are not mutually replaceable and administrations need to invest in them all to enhance urban competitiveness, even if considering different types of digital and resilience-related investments. That is why the last part of the research was dedicated to the development of a support toolkit for public decision-makers. The toolkit aims to assist urban planning public technicians in identifying the most appropriate and beneficial interventions to be included in strategic plans to enhance or equalize the competitive potential of urban areas. The objective is to offer policymakers an easily accessible tool that can help them identify areas within the territory where intervention is crucial for competitiveness, and provide suggestions on the type of intervention required.

The results achieved within this research work can be of great relevance for the distribution of the NGEU resources in European cities, but also for the definition of a pattern through which programming investments of similar financial tools at a territorial scale in the future. The originality of the work lies precisely in seeing

competitiveness in relation to urban areas' latent qualities and intrinsic features, casting this relationship in a real context which is the post-Covid-recovery, proposing a quantitative model to interpret them, as well as a way to intervene efficiently and effectively to increase the competitiveness of metropolitan areas, cities and districts alike.

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ANNEX I. ACTION SHEETS

List of Actions

T01. Recovery, reuse and refunctionalisation of degraded and abandoned built heritage

T02. Ordinary maintenance of cultural heritage and accommodation facilities

T03. associations for tourist and cultural enhancement

T04. Establishment of new activities with forms of financing and cultural and tourism competitiveness objectives

E01. Transformation of abandoned areas into public green spaces

E02. Monitoring of public buildings' energy consumption

E03. Efficiency enhancement of buildings installations

E04. Installation of conventional or storage photovoltaic systems in existing buildings through renovation plans

D01. Provision of new university poles

D02. Promotion of "smart city" image

D03. Creating networks with other smart cities

D04. Digitalization of existing services

M01. Integration of the shortcomings of the public transport network

M02. Improvement of mobility systems quality

M03. Urban mobility branding

M04. Improvement of road safety

R01. Regeneration of degraded urban areas

R02. Improvement of accessibility for fragile population at the district level

R03. Education campaigns and events

R04. Localization of new activities

ID	**T01.**
Macro-Area	Tourism and Culture
Quadrant	I - Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).
Action	**Recovery, reuse and refunctionalisation of degraded and abandoned built heritage**
	Recovery of the built heritage with retention or change of use, provided it is compatible with a tourist-cultural function
Objective	To redevelop the existing built heritage, preserving and promoting its historical, artistic and cultural value and increasing the tourist attractiveness
Sub-system	Physical
Type of action	GREY
Impacts	Lack of compensation for investment costs, waste production, increased traffic, higher prices of goods, services and real estate.
Transversal Macro-areas	Economic and Social Resilience
Monitoring indicators	Density of cultural facilities (TC1), Institutions for culture promotion (TC7), Airbnb (TC8), Tourists accommodation facilities (TC10), Average real estate value (I&C9)[11]
Time frame	Long-term
Territorial scale	Municipal and sub-municipal
Normative re-ference	D.lgs. n. 42 del 2004; Regional Regulations, PRG[12]

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[11] As explained in section 6.2 (Chapter 6) the matrix has been filled with interventions at the sub-municipal scale to date. For this reason, the monitoring indicators refer to the indicators chosen to measure urban competitiveness at the sub-municipal scale (see Section 5-4, Table 5-14).

[12] Since two of the applications proposed regarded the Italian context, normative references refer to Italy, but, of course, the references could be extended based on the country, region or city of implementation.

ID	T02.
Macro-Area	Tourism and Culture
Quadrant	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).
Action	**Ordinary maintenance of cultural heritage and accommodation facilities**
	Ordinary maintenance interventions are those building works that concern the repair, renovation and replacement of building finishes and those necessary to integrate or maintain existing technological systems.
Objective	Preserving the state of the existing built heritage with cultural value or intended for tourist reception facilities by preventing it from deteriorating; to be preferred to large, sporadic and costly restoration work to retain competitive values.
Sub-system	Physical
Type of action	GREY
Impacts	-
Transversal Macro-areas	Green Transition, Economic and Social Resilience
Monitoring indicators	Average real Estate Value (I&C9)
Time frame	Mid-term
Territorial scale	Sub-municipal
Normative reference	D.lgs. n. 42 del 2004; T.U. 380/2001; Regional Regulations, PRG

ID	T03.
Macro-Area	Tourism and Culture
Quadrant	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).
Action	**Associations for tourist and cultural enhancement**
	Favouring the formation of cultural/tourism associations linked to the valorization of the territory and its heritage, throughout incentives, collaboration with institutions, and promotion.
Objective	Valorizing existing heritage and strengthen the district cultural identity, also contributing to tourism and economic development, as well as sense of community, contributing to enhance the competitiveness of tourism and culture sectors.
Sub-system	Socio-economic and anthropic
Type of action	SOFT
Impacts	Risks associated with lack of compensation for investment costs and management of tourists flows within the district.
Transversal Macro-areas	Economic and Social Resilience
Monitoring indicators	Density of cultural facilities (TC1), Institutions for culture promotion (TC7), Airbnb (TC8), Tourists accommodation facilities (TC10), Unemployment rate (I&C4), Social structures (I&C5)
Time frame	Mid-term
Territorial scale	Municipal, Sub-municipal
Normative reference	artt. 14 - 42 Codice Civile; artt 143 - 150 T.U.I.R.

ID	T04.
Macro-Area	Tourism and Culture
Quadrant	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)
Action	**Establishment of new activities with forms of financing and cultural and tourism competitiveness objectives**
	Co-ordinating economic activities that support the conservation of Cultural Heritage, the landscape, and the tourism sector, in relation to the demand-supply relationship and the needs of the territory.
Objective	Finding new funding solutions to support the cultural tourism sector and at the same time curb tourist crowding and congestion in other districts.
Sub-system	Functional
Type of action	SOFT
Impacts	Risks associated with lack of compensation for investment costs and management of tourists flows within the district.
Transversal Macro-areas	Sustainable Mobility, Economic and Social Resilience
Monitoring indicators	Density of Bars and Restaurant (TC2), Institutions for culture promotion (TC7), Unemployment rate (I&C4), Ratio of female to male labour force (I&C1)
Time frame	Brief-term and Mid-term
Territorial scale	Municipal, Sub-municipal
Normative reference	Regional Regulations, PRG

ID	E01.
Macro-Area	Green Transition
Quadrant	I - Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).
Action	**Transformation of abandoned areas into public green spaces**
	Recovery and redevelopment of abandoned areas, interstitial to the urban fabric, with the creation of public green areas as services for residents and visitors alike.
Objective	Regenerating degraded areas through green interventions, building a green network between residences, facilities, and services, and promoting clean, bicycle-pedestrian and ecological mobility.
Sub-system	Systemic/territorial
Type of action	GREEN
Impacts	Costs of requalification, increased real estate value, lack of cooperation or obstructionism by the resident population.
Transversal Macro-areas	Toruism and Culture, Sustainable Mobility, and Economic and Social Resilience
Monitoring indicators	Areas with landscape value (TC4), Sports facilities (TC6), Impermeabilised soil (TC9), Number of parks (TED1), PM2.5 concentration (TED2), NO_2 concentration (TED3), Green urban areas (TED4)
Time frame	Mid-term, Long-term
Territorial scale	Municipal and sub-municipal
Normative reference	Regional Regulations, PRG

ID	E02.
Macro-Area	Green Transition
Quadrant	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).
Action	**Monitoring of public buildings' energy consumption**
	Favouring the installation of innovative monitoring systems to control energy consumptions in public buildings, also in collaboration with university, centres of research, and enterprises.
Objective	Controlling energy consumption and combatting energy losses.
Sub-system	Physical
Type of action	GREY
Impacts	-
Transversal Macro-areas	Digitalization/smartness
Monitoring indicators	PM2.5 concentration (TED2), NO2 concentration (TED3), Energy consumption
Time frame	Brief-term
Territorial scale	Sub-municipal
Normative reference	Energy performance of building directive (Epbd); Regional Regulations, PRG

ID	E03.
Macro-Area	Green Transition
Quadrant	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).
Action	**Efficiency enhancement of buildings installations**
	Adaptation of building installations to energy standards, reduction of dispersed surfaces, enhancement of natural lighting and renewable energy sources, and implementation of more technological building envelopes
Objective	Improving the energy efficiency of existing heritage to minimise pollutant emissions, combatting the obsolescence of heating and cooling systems in existing buildings, and monitoring old generation plants that cannot be replaced, in order to reduce costs associated with energy consumption and improve the district liveability.
Sub-system	Physical
Type of action	GREY
Impacts	Excessive costs, waste production, increased prices of goods and services.
Transversal Macro-areas	Digitalization/smartness
Monitoring indicators	PM2.5 concentration (TED2), NO_2 concentration (TED3), Energy consumption
Time frame	Mid-term
Territorial scale	Municipal and sub-municipal
Normative reference	Energy performance of building directive (Epbd); Regional Regulations, PRG

ID	E04.
Macro-Area	Green Transition
Quadrant	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)
Action	**Installation of conventional or storage photovoltaic systems in existing buildings through renovation plans**
	The installation of photovoltaic systems in public and private buildings. Installation should be pursued in existing buildings with good exposure and the possibility of integrating the panels into the building envelope. Numerous technical solutions are available such as photovoltaic tiles, photovoltaic sheathing, photovoltaic façade modules.
Objective	The use of renewable energy sources is of fundamental importance for reducing consumption, improving air quality, and reducing energy costs and can lead to significant improvements in competitiveness.
Sub-system	Physical
Type of action	GREY
Impacts	Risks associated with lack of compensation for investment costs, management of new infrastructures, and future plant disposal.
Transversal Macro-areas	-
Monitoring indicators	PM2.5 concentration (TED2), NO2 concentration (TED3), Energy consumption
Time frame	Mid-term
Territorial scale	Municipal, Sub-municipal
Normative reference	L.142/2022, Regional Regulations, PRG

ID	D01.
Macro-Area	Digitalization/smartness
Quadrant	I - Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).
Action	**Provision of new university poles**
	Establishment of new university structures within the districts
Objective	Regenerating degraded areas through the establishment of university poles, with the benefits of improving safety, accessibility, create new economic opportunities such as houses for rent for students or economic/commercial activities to support education
Sub-system	Systemic/territorial
Type of action	GREY
Impacts	Costs of requalification, increased real estate value, lack of cooperation or obstructionism by the resident population.
Transversal Macro-areas	Sustainable Mobility, Economic and Social Resilience
Monitoring indicators	Density of bars and restaurant (TC2), Gyms, Pools and SPA (TC5), Sports facilities (TC6), Number of university facilities (TED6), Density of metro network stations (MS2), Number of graduates (I&C8), Average real estate value (I&C9)
Time frame	Mid-term, Long-term
Territorial scale	Metropolitan, Municipal and sub-municipal
Normative reference	Regional and Metropolitan/Provincial Regulations, PRG

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ID	D02.
Macro-Area	Digitalization/smartness
Quadrant	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).
Action	**Promotion of "smart city" image**
	Promoting the image of the district, already on the way to digitalization, as a "smart" district by launching promotion campaigns.
Objective	Publicise the high level of digitisation to attract people and workers,enhancing the level of occupation and skilled labour, and activities and investments also in other sectors such as the Green Transition sector
Sub-system	Socio-economic and functional
Type of action	SOFT
Impacts	-
Transversal Macro-areas	Green Transition, Economic and Social Resilience
Monitoring indicators	Foreign residents (I&C2), Number of graduates (TED3)
Time frame	Brief-term
Territorial scale	Municipal and Sub-municipal
Normative reference	-

ID	D03.
Macro-Area	Digitalization/smartness
Quadrant	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).
Action	**Creating networks with other smart cities**
	Create an innovative environment or enter an existing cities network to boost the competitive ability of companies by bringing together businesses, citizens, public authorities, R&D institutes and structures that support innovation.
Objective	The creation, development (including product development) and import of innovative solutions taking in different spheres of urban life.
Sub-system	Functional and Systemic/territorial
Type of action	SOFT
Impacts	Difficulties in realising initiatives
Transversal Macro-areas	Economic and Social Resilience
Monitoring indicators	Foreign residents (I&C2), Number of graduates (TED3)
Time frame	Mid-term
Territorial scale	Metropolitan, Municipal and sub-municipal
Normative reference	European legislation

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ID	D04.
Macro-Area	Digitalization/smartness
Quadrant	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)
Action	**Digitalization of existing services**
	Introduction of digital systems to improve the efficiency of the existing services such as liveability or fruition of cultural heritage.
Objective	Further improving the other Macro-areas where the district has a better performance and at the same time giving a boost to the digital sector in order to attract new investment and improve the city image
Sub-system	Physical
Type of action	GREY/SOFT
Impacts	Difficulties in management and maintenance of digital services.
Transversal Macro-areas	Tourism and Culture, Green Transition, Sustainable Mobility, and Economic and Social Resilience
Monitoring indicators	All the indicators proposed in Table 5-14 according to the services to be digitalized
Time frame	Mid-term
Territorial scale	Metropolitan, Municipal, Sub-municipal
Normative reference	-

ID	M01.
Macro-Area	Sustainable Mobility
Quadrant	I - Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).
Action	**Integration of the shortcomings of the public transport network**
	Introduction of new metro or bus station to ensure adequate public transport offer to population
Objective	Promoting sustainable forms of mobility, enhancing accessibility, and discouraging the use of private vehicles with benefits for the environmental quality and liveability of the neighbourhood
Sub-system	Systemic/territorial
Type of action	GREY
Impacts	Excessive Costs of requalification, long implementation times, lack of cooperation or obstructionism by the resident population.
Transversal Macro-areas	Green Transition, Economic and Social Resilience
Monitoring indicators	PM2.5 concentration (TED2), NO2 concentration (TED3), Density of bus stations (MS1) Density of metro network stations (MS2), Average real estate value (I&C9)
Time frame	Long-term
Territorial scale	Metropolitan, Municipal and sub-municipal
Normative reference	Mobility plans

ID	**M02.**
Macro-Area	Sustainable Mobility
Quadrant	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).
Action	**Improvement of mobility systems quality**
	Improvement of cyclo-pedestrian paths, public transport means, stations in terms of cleanliness, quality, digitalization, offered services, aesthetic.
Objective	Empowering the travel experience and thus the liveability and accessibility of the mobility system with benefits that affect the attractiveness and competitiveness of the district
Sub-system	Physical
Type of action	GREY
Impacts	Lack of economic efficiency
Transversal Macro-areas	Digitalization/smartness
Monitoring indicators	-
Time frame	Brief-term
Territorial scale	Municipal and Sub-municipal
Normative reference	-

ID	**M03.**
Macro-Area	Sustainable Mobility
Quadrant	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).
Action	**Urban mobility branding**
	Branding the most iconic mobility systems by enhancing them and publicising them.
Objective	Promoting innovative mobility systems and fostering the city image internationally.
Sub-system	Functional
Type of action	SOFT
Impacts	-
Transversal Macro-areas	Economic and Social Resilience
Monitoring indicators	-
Time frame	Brief-term
Territorial scale	Metropolitan, Municipal and sub-municipal
Normative reference	-

ID	M04.
Macro-Area	Sustainable Mobility
Quadrant	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)
Action	**Improvement of road safety**
	Identification of the most dangerous neighbourhood-scale nodes and improvement in terms of safety.
Objective	Reduce risk and enhance the district's safety
Sub-system	Physical
Type of action	GREY/SOFT
Impacts	difficulties in dialogue between institutions
Transversal Macro-areas	Green Transition, Economic and Social Resilience
Monitoring indicators	Road deaths (MS4)
Time frame	Mid-term
Territorial scale	Metropolitan, Municipal, Sub-municipal
Normative reference	Traffic plans

ID	R01.
Macro-Area	Economic and Social Resilience
Quadrant	I - Areas with low potential and low Macro-area competitiveness (Puc_st < 50 and low Mk_st < 50).
Action	**Regeneration of degraded urban areas**
	Development of urban regeneration plans to deal with inequalities, social problems and marginality, throughout the introduction of new activities, the redevelopment of public spaces, and the requalification of degraded green areas.
Objective	Reducing social disparities and inequalities and combatting marginality of the district in order to improve social and economic conditions and rebalance the difference in terms of competitiveness with other districts
Sub-system	Systemic/territorial
Type of action	GREY/GREEN/SOFT
Impacts	Excessive costs of redevelopment, long implementation times, lack of cooperation or obstructionism by the resident population.
Transversal Macro-areas	Tourism and culture, Green Transition, Sustainable Mobility
Monitoring indicators	Gyms pools and SPA (TC5), Sports facilities (TC6), Institutions for culture promotion (TC7) Number of parks (TED1), Km cyclo-pedestrian network (MS3), Foreign residents (I&C2), Average salary (I&C3), Unemployment rate (I&C4), Social structures (I&C5), Number of property dwelling (I&C6), Household with >6 people (I&C7), Average real estate value (I&C9)
Time frame	Long-term
Territorial scale	Metropolitan, Municipal and sub-municipal
Normative reference	Regional Regulations

ID	**R02**.
Macro-Area	Economic and Social Resilience
Quadrant	II- Areas with low potential but high Macro-area competitiveness (Puc_st < 50 and Mk_st > 50).
Action	**Improvement of accessibility for fragile population at the district level**
	Making activities and services easily accessible to fragile categories (elderly, children, women, persons with disabilities), throughout improvement of public lightening, recovery of bumpy pavements, removal of architectural barriers, introduction of new green areas, localization of new services at reasonable walking distance
Objective	Increasing social inclusion and improving quality of life of all categories of population, especially the most disadvantaged.
Sub-system	Physical
Type of action	GREY
Impacts	Difficulties in dialogue between institutions, sizing of interventions according to the demand-supply ratio
Transversal Macro-areas	Green Transition, Sustainable Mobility
Monitoring indicators	Km cyclo-pedestrian network (MS3), Road deaths (MS4)
Time frame	Mid-term
Territorial scale	Sub-municipal
Normative reference	L.13/89, DPR 503/96, P.E.B.A., Mobility plans

ID	**R03**.
Macro-Area	Economic and Social Resilience
Quadrant	III- Areas with high potential and high Macro-area competitiveness (Puc_st > 50 and Mk_st > 50).
Action	**Education campaigns and events**
	Organisation of free or charity events, such as concerts, craft sales, marathons, festivals, guided tours, events or also education campaigns that involve inhabitants in environmental, social, and cultural issues.
Objective	Promoting citizens participation throughout events and campaigns is fundamental to further improve economic and social resilience of already advanced neighbourhood, and may achieve the enhancement of attractiveness and cultural and social value by strengthening sense of community
Sub-system	Functional
Type of action	SOFT
Impacts	-
Transversal Macro-areas	All Macro-areas according to the nature of the event/campaign
Monitoring indicators	All Macro-areas according to the nature of the event/campaign
Time frame	Brief-term/Long-term
Territorial scale	Sub-municipal
Normative reference	-

ID	R04.
Macro-Area	Economic and Social Resilience
Quadrant	IV- Areas with high potential but low Macro-area competitiveness (PUC_st > 50 and Mk_st < 50)
Action	**Localization of new activities**
	Revising the urban planning tools to provide spaces for the localization of new productive/commercial, or tertiary activities.
Objective	Attracting new residents (also foreigners), increasing the level of occupation and the level of wealth, recall international firms and new enterprises to enhance the economic resilience and the overall level of competitiveness
Sub-system	Functional
Type of action	SOFT
Impacts	Compatibility of the new activity with existing activities, impacts on traffic and the environment
Transversal Macro-areas	Tourism and culture, Digitalization/smartness
Monitoring indicators	Ratio of female to male labour force (I&C1), Foreign residents (I&C2), Average salary (I&C3), Unemployment rate (I&C4)
Time frame	Long-term
Territorial scale	Metropolitan, municipal, sub-municipal
Normative reference	Regional and metropolitan regulations, PRG

ANNEX II. BIBLIOGRAPHY

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