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Digitalization, online services, and entrepreneurial environment in the Italian smart cities' transition

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Abstract

Cities are facing increased dynamism due to rapid technological development, digitalization, and citizens' requirements, creating novel opportunities for smart city transformation. If, until a few years ago, the city's development from a smart perspective was an opportunity, today, it has assumed a predominant character on a social and economic level. This study investigates the evolution of the online service implementation in cities over the years and its impact on the entrepreneurial environment. Using panel data based on 20 Italian cities for 11 years period ranging from 2011 to January 2022, this paper evaluates the online services' evolution and implementation using cluster analysis to identify two clusters (cities in transition and developed). Moreover, we performed a predictive validity analysis to identify the relationship between the clusters and the entrepreneurial environment. The results show that, at the emergent stage of the digitalization process, the development of the city's smartness was important to have an advantage over other cities; today, the implementation of smart city services is essential to create a favourable local environment for the development of entrepreneurial opportunities.

Keywords: Smart City, Digitalization, Online Services

1 Introduction

The current relationship between a city and its citizens is considered central to the essence of smart cities. Smart cities' implementation seeks to digitally interconnect and combine services within a city to provide efficient services by increasing efficiency and sustainability of the city[1]. In the transition toward smart cities, cities will be more user-friendly as the functions are improved through digitalization [2]. In implementing this transformation, cities make use of digital technologies such as information communication and technologies (ICTs), Internet of Things (IoT) and Artificial Intelligence (AI) to build platforms and information infrastructure and to collect (and share) data with internal and external stakeholder[3]–[5]. Given the pervasive diffusion of digital technologies, the digitalization process of cities has become mandatory on the public agenda in the coming years.

The digital approach to smart city implementation focuses mainly on implementing and developing services for the cities' users, such as citizens and firms [6]. This connection generates a linkage between the development trajectories of cities and the local environment. Furthermore, the development of cities from a smart perspective, combined with the cities' worldwide competition in terms of human and financial capital, innovation and tourism [7], [8], has led the development of these practices to be considered fundamental in the cities' development at the local and global level [9].

Considering the Italian context, cities' digital transformation and digitalization have enhanced their impact in the recent decade [10]. However, this recent trend makes it difficult to produce a comprehensive analysis. Furthermore, although there is a large body of theoretical contributions focusing on the smart implementation in cities [9], [11], there is still no common framework to assess the smart implementation in cities and its influence on the local economic and environmental context. Thus, this paper will analyze the digital advancement in Italy (a country fully committed to smart urban policies) by considering a sample of 20 cities clustered into 2 groups: cities “in transition” and cities “advanced”. To assess the digital advancement over the years in cities, we construct a dataset that includes a sample of 10 cities. For each city, we consider the number of online services offered by the municipality to the different city actors, i.e., tourists, firms and citizens.

Our level of analysis is city-level; this allows us to systematically analyze this phenomenon and consider differences in the implementation of the smart city model according to different cities’ sizes and geographical areas. Building on an original dataset described above, we aim to answer the following research questions: "How is the smart cities transition taking place in Italy over the last decade" and “what is the relation between the smart city transition and the entrepreneurial environment?”
In order to do so, we will investigate the evolution of online services offered by municipalities over the years and how this evolution has impacted Italian cities by changing their scenarios and trajectories. Furthermore, we will explore the relationship between the development of smart city services and the city's business environment.

The paper is organized as follows. The second section provides a brief literature review by considering the influence of digital advancement in cities and its relationship with the economic environment and smart city implementation; in the third section, we

describe our research methodology. In the four-section, we discuss our results and their significance. Finally, in the last section, we present the conclusions of the study, limitations, and future avenues.

2 Literature Review

The smart city's implementation and advancement attracted relevant attention over the past decades [10], [12], [13]. To understand this concept is important to understand the role played by the cities in society and consider them as an influent element for the future. Today, cities play a key role in the social and economic aspects worldwide and have a huge impact on the environment as they are able to attract a large flow of people [14], companies [15] and tourists [16] by offering an ad-hoc scenario based on their needs and objectives.

At the same time, the existing scenario requires cities to reshape their trajectories to manage new challenges properly [10]. Thus, throughout the "smart" cities implementation, cities have started to advance solutions which influence users and stakeholders, aiming to have long-term positive effects on the economy and urban landscape [13]. For instance, technological advancement in cities and citizens-centric policies respond to cities' development needs and linking digital advancement with its users is considered a key element for city growth [17], [18]. Therefore, ICT, IoT and AI are a (non-mandatory) part of cities' transformation process and directly impact cities' development trajectories [19].

2.1 Smart City and digital advance

Today, cities are changing their relationship with stakeholders by offering an increasingly dynamic and competitive environment capable of responding quickly to the needs of society.[20]. This transformation takes advantage f the preponderant impact of technological advancement and digitalization that reshapes services and offers new development models.

Following the definition proposed by Bakici [21], smart cities are considered high-tech intensive and advanced cities that connect people, information and city elements using new technologies to create a sustainable, greener city, competitive and innovative commerce, and increased life quality. The implementation of technology and technological advancement has made it possible to reorganize urban architecture to become efficient, sustainable and perform in the urban context. This evolution allows you to interact in time with your users and stakeholders, obtaining the necessary information and creating a user-friendly environment. Furthermore, this transformation has allowed cities to become a container capable of supporting entrepreneurs, citizens and tourists by placing them at the centre of the city's development trajectories [19], [22]. Specifically, based on a user-centric approach, digitalization in cities aims to enhance the engagement of citizens and communities [23].

Specifically, numerous cities made important investments to provide extensive and proactive online services, and interest began to be identified in the factors determining the users' reactions to and the use of smart services in the urban area [24], [25]. However, these investments modify the relationship between users and cities. Consequently,

the online services propose a more user-oriented approach, where the citizen must be positioned at the centre of the development and the transformation of electronic public services [4].

The cities' digitalization focuses on developing online services for different city actors, including institutions, firms, and citizens, on providing services to improve citizens' quality of life and the city's competitiveness [26]. Although today the role of technology is predominant in our society, online services, ICT applications, implementation of the IoT in cities and innovative technologies have been often underutilized [27]. This topic has grown in importance in light of recent developments in the quality of information, services and systems using digital technologies [9]. This need has led cities to reorganize and modify their services to respond quickly and efficiently. For example, Barcelona is acknowledged as successfully developing an ecosystem where urban development, digital services and quality of life pursue policies that benefit the local dynamics of innovation [28, p. 269].

At the same time, smart city discourses in Italy support the construction of a new urban identity, functioning as a discipline mechanism that can be defined as a 'Smartmentality [10]'. In those scenarios, smart cities consider a specific model of a technologically advanced, sustainable and economically attractive city, while 'diverse' cities, those following different development paths, are implicitly reframed as smart-deviant [10, p. 889]. The difference between being a smart city or not being smart leads to obvious local influence. In Italy, the smart city implementation faced cut-throat competition in creative solutions to people's problems and obtaining national and European funding [29]–[31]. This transformation has created the need to modify one's practices to adapt to an increasingly competitive context [32].

In this transformation, Italy represents an interesting case in the relationship between technological development and the geographical environment [9], [10]. Although, to date, there are still regional disparities between north and south, the development of smart cities over the years appears to play a normalizing role. Specifically, the development of the smart city project in Italy has started and coincided with the transformation taking place in the north's main cities [10], [33]; the south has been reducing this gap over the years by developing projects aimed at elevating the urban context in a smart perspective [34], [35].

For example, cities like Naples and Caserta represent metropolitan areas that implement smartness and smart services as an urban policy paradigm. Those online services and smart actions have targeted young people across Naples. While the initial project focuses on the economic development around users and firms, the long-term objectives involve nurturing a "local information society" by creating and promoting digital knowledge in its users [34, p. 216].

Thus, since digitalization in cities bears the potential to help cities to move into a new competitive and technological advanced scenario useful to embrace sustainable and efficient practices [19], [36], in this study, we explore how the evolution of smart cities' services offerings is taking place in Italy in the last decade.

2.2 Digitalization and entrepreneurial environment

Digital development in cities has always influenced the social and business environment. Today, through the use of ICT, AI, and IoT, governments aim to consider the

information they collect from citizens, firms, entrepreneurs, and startups to provide public and private services more efficiently and sustainably [7], [26], [37]. This evolution aims to promote the development of a local system of innovation and entrepreneurship through the collaboration of various local programs, where different actors in the ecosystem, such as citizens, entrepreneurs, startups and universities, interact to generate synergies and urban advancement [38, p. 144].

This synergy increased the relationship between the city's urban and economic development. Specifically, recent trends in urban literature have demonstrated that certain features of city policies in terms of innovation and technological advancements influence the supply and demand for entrepreneurship, thus shifting the equilibrium level of local entrepreneurship [39, p. 3]. This influence led to important determinants of local entrepreneurship. For example, large cities or urban clusters often influence developing economic activities and create a more advanced economic environment [40], [41]. At the same time, the development and digitization of cities reduce the gap between small/medium and large cities by offering a technological environment suitable for developing entrepreneurial activities and innovative firms, as well as promoting and attracting knowledge in the city [42].

Therefore, the development and implementation of online services increasingly customized to the needs of stakeholders will play a fundamental role in the urban landscape of cities. However, the entrepreneurial geography highlight that the clustering of entrepreneurial tech startups tends to be across a relatively small set of global cities and metro areas[43]. Previously, considering the geographical level, only a limited sample of cities could provide more of the key inputs, like online services, technological advancement, innovative policy and a smart environment useful to offer a diverse array of services to end-user such as entrepreneurs and companies that are strongly connected for their innovative and entrepreneurial activities [4], [9], [44].

This gap has been reduced over the years; cities are evolving into a smart perspective over the years. This evolution is mainly present in cities that have started their digitalization process, and technological advancement affects the entrepreneurial environment [45]. Transforming cities is not only a consequence of the demographic shifts associated with the mass urban migration but also of the ability of cities to adapt by exploiting opportunities and available resources, adapting them to an increasingly competitive context.[34], [46], [47]. Today, cities are becoming a container for innovation and entrepreneurial opportunities. The change of recent years, combined with the reorganization of cities in the last decade, allows us to raise the smart city vision in a much broader and more efficient context than the cities, metropolises, and megalopolises considering the business environment. Following this process, digitalization in cities works as a "driver of innovation". The technological advancements in cities are converging paradigms helping to drive entrepreneurship and innovation in urban areas worldwide [48, p. 5].

Despite this growing trend about the relationship between entrepreneurship, innovation and smart cities concerning the role of digitalization, there is still a gap in the scientific relevance of the matter. The literature on that relationship is still embryonic, and the current research results are mainly theoretical.

3 Methodology

3.1 Sample and variable description

Cities are increasingly providing smart services for their users, and this caused a proliferation of technological implementation. This led to profound structural change in cities, modifying at the same time the provision of services and the relationship with users. However, the technological transition toward a smarter city follows different paths and routes according to the plethora of indicators and tools useful to advance this comprehensive phenomenon. To evaluate the smart services advancement in cities, we collected data on a sample of 20 Italian cities over 11 years (2011- January 2022.) Italy represents an ideal context to study the development of smart cities as it is widely treated in academic literature in terms of technological development [49] and smart city implementation [10].

The choice of this sample is motivated by the following 2 reasons. Firstly, the sample of Italian cities is equally distributed on the Italian territory. Therefore, to statistically assess the sample's representativeness and guarantee the sample's heterogeneity, we applied probability-proportional-to-size sampling [50]. Moreover, to consider the economic development of each stratum, we based on the European Commission distinction. This distinction considers the GDP as an economic measure in each city by assessing less-economic developed (<20.000€ per capita), medium development (20.000€ to 40.000) and high development cities (<40.000€). Secondly, it relates to the homogeneity of the identified variables within each city, reducing the risk of inferences or distortions of the data.

Based on these criteria, we identified 20 Italian cities for analysis. We constructed an original database as follows: data has been collected using the "*Wayback Machine*" website (https://archive.org), which allowed us to collect and record backwards online services offered by the municipalities from 2011 to 1 January 2022 throughout the following procedure. Based on the official website of the cities, we (i) identified the online services proposed by the cities, (ii) considered and computed the total number of online services proposed by thematic areas each year (iii) carried out the same procedure backwards in previous years using the previously indicated website.

The variables construction is based on the number of services each city offers in the various categories (i.e. online tourism considers services related to public events, tourist information requests, renting public spaces for events ...) proposed by the city in the specific section of its website. Therefore, most of the services were naturally grouped on the site of each city. However, when this grouping was not present on the website, we distributed the services present in proportion to the sample analyzed.

This data evaluation and retrieval process led to the creation of 10 variables used in the city evaluation process (see. Table 1).

Table 1. Variables description.

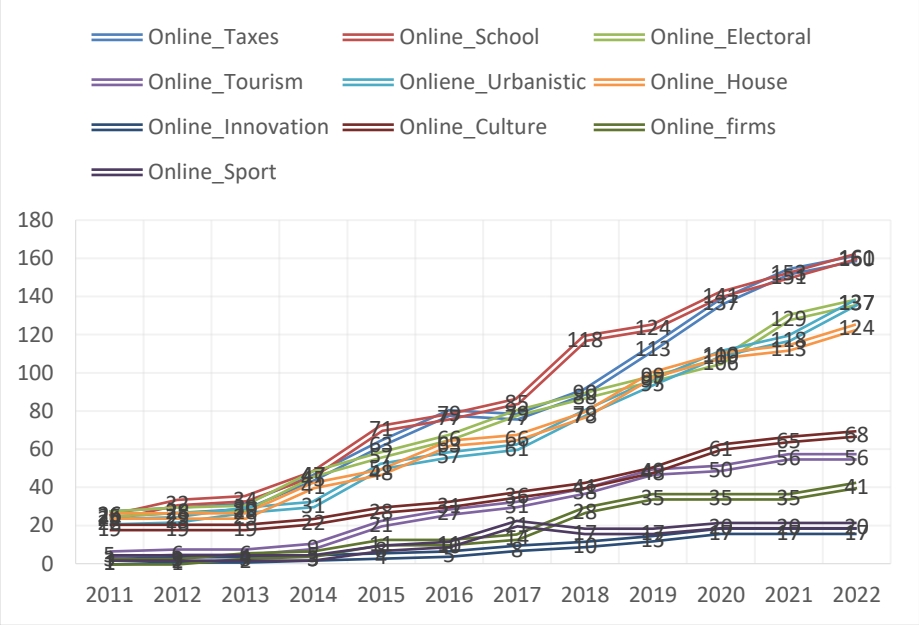
Variable	Description
Online Taxes	Taxes and duties (Fines, Tari, Catering, IMU, Tasi etc.
Online School	Educational services (Scholarships, schools, books, Conventions etc.

Online Electoral	Certification, declarations, corrections, certifications etc.
Online Tourism	Accommodation, events, public spaces, tourist activities etc.
Online Urban Environment	Work in progress, traffic, public land, special services etc.
Online House	Social housing, rental support, requests, certifications, amnesty, SUE, GEBAC etc.
Online Innovation	Wi-Fi, innovation calls, Smart city, IT equipment sale, call for digitalization etc.
Online Culture	Cinema, Libraries, Events, Updated program calendar, cultural events etc.
Online firms	SUAP, Calls, Funds, Youth Entrepreneurship etc.
Online Sport	Sports events, tickets, charity marathons, renting, Baby Camps etc.

Today, scholars and practitioners highlight the role of digitalization and technological advancement in cities [9], as well as the prominent role of digital technologies in the relationship between cities and stakeholders [4]; however, there is still no well-accepted definition of the variables in literature to explain this phenomenon, given the multidisciplinary and the still embryonic development of the phenomenon [13]. Thus, in this study, we focus on the relationship between the digital development of cities and stakeholders by considering specific cities' online services, such as Taxes, School, Electoral, Tourism, Urbanistic, House, Innovation, Firms, Culture, and Sports.

As shown in Figure 1, the implementation of those online services has been spread over the last decades. Today, a large set of online services are concentrated into the *Online Schools*, *Online Taxes*, *Online Urban Environment* and *Online Electoral*, which aim to simplify the bureaucracy for citizens, offer intuitive services and respond promptly to citizens' needs. Those constant evolutions over the years had an impact on the relationship between the city and citizens by improving not only the service offered but also reducing waiting times [17] by producing services more efficient and in line with the current technological development [47]

Figure 1. Variables description.



3.2 Analytical Approach

To assess the development of smart city online services and to investigate how cities introduced and implemented online services over the years, we performed cluster analysis, which aims to cluster cities according to the online services development in two different stages: initial stage (2012) and current situation (2022). Using cluster analysis, we aim to identify groups of cities similar to one another in relation to a large set of online services over the years. Furthermore, this process aims to integrate heterogeneous units in several levels of clusters that tend to be both homogeneous in terms of internal characteristics and mutually comprehensive. In other words, we divided our sample into a limited number of clusters according to the level of "similarity" based on the implementation and development of online services over the years.

Thus, we performed a hierarchical cluster analysis to highlight the evolution in Italy in the last decade, the characteristics of the cities, and how they have changed their trajectories according to different development strategies and policies. In addition, cluster analysis provides a tool to visualize the data structure through a dendrogram (See Figures 2 and 3), highlighting two different clusters expressing two distinct levels of development in 2012 and 2022.

To assess this analytical approach's robustness and validity, we test the statistical significance of the configurations by performing a series of one-way comparisons. Moreover, using the Kruskal-Wallis equality-of-populations rank, we test the configuration among clusters using the discriminating variables.

Finally, to assess the external validity of the proposed configurations, we associate the clusters with four economic indicators that act as a proxy for the entrepreneurial

environment in cities. The set of indicators considered are *New Firms* (number of new companies registered yearly), *Innovative Firms* (number of high-tech startups and spin-offs registered in the city yearly), *Youth Entrepreneurship* (Enterprises founded yearly by entrepreneurs under 30 years) and *Investment R&D* (yearly companies' investments in R&D). These indicators are based on the analysis proposed by the Italian National Statistical Institute (ISTAT) in the annual monitoring. The variables were operationalized on the population of each city and on the total number of companies present in each city to weigh the strength of each variable on our sample's characteristics and ensure the rigour of our results.

4 Results

Using the cluster analysis, we capture the evolution of cities in terms of online services by showing that the implementation of these practices has changed over the years. Specifically, Table 2 shows the characteristics of the Clusters and Figures 2 and 3 show the clustering in 2011 and 2022. Specifically, Table 2 explicitly describes the change over the last decades in the clusters emerging in our analysis which considered cities well developed in terms of online services and still in a transaction.

4.1 Cluster Analysis

The clusters display significant differences in both development and timeline. Specifically, they were highlighted as the most prominent services in cluster analysis in 2011 were the *Online Electoral* ($F = 37.22$, with $p < 0.000$) and *Online House* ($F = 22.23$, with p 0.000), respectively. Services that in 2022 took on less importance to the benefit of customized services for citizens, such as *Online Taxes* ($F = 19.42$, with $p < 0.000$), *Online Tourism* ($F = 33.63$, with $p < 0.001$), *Online School* ($F = 24.32$, with $p < 0.001$) and *Online Firms* ($F = 23.62$, with $p < 0.000$). This highlights how the constant evolution is in line with the current development trends of smart cities moving into a stakeholder-centric perspective, where cities modify and evolve their architecture based on national and international development needs and opportunities [9], [23].

Table 2. Characteristics of the Clusters

	2011			**2022**		
	Cluster 1 (n=14)	**Cluster 2** (n=6)	F-value *or* chi-squared [2] (probability)	**Cluster 1** (n=11)	**Cluster 2** (n=9)	F-value *or* chi-squared [2] (probability)
Taxonomic Variables						
Online Taxes						
Cluster mean	*0.987*	*2.411*	*7.91*	*3.221*	*9.752*	*19.42*

Std.Deviation	*0.631*	*1.631*	*0.008*	*2.891*	*5.342*	*0.000*
Online School						
Cluster mean	*0.528*	*3.454*	*9.22*	*3.768*	*13.325*	*24.32*
Std.Deviation	*0.652*	*1.976*	*0.002*	*2.231*	*6.112*	*0.002*
Online Electoral						
Cluster mean	*0.842*	*3.125*	*37.22*	*3.665*	*9.753*	*3.11*
Std.Deviation	*0.771*	*2.443*	*0.000*	*3.113*	*8.212*	*0.076*
Online Tourism						
Cluster mean	*0.121*	*0.756*	*2.65*	*0.918*	*4.242*	*33.65*
Std.Deviation	*0.198*	*0.881*	*0.082*	*1.764*	*4.535*	*0.000*
Online Urbanistic						
Cluster mean	*0.699*	*2.371*	*6.12*	*4.019*	*10.231*	*11.34*
Std.Deviation	*0.845*	*2.198*	*0.139*	*2.003*	*7.432*	*0.001*
Online House						
Cluster mean	*0.177*	*4.122*	*22.23*	*1.652*	*12.454*	*14.23*
Std.Deviation	*0.334*	*2.454*	*0.000*	*2.719*	*6.219*	*0.002*
Online Innovation						
Cluster mean	*0.000*	*0.191*	*2.324*	*0.716*	*1.442*	*0.77*
Std.Deviation	*0.000*	*0.388*	*0.177*	*1.088*	*1.064*	*0.347*
Online Culture						
Cluster mean	*0.214*	*2.833*	*9.22*	*2.090*	*5.112*	*2.03*
Std.Deviation	*0.425*	*2.224*	*0.019*	*2.221*	*4.255*	*0.162*
Online Firms						
Cluster mean	*0.000*	*0.166*	*2.27*	*0.636*	*3.778*	*23.62*
Std.Deviation	*0.000*	*0.408*	*0.134*	*0.924*	*5.459*	*0.000*
Online Sport						
Cluster mean	*0.000*	*0.641*	*2.27*	*0.909*	*2.275*	*2.75*
Std.Deviation	*0.000*	*0.545*	*0.134*	*0.301*	*3.248*	*0.092*
Predictive variables						
New Firms						
Cluster mean	*8.762*	*9.161*	*1.331*	*8.223*	*9.243*	*3.713*
Std.Deviation	*0.628*	*0.570*	*0.099*	*0.465*	*0.707*	*0.0001*
Innovative Firms						
Cluster mean	*7.248*	*7.974*	*2.029*	*7.192*	*8.309*	*4.777*
Std.Deviation	*0.791*	*0.552*	*0.029*	*0.354*	*0.671*	*0.001*
Youth entrepreneurship						.
Cluster mean	11.039	11.254	1.164	10.911	11.268	2.132

Std.Deviation	0.419	0.245	0.001	0.439	0.218	0.041
Investment R&D						
Cluster mean	12.085	14.445	3.567	12.516	15.032	5.352
Std.Deviation	1.544	0.646	0.003	0.867	0.753	0.001

Cluster means considering the average values of the taxonomic variables for the clusters. F-values represent the continuous variables, and Chi-squared values report the categorical variables

Focusing on the cluster representation of our sample, Figure 2 highlights the situation in 2011, which displays a low level of development of online services, with few cities (mainly located in the north) advanced in the online implementation and others that have not yet started this process in their development plan. Furthermore, Figure 3 shows the current situation (2022) and highlights how although many cities are still behind in this process, other cities have taken this path by eliminating the main gap due to geographical position (see Caserta, Rome and Naples).

Figure 2. Dendrogram for the Cluster Analysis 2011

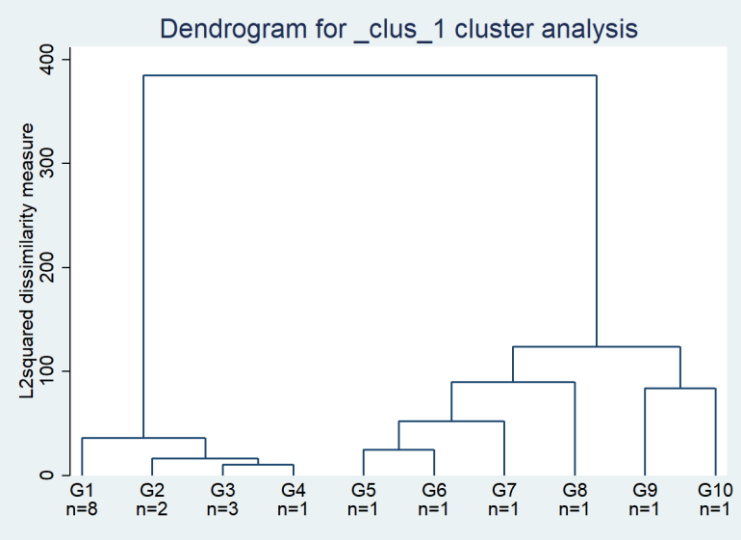


Figure 2 shows that the first cluster groups 14 and the second 6 cities. The cities in the first cluster are those in transition to digitization and online services development. Specifically, G1 highlights the less developed cities in terms of online services (i.e.., Cosenza, Palermo, Salerno, Reggio Calabria, Messina, Lecce, Verona, Bari) and the groups G2 (Genoa and Verona), G3 (Naples, Foggia and Catania) and G4 (Rome) has begun the implementation of online services. Meanwhile, the second cluster highlights how only some cities (i.e., Bergamo, Brescia, Milan, Turin, Florence and Bologna) have started providing online services to their citizens and how these cities are mainly located in northern Italy.

Figure 3. Dendrogram for the Cluster Analysis 2022

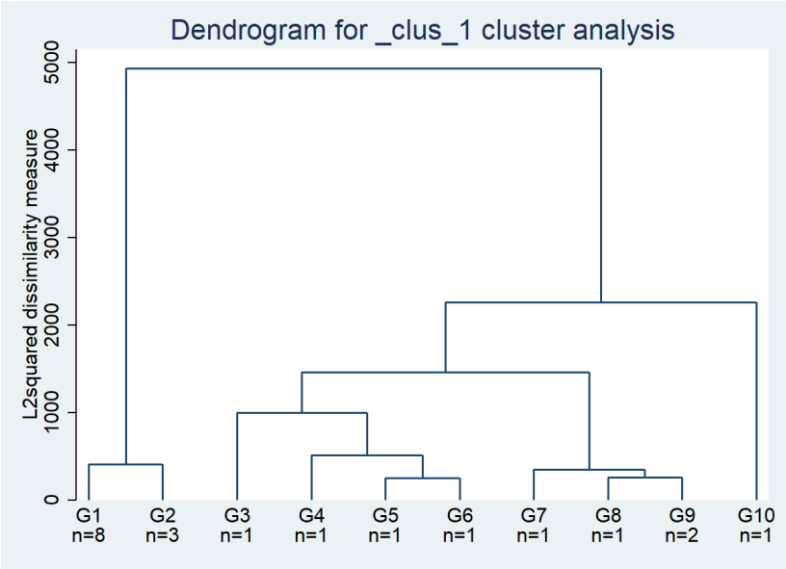


Figure 3 shows the current state of the art, highlighting the cities' evolution in terms of online services as well as the cities' trajectories over the last decade. Specifically, the cluster analysis highlights how the distribution of cities has changed and how, over the years, the geographic influence on the implementation of online services in Italian cities has been reduced. Specifically, although there has been a generalized increase in service implementation, there are still two very distinct clusters. In the first cluster, we highlight the cities further back in the G1 (i.e. Cosenza, Salerno, Palermo, Reggio Calabria, Messina, Verona, Bari and Foggia) and those that are even less developed but are beginning a transformation process in the G2 (Genoa, Catania and Lecce). Meanwhile, the second cluster highlight two clear divisions. The group of cities that initiated this process (i.e., Bergamo, Brescia, Bologna, Turin, Caserta, Florence, Rome and Naples) and the city with the greatest development in the area G10 (Milan). This progress highpoints that southern cities such as Caserta and Naples have taken an important step forward in the implementation of these services and that Milan, currently at the centre of innovative, commercial and financial development in Italy, is the most developed city in terms of online services offered to its users.

4.2 Predictive Validity

Table 2 explicitly describes the two clusters that group cities "in transition" and the cities "developed" in terms of online services implementation in two distinct moments, 2011 and January 2022. Table 3 reports the results of the predictive validity of the clusters for the variables youth entrepreneurship, new firms, innovative firms and Investment in R&D to determine which cluster has more potential to channel the local

entrepreneurial environment and foster innovation. Specifically, Table 2 sheds light on the impact of the two clusters over the years on the entrepreneurial environment in cities.

The results provide evidence of predictive validity, as we found significant differences among the two configurations in the set of variables used to validate clusters and highlight how clusters configuration have changed their relationship with the local ecosystem over the years (2011-2022)

Whilst the two clusters display significant differences in the *New Firms* ($F = 3.713$, with $p < 0.001$) and in *Innovative Firms* ($F = 4.777$, with $p < 0.001$), they display marginal differences in the firm's *R&D Investment* ($F = 2.132$, with $p > 0.041$) and display not equally large differences in the promotion of *Youth Entrepreneurship* in the city over the years ($F = 5.352$, with $p > 0.001$). This leads us to consider three possible directions.

First, the positive value for *New firms* ($F = 3.713$ with $p < 0.001$) and *Innovative Firms* ($F = 4.777$ with $p < 0.001$) in 2021 compared to 2012 (*New firms*, $F = 1.331$ with $p < 0.099$, and *Innovative Firms*, $F = 20.29$ with $p < 0.029$) suggested that over the years the evolution of smart cities is having an impact on the system local entrepreneurial and innovative drive. This result is in line with the theoretical development of smart cities, which increasingly represent a centre of economic, technological and innovative development [51]

Second, we highlight how the impact of smart city development is marginally reduced compared to the drive towards *Youth Entrepreneurship*, reducing the positive difference from 2012 ($F = 1.164$, with $p < 0.001$) to 2022 ($F = 2.132$, with $p < 0.041$). This result highlights that, over the years, the most advanced cities in the implementation of the smart city had an impact on youth entrepreneurship development. However, this value has decreased over the years with the overall growth and development of cities in this perspective.

Third, we highlight how there is a partial difference between the development and implementation of online services and the *R&D Investments* of firms in the city with an increasing trend from 2012 ($F=5.467$, with $p < 0.003$) to 2022 ($F=5.352$, with $p < 0.001$). This result is in line whit the current literature [52] and displays how both cities and firms are currently anchored to the digital revolution that is taking place globally [26].

5 Conclusion and discussion

Although the smart cities' implementation is still ongoing and its development is highly debated, in recent years, it has undoubtedly recorded a remarkable interest for academics, urban planners and policymakers [5], [9], [53] and has progressively become crucial in designing urban policies [8].

For this reason, issues in city evolution from city to smart city have gained attention, and scholars and practitioners have dealt with the influence of the smart transition in relation to users such as citizens and tourists and entrepreneurial environment in terms of firms and innovation [7], [37]. The study explores the evolution over the years of the smart transition in the Italian context, showing how the approach to the smart city has

changed in the last decade. Specifically, if at the beginning of this process (2011), being smart was an advantage for cities in terms of urban development and economic environment, today, a smart city assumes a fundamental role in urban dynamics by becoming a central part of policymakers and governments.

Considering a sample of 20 Italian cities, we identified 2 clusters (cities in transition and developed) in 2011 and 2022. The two clusters have been tested to assess their predictive validity related to the entrepreneurial environment and determine which clusters have better performance. The results suggest that cities in a cluster whit a high development of online services are more sensitive to the business environment showing a positive value in the creation of new firms and influencing the development and promotion of innovative firms in the city compared to the first cluster. At the same time, no distinct differences related to youth entrepreneurship and the local firms' R&D investments in the past decades are highlighted.

These results provide two interesting insights. Firstly, the results show how digital development and online services influence the entrepreneurial environment by promoting new business activities and attracting others based on the services and the technological environment offered. Secondly, it shows that the implementation of smart cities is becoming predominant in the development strategies of cities. As a result, many cities have reshaped their policy over the years to reduce the gap with the more advanced smart cities. Specifically, to date, this smart transition of cities is assuming a central role in the internal dynamics of development. If, in 2011, being smart was an advantage over other cities in terms of planning and services offered, now do not follow this smart transition can be a problem in long-term scenarios. Therefore, it has become imperative to support the local economic context.

Based on these results, this manuscript contributes to the current academic debate about smart city development and the "smart" transition. Specifically, our findings enrich the current debate on the role of digitization in urban architecture and the relationship between users and cities. Furthermore, we contribute to the debate on the relationship between smart cities and the economic environment, highlighting how the "smart" transformation of cities relates to the local economic context to create a favourable local environment for the development of entrepreneurial opportunities.

This research has some limitations. First, due to the nature of the open data and the sources, we focus on 20 Italian cities. Future studies could enrich our analysis using a larger sample of analysis. Second, we focus on one country (Italy), and we are unable to catch country differences, urban development plans and local policies. Third, our analysis is based on online services proposed by the cities as a proxy for the digitalization process. Although online services represent a representative variable of this process, future studies could enrich this dataset by investing in R&D and technological services (Public Wi-Fi, Mobility, App ...) to test our proposed taxonomy. Despite these limitations, which open up new directions for future studies, we believe this research presents important findings that will be useful to policymakers and academics interested in smart city development, digital transformation, online services, and technological advancement in the city.

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