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ECONOMICS
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DETERMINING FACTORS IN BECOMING A SUSTAINABLE SMART CITY: AN EMPIRICAL STUDY IN EUROPE

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ABSTRACT. This paper aims firstly to identify differences and similarities between cities according to the activities which are necessary to become a smart city and secondly to identify relevant factors that could influence positions in the smart cities ranking. To achieve these goals, this study uses a quantitative analysis applied to 73 European cities to identify the factors that influence differences between smart cities. The results suggest the formation of clusters around European smart cities and also that cities located geographically in the west of Europe and with governance by women present higher levels in the European Smart Cities rankings.

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Introduction

Cities around the world are registering rapid growth, which implies improvements in the quality of life and improvements in the efficiency of city administration activities (Karyy & Knjazevska, 2008). In this context, studies on smart cities around the world have become more popular in recent years (Abdala et al., 2014). National and international organizations have developed studies in order to define smart cities and to create and apply relevant indicators to measure them. Several studies suggest that these cities reveal higher values in the indicators for measuring and classifying smart cities.

The importance of the relationship between sustainable smart cities and the factors fpr their development in the business world has increased in recent years. Regional development is based on the dynamics of creative and intelligent territories, where different partners intervene in a collaborative way, creating conditions that contribute to an improvement in the state of living, the economy, mobility, job creation, regional competitiveness and other benefits. Intelligent cities work in networks to promote political and social efficiency, which allows social, cultural and urban development in the territory (Carvalho, 2017) and also make use of digital tools and ICT (Lee et al., 2013; Walravens, 2012). Smart cities generate various business opportunities and possibilities for collaboration between the public and private sectors. All stakeholders can contribute by creating a network with public organizations, institutions, governments, universities, experts, research centres, etc. A smart city is linked to some components which are related to a set of aspects of urban life (Lombardi et al, 2012):

- smart economy: industry
- smart people: education
- smart governance: e-democracy
- smart mobility: logistics and infrastructures
- smart environment: efficiency and sustainability
- smart living: security and quality

In these times, cities are urban spaces that face challenges and opportunities (Washburn et al., 2010; Carvalho, 2017). According to UNEP (2011), cities account for 50% of the world's population. They contribute to 60%-80% of the energy consumed, 75% of the carbon emitted and give rise to inequalities and social exclusion. The UNO (2012) forecasts a population growth from 7 to 9 billion by 2040, especially in developing countries. However, cities are regional spaces that promote innovation, knowledge and creativity. The biggest cities in the world will manage 60% of the world's GDP in 2025 (McKinsey, 2011). Consequently, it is imperative to develop and adjust urban models attending to demographic, economic, social and environmental constraints (Hammer et al., 2011; Turcu, 2013).

Over recent decades, national and international organizations have produced studies focusing on the definition, creation and use of indicators for the measurement and benchmarking of smart cities. Moreover, several approaches, aims and methodologies can be found to diagnose and rank smart cities. Most of the literature reports that these cities reveal high values in the indicators created to measure and rank intelligent cities (Giffinger et al., 2007). In this context, this study aims to identify which factors influence the development of sustainable smart cities. This study is important because empirical academic studies on smart cities are still underexplored and have not addressed this perspective.

The objective of this study is to analyse the factors that influence the development of sustainable smart cities. More specifically, we present descriptive and stylised evidence on factors that evidence differences across smart cities in Europe, using multivariate analysis. After that, we discuss which clusters are likely to persist given the complementarities among different factors. The empirical study investigates factors that influence the development of sustainable

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smart cities in Europe. We conducted our empirical study in European smart cities because the European Union highlights the importance of smart cities to the economy and to sustainable development. The EU's 2020 objectives include developing and redeveloping smart, sustainable and inclusive cities and communities in Europe (European Union, 2014).

We used the data from the IESE Cities in Motion Index 2017 (CIMI) developed by the IESE Business School (Berrone & Ricart, 2017). The CIMI has developed an empirically validated conceptual model which assesses cities in 10 key dimensions: the economy, human capital, technology, the environment, international outreach, social cohesion, mobility and transportation, governance, urban planning and public management. All the indicators are linked to a strategic aim that leads to a novel form of local economic development: the creation of a global city and the promotion of entrepreneurial spirit and innovation, among others. Our final sample is composed by 73 European cities ranked by the IESE Cities in Motion Index 2017.

We focus on the cluster analyses used by previous empirical studies such as Mar and Serrano (2001), Pérez (2001), Pardo and Ruíz (2005), Navarro et al. (2010) and Nevado and Gallardo (2016), applying the most appropriate method to obtain more interpretable information. Our results demonstrate that there are robust institutional clusters around European smart cities. We discuss whether these clusters are likely to persist given the complementarities among different factors. Analysis of the factors that influence the development of sustainable smart cities is in a relatively early phase of development and our study makes several contributions to the literature addressing regional development and smart cities.

This study makes several contributions to the literature. Principally, it contributes to and understanding of the factors that influence the development of sustainable smart cities in the European context.

The remainder of the paper is organized as follows. The next section reviews the previous literature on and regional development of smart cities and presents our hypotheses. In the third section, we describe the data and research method. The fourth section presents the results of the descriptive analysis and cluster analysis. The work concludes by outlining the main aspects of current problems and future challenges of smart cities.

1. Literature review

1.1. Smart cities

As far as the definition for "smart city" is concerned, there is no universally accepted definition and some authors have registered a "lack of definitorial precision" (Hollands, 2008). Cities use this discrepancy and try to self-define as smart cities (Hollands, 2008; Caragliu et al., 2011; Tranos and Gertner, 2012). Early research suggests that a smart city is "the urban center of the future, made safe, secure environmentally green, and efficient because all structures – whether for power, water, transportation, etc. are designed, built and maintained making use of advanced and integrated materials, sensors, electronics, and networks which are interfaced with computerized systems" (Hall, 2000, p. 1).

Komninos (2006) related the definition of the smart city to knowledge and learning, stressing the potential for knowledge creation using digital infrastructures. Smart cities are "Territories with high capacity for learning and innovation, which are built on the creativity of their population, their institutions of knowledge creation, and their digital infrastructures for communication and knowledge management" (Komninos, 2006, p. 6). Giffinger et al. (2007, p. 11) related smart cities to six characteristics, supported on the smart combinations of

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endowments (a smart economy, smart mobility, smart environment, smart people, smart living and smart governance).

Hollands (2008) argued that smart cities are based on the utilization of networks to promote economic and political efficiency and to allow social, cultural and urban development. Caragliu et al. (2011) proposed that for a city to become smart, it must invest in human and social capital, traditional and modern information and communication technologies (ICT) and communication infrastructure, and must fuel sustainable economic growth and a high quality of life, with careful management of natural resources through participatory governance.

According to Carvalho (2017), a smart city is a smart regional ecosystem that includes various interconnected stakeholders that develop collaborative networks (firms, citizens, public organizations, cultural, economic and social infrastructures) to create an open and creative environment which is useful for improving the population's quality of life and for developing smart and innovative businesses and social projects. These regions present high standards regarding indicators associated with innovation, creativity, environment, quality of life, entrepreneurial activities and support facilities.

In general, the eclectic smart city concept includes not only infrastructures but also human and social factors (Aguilera et al., 2013). Nevertheless, as stated above, there is no consensual definition for this concept (Al Nuaimi et al., 2015) and the literature in general explores dimensions that influence cities' characteristics, as can be seen in *Table 1*.

Table 1. Smart cities dimensions

Dimension	Authors
ICT (use and availability)	Bakici et al., 2013; Caragliu et al., 2011; Hollands, 2008; Komninos, 2002; Thite, 2011; Tranos and Gertner, 2012.
Entrepreneurial ecosystems (entrepreneurial activities and business creation)	Carvalho, 2016; Gottdiener, 2001; Klein, 2000; Monbiot, 2000; Hollands, 2008; Lombardi et al., 2012; Thite, 2011; Lucas et al, 2017.
E-government and resident inclusion	Bakici et al., 2013; Caragliu et al., 2011; Hollands, 2008; Schaffers et al., 2011; Bernardo, 2017.
Creative industries and high tech	Hollands, 2008; Florida, 2002; Winters, 2011
Human capital and community	Bolisani and Scarso, 2000; Kourtit et al., 2012; Albuquerque, 2017.
Social capital and relationships	Coe et al., 2001; Kourtit et al., 2012.
Social and environmental sustainability	Caragliu et al., 2011; Nathan, 2013; Sen et al., 2012; Shafiullah et al., 2013; Sivaram et al., 2013.; Strielkowski, 2017

Source: *Carvalho, 2017, adapted*

Previous literature has explored dimensions that affect the characteristics of smart cities: the economy, human capital, technology, the environment, international outreach, social cohesion, mobility and transportation, governance, urban planning and public management (Berrone & Ricart, 2017). However, it must be said that the determinants of the status quo of smart cities have been analysed to a lesser extent. In this sense, one of the approaches which is most often employed is to determine the factors that could also affect the development of smart cities.

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1.2. Regional development and geography of smart cities

The use of the term smart is connected to city and regional development (Dierwechter, 2017). In fact, smart growth is associated with a regional dimension. According to Dierwechter et al. (2017), "municipal borders should not hamper the search for sustainable development. Rather, regional cooperation between large cities and their suburbs and smaller towns, especially around curbing suburban sprawl, promoting public transport alternatives, and facilitating quality urban infill and creative densification, requires effective joint thinking and new forms of decision-making and civic trust". This perspective suggests that political and planning decisions are made at the regional scale (or city-regional level), raising the key question of governance. Governance implies collaboration, negotiation and deliberation among multiple actors, seeking to find mutually beneficial answers to complex problems (Herrschel & Dierwechter, 2015; Hudalah, Zulfahmi & Firman, 2013).

The study of smart cities assumes a regional dimension that justifies the application of empirical studies in a delimited geographic space, such as Europe. And why should smart cities in Europe be studied? According to the European Parliament (2014) in 2011, 240 of the 468 EU-28 cities with at least 100,000 inhabitants (51% of the total) had at least one smart city characteristic and can therefore be classed as smart cities. The highest absolute number of smart cities is found in the UK, Spain and Italy; the countries with the highest proportion of smart cities are Italy, Austria, Denmark, Norway, Sweden, Estonia and Slovenia. Most smart city initiatives are still in the early phases of development, but larger cities tend to be the most mature (with at least one fully launched or implemented initiative). Based on the arguments outlined above, we test the following hypothesis:

H1: There is a significant relationship between the smart level of cities and the region to which they belong.

1.3. Leadership and gender of smart cities

The literature highlights the importance of governance in the achievement of the requisites for becoming a smart city. According to Mosher (1982), organizations will be more responsive to the public if they reflect the demographic characteristics of those they serve. Management literature on gender suggests some differences between the styles of women and men (Duflo, 2012).

Recent regulations echo the concern that discrimination may exist in access to boards, leading to inefficient use of the talent pool. Thus, they recommend increasing the number of female directors on governance boards. Several of these legislations explicitly argue that gender diversity improves the effectiveness of the council. However, emerging literature questions the view that female directors behave differently from their male colleagues (see, for example, Adams and Funk, 2012) and calls for research on the role of women in governance.

Previous literature suggests that male and female local councillors agree that women are more responsive to their constituencies (Beck, 2001); female mayors encourage citizens' participation, communication, and input more than men in that position (Fox & Schuhmann, 1999). The increase in numbers of women in formal political representation, as council members or as mayors in municipalities, has influenced the structure of power and the functioning of municipalities in Spain (Araujo & Tejedo-Romero, 2017). Nevertheless, studies on leadership and gender in municipalities of smart cities still are in their infancy. Based on the arguments outlined above, we test the following hypothesis:

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H2: There is a significant relationship between the smart level of cities and the gender of the person governing.

1.4. Political ideologies and smart cities

Previous literature claims that certain political ideologies are more favourable to influencing sustainable policies and consequently the development of smart cities (Steurer & Hametrer, 2010; García-Sánchez & Prado-Lorenzo, 2008; Nam & Pardo, 2011). Nam and Pardo (2011) underline the key components of a smart city, which are technology, people (creativity, diversity, and education), and institutions (governance and policy). Connections exist between these latter two components and smart cities, so that a city is really smart when investments in human and social capital, together with information and communications technology (ICT) infrastructures, fuel sustainable growth and enhance the quality of life. The point of view of this study is that the smart city must provide some sort of interoperable and Internet-based government services that enable ubiquitous connectivity and transform key government processes towards citizens and businesses.

Public choice theory, developed by Mueller (1979, 1989), states that a complex political environment in which voters, interest groups and politicians play an important role in government decisions to adopt particular policies in general influences certain plans in the development of smart cities, in particular. Politicians play the role of agents appointed through an electoral process and always act in order to maximize the number of votes they expect to receive in the next election. According to Bavetta and Padocano (2000), politicians select an amount of resources and agents' time to provide policies to voters in exchange for votes, and to interest groups in exchange for resources, insofar as these can be reinvested to affect electoral outcomes.

Batty et al. (2012) point out that intelligent governance is an attribute that is associated with the governmental management of a city only when the city promotes itself as intelligent. Alkandari et al. (2012) indicate that the government should approve the development of the smart city and prioritize some areas, and Winters (2011) argues that urban governments should only promote higher education centres in order to develop smart cities. Finally, Nam and Pardo (2011) emphasize that smart governance is about promoting smart city initiatives.

Moreover, Smith and Fridkin (2008) argue that interparty competition plays a key role in the decision of politicians to devolve institutional power to citizens to a greater or lesser extent so that they have to pay attention to the demands of their constituents. Good governance and good policies can result in strong interactions at the urban level, while focusing on smart collaboration can result in more attention to collaboration issues than actually making things work. The question of what political ideology (for example, conservative or progressive parties) is more effective and more legitimate is an current issue. Anderson and Mizak (2006) relate that the main predictor of a vote for pro-environmental law is whether the American legislator is a liberal (left-wing) Democrat. In this sense, in Spain, Prado-Lorenzo et al. (2011) show that political competition improves cities' sustainability, while a leftist ideology has an inverse impact. Based on the arguments outlined above, we test the following hypothesis:

H3: There is a significant relationship between the smart level of cities and the political ideology of the rulers.

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2. Methodological approach

2.1. Sample and data

The selected population consists of 73 European cities whose smart city levels for the year 2017 were studied and classified by the IESE Business School; this is one of the most important business schools in the world and has been publishing an index of cities in recent years. Objective, exhaustive, broad and guided by the criteria of conceptual relevance and statistical rigour, the 2017 edition of the CIMI includes 180 cities, 73 of them capitals, representing 80 countries. The breadth of the project establishes the CIMI as one of the city indexes with the widest geographical coverage available at present. In addition, to calculate the index, the authors included 79 indicators that provide a complete overview of each city. Frameworks such as the Smart Cities Wheel (Cohen, 2017) and the European Smart Cities Ranking (Giffinger et al., 2007) have been developed to enable the comparison of cities and to assess cities' development in the desired direction. Other smart city performance assessment systems have been presented, for example by Albino et al. (2015), Lazaroiu and Roscia (2012), and Ahvenniemi, Huovila, Pinto-Seppä, and Airaksinen (2017).

The CIMI has empirically validated the conceptual model developed from 79 indicators that provide a complete vision of each city, grouped into 10 key dimensions to determine efficiency: economy, human capital, technology, environment, international impact, social cohesion, mobility and transport, governance, urban planning and public management. All the indicators are linked to a strategic objective that leads to a new form of local economic development: the creation of a global city and the promotion of entrepreneurial spirit and innovation, among others. In *Annex I*, the scores of the cities included in the ranking and their positions are listed according to the 10 dimensions evaluated.

2.2. Method

The objective of this study is to analyse the factors that influence the development of sustainable smart cities. More specifically, in the first place we intend to identify possible similarities or differences between the cities of the sample in terms of their results as smart cities in relation to the ten dimensions established by the CIMI. For this purpose, a cluster analysis used in numerous studies, such as Mar and Serrano (2001), Pérez (2001), Pardo and Ruíz (2005), Navarro, Alcaraz and Ortiz (2010) and Nevado and Gallardo (2016), among others, was applied, was applied with variables to segment the positions of each of the ten dimensions. A hierarchical cluster was considered the best method to determine the optimum number of clusters in the data (Vilá, Hurtado, Berlanga and Fonseca, 2014).

Subsequently, in order to contrast the possible association or independence between the proposed factors (region, gender and political ideology) and the smart city levels resulting from the cluster analysis, contingency tables are used, due to the nature of the variables to contrast – in our case, qualitative. All estimates are made using SPSS software, version 20.

3. Conducting research and results

Once the cluster analysis had been applied, in order to classify the cities according to the similarities and differences with respect to their smart city levels, three conglomerates were identified, which we called "High Level", "Medium Level" and "Low Level". Later, in order to verify that there are significant differences between the clusters obtained, an analysis of variance (ANOVA) was carried out. *Table 2* demonstrates that the probabilities associated with

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the "F" statistic are zero for the ten dimensions, so we can confirm that there are statistically significant differences between the groups.

Table 2. Analysis of variance

	Sum of squares	gl	Quadratic media	F	Sig.
Economy	51279.355	2	25639.677	34.336	0.000
Human capital	2672.431	2	13360.215	12.774	0.000
Social cohesion	68081.381	2	34040.691	34.971	0.000
Environment	33098.114	2	16549.057	21.573	0.000
Public management	60153.908	2	30076.954	31.105	0.000
Governance	76080.241	2	38040.121	42.925	0.000
Urban planning	60203.071	2	30101.536	42.648	0.000
International impact	65983.561	2	32991.780	24.074	0.000
Technology	50138.104	2	25069.052	25.813	0.000
Mobility and transportation	52318.160	2	26159.080	17.120	0.000

Source: *own compilation*

In *Annex II*, the cities grouped in the different clusters obtained are presented. *Graph 1* shows the behaviour of the clusters in relation to the average of the positions of the 10 dimensions. As can be seen, the cluster called "High Level" includes those cities that stand out favourably for reaching the best positions in the ranking. At the other extreme is the "Low Level" cluster, which includes those cities that obtained the least favourable positions in the ranking. The rest of the cities constitute the "Medium Level" cluster with intermediate positions.
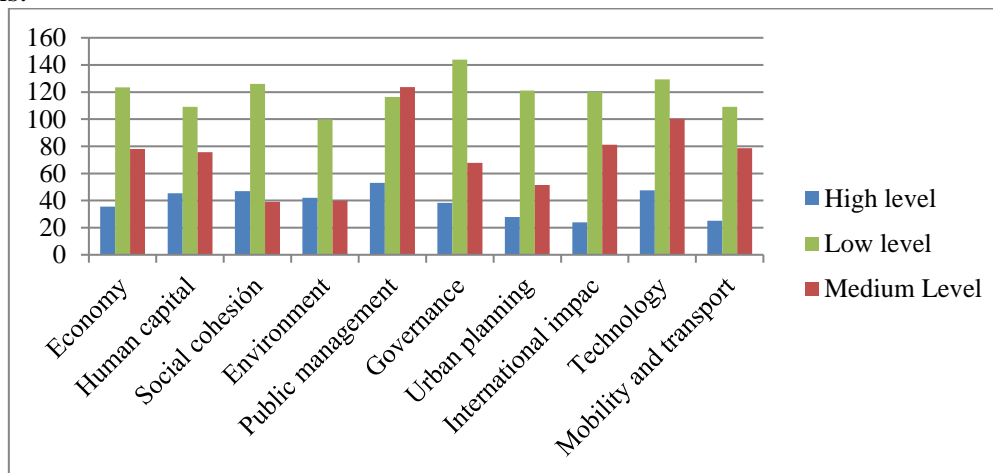
Graph 1. Distribution of means of the total ranking of smart cities (hierarchical procedure)
Source: *own data*

Secondly, once the clusters were formed, we proceeded to the analysis of the possible factors that affect the different levels of smart cities. *Table 3* demonstrates the results of our analysis to test the first hypothesis of our study. In the first place, regarding the variable "geographic location" (*Table 3*), it can be observed that 21.9% of European cities have the highest smart city levels. All these cities belong to the western region. The average levels account for 63% of the cities in our sample, with the highest percentage (68.6%) for the cities in the western region. Finally, 15.1% of European cities obtain the lowest smart city levels, all concentrated in the eastern region. A priori, a relationship can be seen between the variables. To verify this relationship, Pearson's chi-squared statistic was calculated, which yields a value

of 33.24 with an associated probability of 0.000, less than 0.01. We can affirm, therefore, with a level of confidence of 99%, that there is a significant relationship between smart city levels and the region to which the European cities belong, thus confirming hypothesis *H1*. These results are consistent with the literature since, as mentioned above, it identifies Western Europe as being more prosperous and more industrialized than Eastern.

Table 3. Contingency Tables Smart City Levels * Region

			Region		Total
			West	East	
Smart City Level	High	Count	16	0	16
		% by region	31.4%	0.0%	21.9%
	Medium	Count	35	11	46
		% by region	68.6%	50.0%	63.0%
	Low	Count	0	11	11
		% by region	0.0%	50.0%	15.1%
Total		Count	51	22	73
		% by region	100.0%	100.0%	100.0%

Source: *own compilation*

Table 4 demonstrates the results of our analysis to test the second hypothesis of our study. For the variable "gender", the results reveal higher percentages of cities governed by women (28.6% compared to 19.2% of those governed by men) in the European cities that obtain the highest smart city levels. The same occurs with the cities that obtain average levels (71.4% of cities governed by women as opposed to 59.6% of those governed by men). On the other hand, all cities that obtain the lowest levels of smart cities are governed by men. Given the value of chi-squared (0.369) and its associated probability (0.068), we can say with 90% confidence level that the gender variable is related to smart city levels in European cities, so hypothesis *H2* should not be rejected. Although the literature suggests some differences between men and women in governance, studies on leadership and gender in smart cities are still in their early stages. That is why this study provides relevant and novel information on one of the factors that favour the development of smart cities: the gender of the governor.

Table 4. Smart city Contingency levels' * Gender

			Gender		Total
			Man	Woman	
Level of the Smart Cities	High	Count	10	6	16
		% by gender	19.2%	28.6%	21.9%
	Medium	Count	31	15	46
		% by gender	59.6%	71.4%	63.0%
	Low	Count	11	0	11
		% by gender	21.2%	0.0%	15.1%
Total		Count	Count	21	73
		% by gender	% by gender	100.0%	100.0%

Source: *own compilation*

Finally, *Table 5* demonstrates the results of our analysis to test the third hypothesis of our study. Regarding the variable "political ideology", no significant differences are observed between the cities governed by conservative or progressive parties, so this variable does not

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seem to be significant for our model and sample. The calculated statistic (chi-squared = 0.077) and its associated probability (0.962) indicate that the contrasted variable is not associated with smart city levels, which leads us to reject the proposed hypothesis *H3*. However, these results are contradictory to the works of other authors such as Prado-Lorenzo et al. (2011) and Anderson and Mizak (2006), who obtained evidence that the political ideology of the governing parties affected the sustainability of cities. Specifically, they concluded that a leftist ideology negatively affects the development of cities.

Table 5. Contingency Smart Cities levels * Political ideology

			Political ideology			Total
			Conservative	Progressive/Liberal	Independent	
Smart City Level	High	Count	8	8	0	16
		% by political ideology	22.9%	23.5%	0.0%	21.9%
	Medium	Count	23	21	2	46
		% by political ideology	65.7%	61.8%	50.0%	63.0%
	Low	Count	4	5	2	11
		% by political ideology	11.4%	14.7%	50.0%	15.1%
Total		Count	Count	34	4	73
		% by political ideology	% by political ideology	100.0%	100.0%	100.0%

Source: *own compilation*

Conclusion

This work allowed us to obtain empirical evidence and contribute to the generation of knowledge about smart cities, which is important given the lack of research with this orientation so far. Thus an existing void in the academic literature is filled, since the analysis of the factors that influence the development of smart cities is at a relatively early stage of development and the study of it is considered as necessary and of interest.

To do this, based on the values of the CIMI developed by IESE Business School, the similarities and differences between 73 European cities were analysed in terms of their economy, human capital, technology, environment, international impact, social cohesion, mobility and transport, governance, urban planning and public management, obtaining three clearly differentiated groups: a first group of cities that obtain the highest smart city levels, a second group of cities with medium levels and a third group that present the lowest levels.

Regarding the analysis of the associated factors, evidence was found showing that smart city levels are related to the geographical location of the cities and the gender of the governors. However, it was not possible to ascertain any type of association with the political ideology of the governing team. We can conclude, therefore, that those cities located in the western region obtain better results as smart cities. The same applies to cities governed by women, which achieve the best results in the smart cities ranking. Finally, whether the representatives of the government of the cities have conservative or progressive ideologies does not seem to be determinant for the cities to reach high positions in the ranking.

Smart cities have raised many questions which remain unsolved at the moment. One key question is the role of governments in these cities (Rodríguez-Bolívar, 2015). Prior research has no definitive conclusions about these questions. In fact, experiences around the world seem

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to indicate that each smart city has been developed according to its own characteristics and environment. So what are the developmental factors for becoming smart? Do governments have to be forced to follow guidelines to achieve these goals? Previous research has indicated that the transformation process will only be achieved with better governance and its particular features such as leadership, gender and political ideologies (Araujo & Tejedo-Romero, 2017; Prado-Lorenzo et al., 2011). The idea of intelligent city governance fits well in the public management perspective, which highlights that the solution of social problems is not only a matter of developing good policies, but is much more a managerial issue of organizing strong collaborations between government and other stakeholders (Torfing et al., 2012). In fact, it is important to explore the factors based on smart and sustainable urban initiatives in the long term.

In addition, the environment is a key factor for smart cities. Thus, the regional and transnational location of cities is a relevant factor for the construction of dense and diversified relations of economic networks. It is also important to note that government administrations are key actors in the governance process. These should stimulate investment and focus on the development and implementation of policies that foster smart and sustainable development.

Finally, this study suggests some clues for future research, such as analysis of the reasons and motivations that may lead cities to obtain high smart city levels and studies on governance and influence of the leadership in local administration.

Funding

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Annex I. *Cities in Motion Index* (CIMI) Ranking

Ciudad	CIMI	Economy	Human capital	Social cohesion	Environment	Public management	Governance	Urban planning	International impact	Technology	Mobility and transport
London-United Kingdom	98.71	4	1	105	35	34	23	22	2	23	1
Paris-France	91.97	11	7	86	20	45	42	8	1	25	5
Berlin-Germany	83.40	54	23	10	11	42	33	7	10	63	8
Amsterdam-Netherlands	82.86	32	34	26	95	56	31	1	7	6	20
Zurich-Switzerland	82.51	18	78	2	1	24	25	32	48	75	80
Vienna-Austria	81.94	46	42	12	3	87	36	19	14	46	9
Sydney-Australia	81.14	17	37	58	30	16	37	20	33	24	71
Geneva-Switzerland	81.14	25	105	14	55	1	64	4	46	33	58
Munich-Germany	80.71	35	33	8	18	61	32	11	34	34	10
Stockholm-Sweden	77.76	24	75	54	4	81	30	66	37	55	7
Oslo-Norway	77.75	20	20	21	22	96	77	3	58	72	18
Copenhagen-Denmark	77.56	31	31	6	41	162	17	29	27	53	17
Madrid-Spain	77.00	57	43	66	52	50	48	31	15	59	6
Helsinki-Finland	76.91	42	62	1	29	117	10	33	63	52	28
Dublin-Ireland	74.47	22	77	64	70	52	21	65	24	89	54
Hamburg-Germany	74.20	47	36	18	47	70	27	23	79	85	24
Barcelona-Spain	74.10	77	39	72	84	67	35	43	4	64	26
Frankfurt-Germany	74.03	41	29	56	59	80	41	49	54	58	3
Milan-Italy	73.66	56	35	71	46	69	79	14	23	61	15
Glasgow-United Kingdom	73.18	53	40	16	57	91	18	52	93	48	59
Brussels-Belgium	72.89	49	68	47	89	84	34	53	30	45	30
Prague-Czech Republic	71.87	93	73	5	14	114	114	21	16	105	67
Rome-Italy	71.64	78	41	115	36	60	89	16	9	60	65
Stuttgart-Germany	70.83	45	70	3	33	119	59	28	124	110	52
Linz-Austria	70.22	55	24	27	5	163	40	61	28	71	161
Basel-Switzerland	70.13	34	101	4	68	37	62	57	119	146	53
Florence-Italy	70.02	98	65	15	31	100	58	17	26	96	126
Lyon-France	70.00	64	47	24	23	94	86	39	90	65	50
Málaga-Spain	69.71	123	134	35	51	116	56	62	13	76	45
Lisbon-Portugal	69.42	71	99	60	44	92	39	58	22	86	110
Tallinn-Estonia	69.25	63	69	9	2	126	102	74	62	87	101
Warsaw-Poland	68.96	95	59	29	16	142	93	6	83	70	41
Liverpool-United Kingdom	68.77	50	52	20	21	128	16	91	110	149	72
Manchester-United Kingdom	68.59	52	25	37	73	63	22	76	103	100	125
Eindhoven-Netherlands	68.55	62	94	36	81	156	38	18	87	31	109
Rotterdam-Netherlands	68.26	60	61	30	71	120	53	9	111	93	106
Cologne-Germany	67.81	59	57	48	67	138	66	56	53	112	27
Turin-Italy	67.53	103	109	80	17	139	50	12	92	99	32
Birmingham-United Kingdom	67.10	48	30	31	75	133	9	98	153	143	70
Valencia-Spain	66.83	111	126	39	45	105	60	54	80	78	34
Antwerp-Belgium	66.51	72	95	7	40	127	47	26	135	153	107
Budapest-Hungary	65.93	105	45	73	72	158	81	48	32	92	25
Seville-Spain	65.88	118	130	45	50	130	43	59	65	69	64
Nottingham-United Kingdom	65.82	61	50	25	24	168	22	85	158	128	87
Ljubljana-Slovenia	65.58	102	86	23	9	124	88	79	117	94	75
Vilnius-Lithuania	65.44	83	64	38	7	135	105	72	99	106	88
Marseille-France	65.27	73	63	83	54	111	82	42	106	97	47
Nice-France	65.00	80	72	19	27	129	101	60	51	171	79
Bilbao-Spain	65.00	99	88	52	49	153	45	77	75	145	35
Leeds-United Kingdom	64.70	58	48	22	25	152	14	84	168	138	164
Bratislava-Slovakia	64.61	74	79	13	66	118	130	40	101	88	120
A Coruña-Spain	64.35	114	143	57	48	166	90	38	35	80	84
Lille-France	64.10	88	80	50	56	146	75	68	67	133	69
Riga-Latvia	63.67	65	74	33	26	99	111	120	78	126	78
Zagreb-Croatia	63.22	121	100	51	6	150	84	92	107	111	94
Gothenburg-Sweden	61.85	37	84	55	12	154	80	90	125	127	146

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Sofia-Bulgaria	61.57	144	66	69	13	90	135	71	118	101	105
Naples-Italy	60.99	128	117	85	69	131	97	37	91	95	83
Athens-Greece	60.90	115	67	160	99	95	95	25	39	98	46
Wrocław-Poland	60.64	127	123	68	19	169	108	10	105	68	155
Duisburg-Germany	59.85	76	133	43	63	147	92	80	104	142	132
Porto-Portugal	59.10	91	151	17	32	151	133	73	55	161	145
Istanbul-Turkey	57.39	92	136	152	134	68	159	87	6	54	124
Bucharest-Romania	56.10	120	83	77	148	62	115	99	88	109	76
Kiev-Ukraine	53.02	132	58	149	97	98	143	111	149	154	31
Belgrade-Serbia	52.11	149	111	122	98	103	128	110	100	91	136
Tbilisi-Georgia	51.89	117	120	106	61	132	131	109	142	136	166
Minsk-Belarus	51.72	101	82	88	64	141	168	155	159	164	86
Sarajevo-Bosnia-Herzegovina	49.88	179	106	148	74	171	125	112	126	130	62
Skopje-Macedonia	47.21	116	168	151	43	112	142	117	140	162	176
Baku-Azerbaijan	47.08	104	89	166	122	143	163	138	155	121	73
Ankara-Turkey	46.76	119	131	136	142	78	154	137	144	134	140
Bursa-Turkey	44.91	130	115	91	116	173	156	157	113	169	131

Annex II. Cities included in the different clusters

High Level of Smart City	Medium Level of Smart City		Low Level of Smart City
London-United Kingdom	Oslo-Norway	Kingdom	Istanbul-Turkey
Paris-France	Copenhagen-Denmark	Valencia-Spain	Bucharest-Romania
Berlin-Germany	Helsinki-Finland	Antwerp-Belgium	Kiev-Ukraine
Amsterdam-Netherlands	Hamburg-Germany	Budapest-Hungary	Belgrade-Serbia
Zurich-Switzerland	Glasgow-United Kingdom	Seville-Spain	Tbilisi-Georgia
Vienna-Austria	Prague-Czech Republic	Nottingham-United Kingdom	Minsk-Belarus
Sydney-Australia	Rome-Italy	Ljubljana-Slovenia	Sarajevo-Bosnia-Herzegovina
Geneva-Switzerland	Stuttgart-Germany	Vilnius-Lithuania	Skopje-Macedonia
Munich-Germany	Linz-Austria	Marseille-France	Baku-Azerbaijan
Stockholm-Sweden	Basel-Switzerland	Nice-France	Ankara-Turkey
Madrid-Spain	Florence-Italy	Bilbao-Spain	Bursa-Turkey
Dublin-Ireland	Lyon-France	Leeds-United Kingdom	
Barcelona-Spain	Málaga-Spain	Bratislava-Slovakia	
Frankfurt-Germany	Lisbon-Portugal	A Coruña-Spain	
Milan-Italy	Tallinn-Estonia	Lille-France	
Brussels-Belgium	Warsaw-Poland	Riga-Latvia	
	Liverpool-United Kingdom	Zagreb-Croatia	
	Manchester-United Kingdom	Gothenburg-Sweden	
	Eindhoven-Netherlands	Sofia-Bulgaria	
	Rotterdam-Netherlands	Naples-Italy	
	Cologne-Germany	Athens-Greece	
	Turin-Italy	Wrocław-Poland	
	Birmingham-United	Duisburg-Germany	
		Porto-Portugal	