UNIVERSIDADE DA BEIRA INTERIOR
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NETWORKS AND MEASURING THE PERFORMANCE IN CURRENT CREATIVE CITIES
A HOLISTIC PERSPECTIVE

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Tese para obtenção do Grau de Doutor em
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Orientador: Professor Doutor Mário José Baptista Franco

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Dedication

To Pedro, life partner of always and forever.

My two loves, Filipa and Marta, by your resilience.

Acknowledgements

Somewhere in time, I realized that only when you put love in the pursuit of a challenge can it be tackled. One of these challenges was to return to the academic life, with all the nuances that this implied. These nuances were surpassed with the support of all the doctoral professors, whom I have to thank for always believing in the success of this whole course, particularly to Professor Maria do Céu Alves and Professor Mário Franco.

At the beginning of this course, the topics to be investigated were open and scattered. However, an invitation to write an article on urban entrepreneurship aroused an interest which led to the study presented here. So, first of all I would like to thank my counselor Professor Mário Franco for having accredited my competences to do this, whose article is part of this research. I would also like to offer special praise to my supervisor for his absolute support in all circumstances of the research process, which was the first pillar to deconstruct all the difficulties encountered, in addition to his transversal support for all the personal implications that this academic endeavour implies. Thank you, Professor Mário Franco for your motivation and friendship that definitely helped me reach the end of a path, which after all is just the beginning of a new journey.

Also a special thank you to Pedro, my husband, who was an crucial landmark for the conclusion of this investigation; to my daughter Filipa for her discernment and maturity during the times of discouragement and weariness, whose words were always sublime; to my daughter Marta for having managed to grow up without my continued presence, which did not stop her from becoming a wonderful person with an indisputable sensitivity.

Also a special thanks to my mother for having taught me that dreams only come true with persistence and resilience; to all my brothers, without exception, who were present at all times and believed in me and, posthumously, to my father for the values and principles that he passed on to me and that guided me throughout this journey and to Hinha for all her love.

I still thank my dear friends, who know who they are, who have always believed in my research project and are always by my side. Ironically, I also thank my enemies who tried to forge this dream, because they still gave me more strength.

Anyway, a dream come true, certainly! It contributes to the enrichment of scientific knowledge, and this makes me happy, as John P. Barlow said, "*The most powerful research machines out there are people*."

Abstrat

The phenomenon of globalization and the need to combat the harmful effects of the recent financial and economic crisis associated with rapid urban development and stagnant economic growth in countries/regions/cities seen in the last decade worldwide, has led to a paradigmatic change in the view of cities' role in urban economic development. This profound change means that cites are faced with a complex and enormous challenge, set out in the European Union's 2020 Strategy based on the premises of long-term intelligent, inclusive and sustainable economic growth. However, these premises imply that models of economic growth and their traditional determining factors are altered, and so development of the so-called new economy is in evidence. This means that the new economy proposed by the European Union, besides being based on traditional factors generating economic growth, has come to include a new own resource, the intangibility and soft and hard amenities of urban places, or cities, as factors associated with cities' urban economic development. The changes in regional and public policies linked to repositioning cities have aroused great interest in the academic world and in other public and private agencies, leading to the emergence of countless constructs, concepts and models aiming to contribute to understanding of this global phenomenon. In this context, the concepts of creativity, intelligence and urban sustainability, as inseparable dimensions of cities, have gained relevance in studies on cities, particularly regarding their measurement. Consequently, a series of models and indices have been developed aiming to answer the question of how to assess cities' performance around these dimensions.

This proliferation of studies has not exhausted the topic, as gaps remain to be filled, particularly those involving great complexity by interlinking various constructs such as urban networks, besides creativity, intelligence and urban sustainability in cities. In this scenario, the general aim of the research presented here is to propose a holistic, multidimensional model for Current Creative Cities (CCCs) and its empirical validation through constructing a Composite Index for their holistic performance. The broad spectrum of this objective is clear, and so it was divided in six specific objectives, namely: 1) to map the most studied topics concerning networks and the performance of creative cities, through a bibliometric analysis; 2) to present a proposal of a multidimensional design for CCCs and the respective indicators to measure their performance; 3) to validate empirically the model proposed for each dimension proposed *per se*, and subsequently, for all the dimensions of the holistic model as a whole; 4) to demonstrate that networks are predictors of CCCs' holistic performance; 5) to propose a taxonomy for the holistic performance of CCCs and 6) to analyse the effect of *living labs* on the economic growth of CCCs. 5) to propose a taxonomy for the holistic performance of CCCs;

To respond to these aims a mixed research methodology was adopted, since quantitative and qualitative approaches complement each other, particularly concerning internal and external

validity, using different research techniques of a deductive and inductive nature, as explained below.

In **Chapter 2**, responding to the first objective, the bibliometrics revealed the most studied topics, besides exponential interest in studying creative cities and networks together. It was also clarified that creativity can be associated with intelligence and urban sustainability in CCCs, that there is still a need to construct a holistic, transversal model for these dimensions, and that this should allow measuring performance and the effect of networks on this. The result obtained in this study directed the research to **Chapter 3**, i.e., to the second aim established, and so a multidimensional, holistic model is presented to measure CCCs' holistic performance.

With the answers to the first objectives defined, **Chapters 4, 5, 6** and **7** aim to provide the response to the third and fourth objectives, presenting individual Composite Indices and for the Holistic Performance of CCCs, obtained through multivariate statistical techniques – Exploratory Factor Analysis (EFA) and Principal Components Analysis (PCA). These indices were validated empirically in Portugal. The results obtained and their discussion revealed that strategies directed to implementing creative, intelligent and sustainable measures are visible in economic growth in Portugal, despite the need to continue to develop and spread the structural and conjunctural bases through public policies aiming to overcome persisting weaknesses. Therefore, the methodological tool presented here is a bonus for local authorities and their public policies.

The demographical, spatial and territorial variations of Portuguese towns and cities led to developing a taxonomy of their holistic performance, to respond to the fifth objective defined by using Hierarchical Cluster Analysis, presented in **Chapter 8**. The results show that improved holistic performance is only achieved when taking all the axes/dimensions of CCCs as a synergetic whole and as a cyclical consequence rather than *per se*. Finally, these results were complemented in **Chapter 9** (sixth objective) by the case study method applied to the town of Fundão, which demonstrated it is not enough to activate the means for citizens to be dynamic actors in improved holistic performance, as current public policies must be strategically managed and promoted by reducing the financial costs involved.

The studies presented here allowed presentation of a Composite Index for the Holistic Performance of Portuguese towns and cities, which with the due adaptations to the context analysed can be applied generally. This instrument forms the main contribution of this research, which is of an innovative and relevant nature by being based on urban networks as inductors and catalysts of improved urban economic growth in cities/local authorities. It is also shown that when cities include networks in their public policies, the intangible returns obtained benefit their holistic performance indirectly.

Finally, **Chapter 10** describes the limitations of the studies presented and makes general conclusions and contributions with implications for theory and practice.

Key-words:

Cities, Networks, Creativity, Intelligence, Urban Sustainability, Holistic Performance, Composite Index

Resumo

O fenómeno da globalização e a emergência de se contornar os efeitos nefastos da recente crise financeira e económica associados ao rápido desenvolvimento urbano e à estagnação do crescimento económico dos países/regiões/cidades a que se assistiu na última década em todo o mundo, originou que a visão do papel das cidades no desenvolvimento económico urbano fosse alterada de modo paradigmático. Esta alteração profunda significa que atualmente as cidades estão perante um desafio complexo e enorme, o qual se consubstanciou na Estratégia 2020 da União Europeia que assenta nas premissas de um crescimento económico inteligente, inclusivo e sustentável a longo prazo. Contudo, estas premissas implicaram que os modelos de crescimento económico e que os seus fatores determinantes tradicionais fossem alterados, pelo que se tem assistido ao desenvolvimento da denominada nova economia. Isto significa que a nova economia preconizada pela União Europeia, para além de assentar nos fatores tradicionais geradores de crescimento económico, passou a incluir um novo recurso próprio, a intangibilidade e as amenidades *soft* e *hard* dos lugares urbanos, vulgo cidades, como fatores associados ao desenvolvimento económico urbano das cidades. As mudanças das políticas económicas regionais e públicas ligadas ao reposicionamento das cidades despertou um elevado interesse no meio académico e em outras agências públicas e privadas, pelo que surgiram inúmeros construtos, conceitos, modelos que visavam contribuir para a compreensão desse fenómeno global. Neste contexto, os conceitos de criatividade, de inteligência e de sustentabilidade urbana, enquanto dimensões indissociáveis das cidades, ganharam relevância nos estudos sobre cidades, particularmente no tocante à mensuração da sua performance. Por conseguinte, uma bateria de modelos e de índices têm sido desenvolvidos visando responder à questão de como avaliar a performance das cidades em torno destas dimensões.

Esta proliferação de estudos não esgotou a fertilidade desta temática, pela que ainda persistem lacunas por colmatar, em particular aquelas que envolvem elevada complexidade ao interligarem vários construtos, como as redes urbanas, para além da criatividade, inteligência e sustentabilidade urbana nas cidades. Neste cenário, o objetivo geral da investigação aqui apresentada passa pela proposta de um modelo holístico e multidimensional para as *Currents Creative Cities* (CCCs) e a sua validação empírica através da construção de um Índice Compósito para a performance holística das mesmas. É clarividente o largo espectro deste objetivo, pelo subdividiu este em seis objetivos específicos a saber: 1) Mapear as temáticas mais investigadas sobre as redes e a performance das cidades criativas, através de uma análise bibliométrica; 2) Apresentar uma proposta de desenho multidimensional para as CCCs e respetivos indicadores para a mensuração da performance das mesmas; 3) Validar empiricamente o modelo proposto para cada uma das dimensões propostas *per si* e, posteriormente, para o conjunto da todas as dimensões de modo holístico; 4) Demonstrar que as redes são preditores da performance holística das CCCs; 5) Propor uma taxonomia para a performance holística das CCCs; e 6) Analisar o efeito que as *living labs* têm no crescimento económico das CCCs.

Para dar resposta a estes objetivos seguiu-se uma metodologia de investigação mista, uma vez que a abordagem quantitativa e qualitativa são complementares uma da outra, nomeadamente no tocante à validade interna e externa, em que se utilizaram diferentes técnicas de investigação de natureza dedutiva e indutiva, como explicado a seguir.

Assim, o capítulo 2 responde ao primeiro objetivo, a bibliometria revelou os tópicos mais estudados, para além de um interesse exponencial em estudar as cidades criativas e as redes em conjunto. Também se clarificou que a criatividade é passível de associação à inteligência e à sustentabilidade urbana nas CCCs, que persiste a urgência de se construir um modelo holístico e transversal a estas dimensões e que possibilitem que se mensure a performance e o efeito das redes nessa. Assim, a resposta obtida neste estudo direcionou a investigação para o capítulo 3, ou seja, para o segundo objetivo estabelecido, pelo que se apresenta um modelo multidimensional e holístico para a mensuração da performance holística nas CCCs.

Ainda com a resposta aos primeiros objetivos definidos, os capítulos 4, 5, 6 e 7 visam ilustrar a resposta aos terceiro e quarto objetivos, em que se apresentaram Índices Compósitos individuais e para a Performance Holística das CCCs, obtidos pelo uso de técnicas estatísticas multivariadas – Análise Fatorial Exploratória (AFE) e Análise dos Componentes Principais (ACP). Estes índices foram validados empiricamente em Portugal. Os resultados obtidos e a sua discussão revelaram que as estratégias direcionadas para a implementação de medidas criativas, inteligentes e sustentáveis são visíveis no crescimento económico em Portugal, porém ainda urge que se continue a germinar e disseminar as bases estruturais e conjunturais através de políticas públicas que visem ultrapassar as fragilidades que ainda persistem. Deste modo, a ferramenta metodológica aqui apresentada é uma mais valia para os municípios e suas políticas públicas.

A disparidade demográfica, espacial e territorial das cidades em Portugal induziu ao desenvolvimento de uma taxonomia de performance holística para as mesmas, dando resposta ao quinto objetivo definido pela utilização da Análise Hierárquica de Clusters (AHC), apresentado no capítulo 8. Os resultados mostram que as melhorias na performance holística só são conseguidas quando se encaram todos os eixos/dimensões das CCCs como um todo sinérgico e como uma consequência em ciclo e não *per si*. Por último, estes resultados foram complementados no capítulo 9 (sexto objetivo) pelo método de estudo de caso aplicado à cidade do Fundão, o que possibilitou que se demonstrasse que não basta acionar os meios para que os cidadãos sejam atores dinâmicos na melhoria da performance holística, pois é premente que as atuais politicas públicas sejam estrategicamente geridas e alavancadas pela redução dos encargos financeiros afetos a essas politicas.

Os estudos aqui apresentados possibilitarem a apresentação de um Índice Compósito para a Performance Holística das cidades portuguesas, que com as devidas adaptações ao contexto em análise é passível de aplicação generalizada. Este instrumento constitui o principal contributo desta investigação e que assume um carácter inovador e pertinente ao ter como pedra basilar as redes urbanas como indutoras e catalisadoras da melhoria do crescimento económico urbano das cidades/municípios. Mostra-se ainda que as cidades que integram as redes nas suas políticas públicas obtêm retornos intangíveis que indiretamente beneficiam a sua performance holística.

Finalmente, no capítulo 10 são explanadas as limitações dos estudos apresentados e tecidas as conclusões gerais e outros contributos com implicações para a teoria e para a prática.

Palavras-chave

Cidades, Redes, Criatividade, Inteligência, Sustentabilidade Urbana, Performance Holística, Índice Compósito

Table of contents

List of figures

List of tables

List of acronyms

%	Percentage
€	Euros
3P's	Public-Private Partnerships
3T's	Tolerance, Talent and Techonology
4P's	Public-Private-People Partnerships
AHP	Analytical Hierarchy Process
CCCs	Current Creative Cities
CCI	Creative and Cultural Industry
DEA	Data Envelopment Analysis
e.g.	Example gratia
EFA	Exploratory Factor Analysis
EU	European Union
GDP	Gross Domestic Product
h^2	Communalities
HCA	Hierarchical Cluster Analysis
HEI	Higher Education Institution
i.e.	Id est
ICT	Information and Communication Technology
INE	National Statistics Institute
INPI	National Institute of Industrial Property
Km^2	Square Kilometers
KMO	Kaiser-Meyer-Olkin
KWH	kilowatt hours
M.€	Millions of Euros
m^3	Cubic meters
N	Population
NUTS II/III	Nomenclature of Territorial Units for statistical purposes
OECD	Organization for Economie and Cooperation Development
PCA	Principal Components Analysis
PORDATA	Database of contemporary Portugal
R&D	Research and Development
TONS	Tonne
USA	United States of America

CHAPTER 1

GENERAL RESEARCH FRAMEWORK

1. Introduction

1.1. Cities as the study context and a challenge

The economic and financial crisis of 2008 caused major impacts on the economic and even political situation in the global economy, with the vision of countries' development and economic growth undergoing a deep transformation to allow construction of a tripartite (economic, social and environmental) sustainable future in the long term. In this context, the European Union (EU) wants its economy to be intelligent, sustainable and inclusive. This means aiming for an economy based on knowledge and innovation (intelligent growth), promoting an economy that uses its resources efficiently and ecologically (sustainable growth) and encouraging an economy that provides high employability and ensures territorial and social cohesion (inclusive growth) (Eurostat, 2015).

Consequently, the academic community has shown growing interest in urban Europe, with the most researched topics (at the macro level) being isolated cities, the hierarchical patterns of cities and towns, global cities, cities of the world, city networks, incredible cities, city paradigms at the social, ecological and cultural levels, geographical clusters from the perspective of industrial networks, the advantages of agglomeration and the conditions of urban creativity in cities (Nijkamp & Kourtit, 2013).

The above descriptions indicate the importance defining the concept of a creative, intelligent and sustainable city, with the term adopted in this research being the current creative cities (CCCs). In the vast literature on the typology of cities, these are understood as multidimensional spaces, where **creativity** (e.g., Florida, 2002, 2005; Grant & Kronstal, 2010; Hospers & Pen, 2008; Kakiuchi, 2016; Kong, 2014; Landry, 2000; Pratt, 2008; Ratten, 2017; Scott, 2000), **intelligence** (e,g., Bouk et al., 2017; Dodgson & Gann, 2011; Letaifa, 2015; Mardikyan et al., 2015; Nam & Pardo, 2011; Ratten, 2017) and **urban sustainability** (e.g., Camagni, Capello, & Nijkamp 1998; Cavalcanti, 1995; Elkington, 1994; Pozdniakova, 2017; Wheeler & Beatley, 2014) stand out as their inseparable dimensions, each being the consequence and result of the others, i.e., intelligence is the result of creative and intensive strategies in knowledge connected to matters of sustainability (Kumar & Dahiya, 2017). Consequently, the literature states that: 1) creative cities are those that advocate socio-cultural, economic and political changes (Romein & Trip, 2009), being characterized by diversity, openness, tolerance, the existence of a creative class and high cultural dynamism (Florida, 2002, 2005; Grant & Kronstal, 2010); (2) intelligent cities are based on participatory governance that is embedded in an urban ecosystem supported by information and communication technologies (Letaifa, 2015) and which invests in social and human capital and own resources to improve the quality of life of its citizens and promote their economic growth (Caragliu, Del Bo, & Nijkamp, 2011); and (3) sustainable cities as a broader concept integrating social development, economic development, environmental management and urban governance, which refers to the management and investment decisions taken by municipal authorities in coordination with national authorities and institutions (World Economic and Social Survey, 2013); this means that in this study, these integrated settings are assumed holistically.

In addition, the topics inherent to cities (micro level) most frequently studied by researchers are presented in Table 1, together with their justification.

Table 1 – Most studied topics

Topics	Justification (why)
Information and communication technology (ICT)	In cities, this is understood as a means to provide political and economic efficiency, and at the same time, social, cultural and urban development (Hollands, 2008; Komninos, 2002);
Businesses	Considered the leaders of urban development, of cities' attractiveness for new businesses, given their innovative spirit, the entrepreneurship involved, their economic image and registered patents (Tranos & Gertner, 2012);
Social inclusion and e-government	Because these are considered crucial areas for cities (Caragliu et al., 2011; Silcock, 2001);
Creative industries	These industries raise urban economic development aiming to create the essential conditions to attract creative people (creative class), who are the driving force of these industries (Tranos & Gertner, 2012);
Social capital	Since cities include communities that learn, adapt and innovate (Coe, Paquet, & Roy, 2001);
Urban sustainability	Due to representing the inter-connection between the physical, social and economic dimensions (Camagni et al., 1998), i.e., including economic sustainability/social and economic prosperity/social inclusion (Tranos & Gertner, 2012) and ICT. For Amin, Massey, and Thrift (2000), intelligent cities should seek to establish a balance between the use of ICT and business, government, people and communities, so that their sustainability will also include environmental sustainability (reduction of negative externalities, such as pollution and natural resources);
Collaboration/networks	Because these are crucial for the sharing/exchange of experiences, knowledge and ideas (Tranos & Gertner, 2012).

Source: Own elaboration

It is easily seen that the above definitions, associated with the topics in Table 1, involve multiple concepts and a relevant degree of complexity, and so in this study, CCCs are defined as pluralist, multifaceted spaces characterised by curiosity, imagination, creativity, culture, knowledge and cooperation (networks) (e.g., Cabrita, Cruz-Machado, & Cabrita, 2013; Carta, 2009; Florida, 2002, 2005; Landry, 2000; Letaifa, 2015; Musterd & Ostendorf, 2004; O'Connor & Shaw, 2014), added to which is the adoption of ICT (Partridge, 2004) in interaction with infrastructure, capital, behaviour and culture (Alkandari, Alnasheet, & Alshekhly, 2012), the physical, cultural, social and economic pillars of sustainability (Camagni et al., 1998; Ratten, 2017; Tranos & Gertner, 2012) and the balance between environmental protection, economic development, urban regeneration, social equity and social justice (e.g., Bibri & Krogstie, 2017a, 2017b). Also implicit in this definition of CCCs are cities' collaborative networks (Brorström et al., 2018; Camagni & Capello, 2004; Ferraris, Santoro, & Papa, 2018).

Furthermore, cities' role in economic development has changed considerably, with them ceasing to be simply places of population density, business and employment (Haberstroh & Pinkwart, 2018). This means that cities hold intangible and tangible resources that allow sustained economic growth in new urban resources (Dahiya, 2012; UN-HABITAT, 2013). Therefore, urban policies reflect new axes – intelligent, inclusive and sustainable growth – that can provide economic and non-economic returns on the benefits of those new resources in cities and which are evident in the 2020 Strategy (European Comission & UN Habitat, 2016).

This paradigmatic change in cities' role in economic growth has led to the present time being called the Century of Cities (Carrillo et al., 2014), since it is forecast that by 2050 around 75% of the population will live in urban areas (Dizdaroglu & Yigitcanlar, 2014).

In the scenario of a new economy (Scott, 2010), recent studies have demonstrated the importance of entrepreneurship, creativity, innovation and networks as intangible assets determining cities' growth (Belitski & Desai, 2016; Cohen, Almirall, & Chesbrough, 2016; Snow, Håkonsson, & Obel, 2016). In this connection, Nijkamp and Kourtit (2013) argue that modern European cities are an open space for creative ideas, innovation and sustainable development and a space to provide quality of life, which has originated their integration in networks. Corroborating this argument, Ratten (2017) claims that another crucial aspect of these cities is their competitive advantage, which is reinforced by considering the cultural, social, environmental and economic dimensions as a whole. Consequently, these cities intend to be innovative (Ballas, 2013) and adopt new urban strategies aiming for sustainable development and an improved quality of life for their residents (Albino, Berardi, & Dangelico, 2015).

However, these paradigmatic changes in how cities are regarded has created new challenges for them (Dowall & Treffeisen, 1991), where entrepreneurial capital has come to be crucial together with human capital, included in social capital. Social capital is the interaction between individuals, allowing the creation of communities with social commitment and a social environment (Putnam, 2000). In turn, this environment provides social networks, where there is a reciprocity of relations based on trust and tolerance (Audretsch & Keilbach, 2005; Putnam, 2000) with beneficial synergies for the whole population. These synergies allow regions/cities to be competitive and grow uninterruptedly (Camagni, 2016), through the involvement of all city actors. This growth capacity is related to entrepreneurship (entrepreneurial capital), which refers to a society's capacity to generate business activity, and has a significant impact on regional economic performance (Audretsch & Lehmann, 2005), which is an essential factor in the process of sustained economic growth and development (Acs & Szerb, 2007; Audretsch & Keilbach, 2004; Wennekers et al., 2005). In recent decades, human capital has become a priority for most world economies, since it has become one of the vehicles of economic growth at all levels (Kiuru & Inkinen, 2017). Its definitions have varied between competences/capacities and the level of education and intensive knowledge (Glaeser & Saiz, 2003; Sabadie & Johansen, 2010) and between talent and tolerance (creative class) (Florida, 2005).

Summarizing, the current challenge for cities includes the development of competences to achieve the *soft* and *hard* structural transformations required by new models of economic growth, and thereby grow economically in the present and future. This challenge was mentioned recently by Hatuka et al. (2018). In addition, Haberstroh and Pinkwart (2018) claim this challenge leads to cities being taken as the unit of analysis in academic studies, due to those new models of growth which promote diversified, cohesive, attractive and healthy cities (Derlukiewicz & Mempel-śnieżyk, 2018).

1.2. Motivation and justification of the subject

CCCs, networks and performance are a fertile area of research, and the extensive literature on cities has not diminished the growing interest of the academic community and other institutions.

However, some gaps remain in this subject and require additional research, namely those between theory and practice (Hatuka et al., 2018; Lee, Hancock, & Hu, 2014), with the need for studies defining holistic models of how CCCs are constructed (Bibri & Krogstie, 2017a; d'Ovidio & Cossu, 2017; Mora, Bolici, & Deakin, 2017), as well as scientific instruments to help all the actors involved in that construction and in assessing and monitoring their holistic performance (Huovila et al., 2016; Priano & Guerra, 2014). Also needed are empirical studies on CCCs performance with increased samples and variables (Çetindamar & Günsel, 2012), the development/construction of a scale of indicators that allow measurement of that performance in the different dimensions of CCCs (Borén & Young, 2013; Flores, & Teixeira, 2017; Lee et al., 2014; Malecki, 2007) and the inherent association between all those dimensions (Bibri & Krogstie, 2017a; Bifulco, Tregua, & Amitrano, 2017; Cabrita et al., 2013; Cohen et al., 2016; Della Lucia, Trunfio, & Go, 2017; Shutters, Muneepeerakul, & Lobo, 2016; Tranos & Gertner, 2012). Furthermore, the academic community has continued to adopt an individual approach to the different dimensions of CCCs, or in comparative terms rather than as an integrated mix (Hatuka et al., 2018), representing yet another gap (Andersson & Andersson, 2015; Caset & Derudder, 2017; Hatuka et al., 2018; Kourtit, Nijkamp, & Arribas, 2012; Miškovičová et al., 2016). There is also a shortage of robust studies on cities' performance going beyond exploratory and qualitative approaches (e.g., case studies) (Della Lucia & Trunfio, 2018). In addition, the association between networks and CCCs performance has been paid little attention in the academic world (Lazzeretti, Capone, & Innocenti, 2017), and so it is crucial to carry out studies on the synergetic effect of networks on CCCs performance (Echebarria et al., 2016; Ferraris et al., 2018; Pain et al., 2011; Walker & Hills, 2012).

In these circumstances, there is evidence of pertinent and topical gaps in the subject of study, specifically concerning the link between the constructs of networks, models and holistic performance of CCCs. This affirmation allows original research contributing to scientific knowledge about cities, this being the researcher's main motivation to carry out integrated study of those constructs from a management perspective. Another fundamental motivation is to make an innovative study of cities based on a joint vision of all those constructs to demonstrate empirically that this vision goes beyond a mere theoretical combination of concepts, and thereby fill the gap remaining in the largely unexplored relationship between theory and practice mentioned by Hatuka et al. (2018) and Lee et al. (2014).

1.3. Objectives and research model

Based on the above-mentioned gaps and the importance of studying theoretically and empirically the network construct in cities and how they predict the holistic performance of CCCs, the general objective of this research includes the proposal of an integrated model for CCCs and its empirical validation to present a Composite Index for CCCs holistic performance. Therefore, responding to this objective is guided by the following specific objectives:

1) To map the most studied subjects concerning creative cities' networks and performance, through a bibliometric analysis;
2) To present a proposal of a multidimensional design for CCCs and the respective indicators to measure their performance;
3) To validate empirically the model proposed for each of the proposed dimensions *per se*, and then for the whole set of dimensions holistically;
4) To demonstrate that networks are predictors of CCCs holistic performance;
5) To propose a taxonomy for the holistic performance of CCCs;
6) To analyse the effect of *living labs*, as open networks, on CCCs economic growth.

Briefly, in responding to these objectives, the aim is to highlight the contributions to theory and practice made by this research, i.e., the proposal of a model for CCCs and presentation of a Composite Index for CCCs.

The literature presented on cities in sections 1.1. and 1.2. and the objectives listed above allowed drafting of the conceptual model central to this research, which is shown in Figure 1.

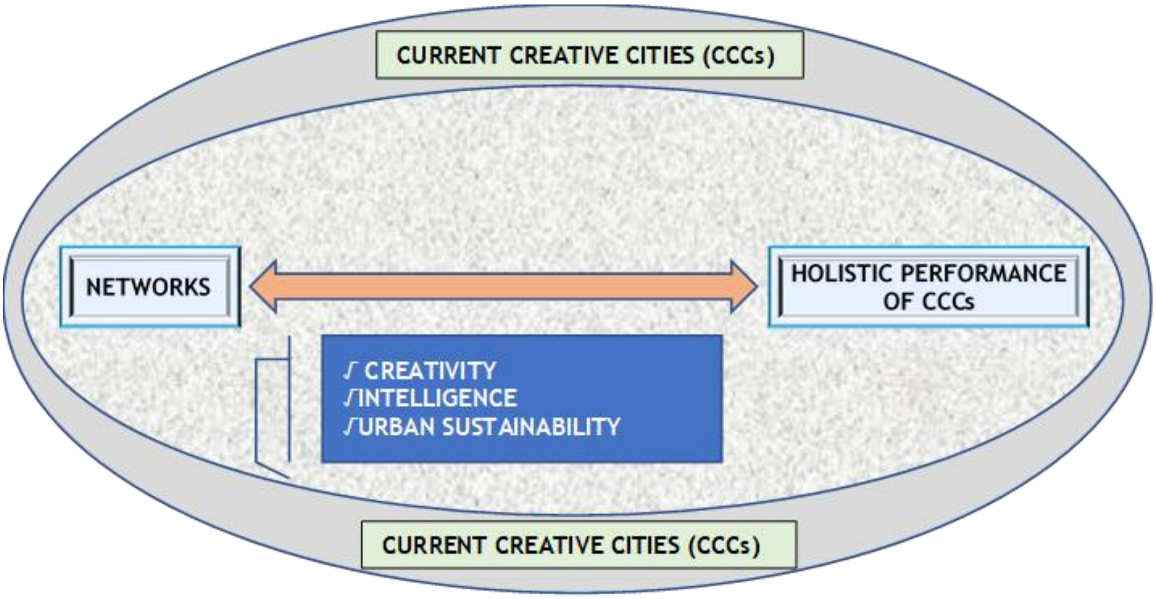

Figure 1 – Core Model (**Source:** Own elaboration)

The unit of analysis in this model is cities, referred to by Erkkilä and Piironen (2018) as extremely important in studies related to indices and rankings, so that comparisons between cities are plausible. In addition, the model proposed here shows networks as predictors of CCCs holistic performance, since cities are connected networks, with a growing level of socio-economic activities resulting from amenities, externalities, proximity and density (Nijkamp & Kourtit, 2013), and belong to an urban global system (Carta, 2009).

1.4. Design and methodological procedures

1.4.1. Research design

This research was designed in the form of articles aiming for each one to respond to the general objective and the six specific objectives defined previously. Consequently, eight articles/studies are presented, of which two are theoretical and six show the empirical evidence obtained, the sequencing being presented in Figure 2.

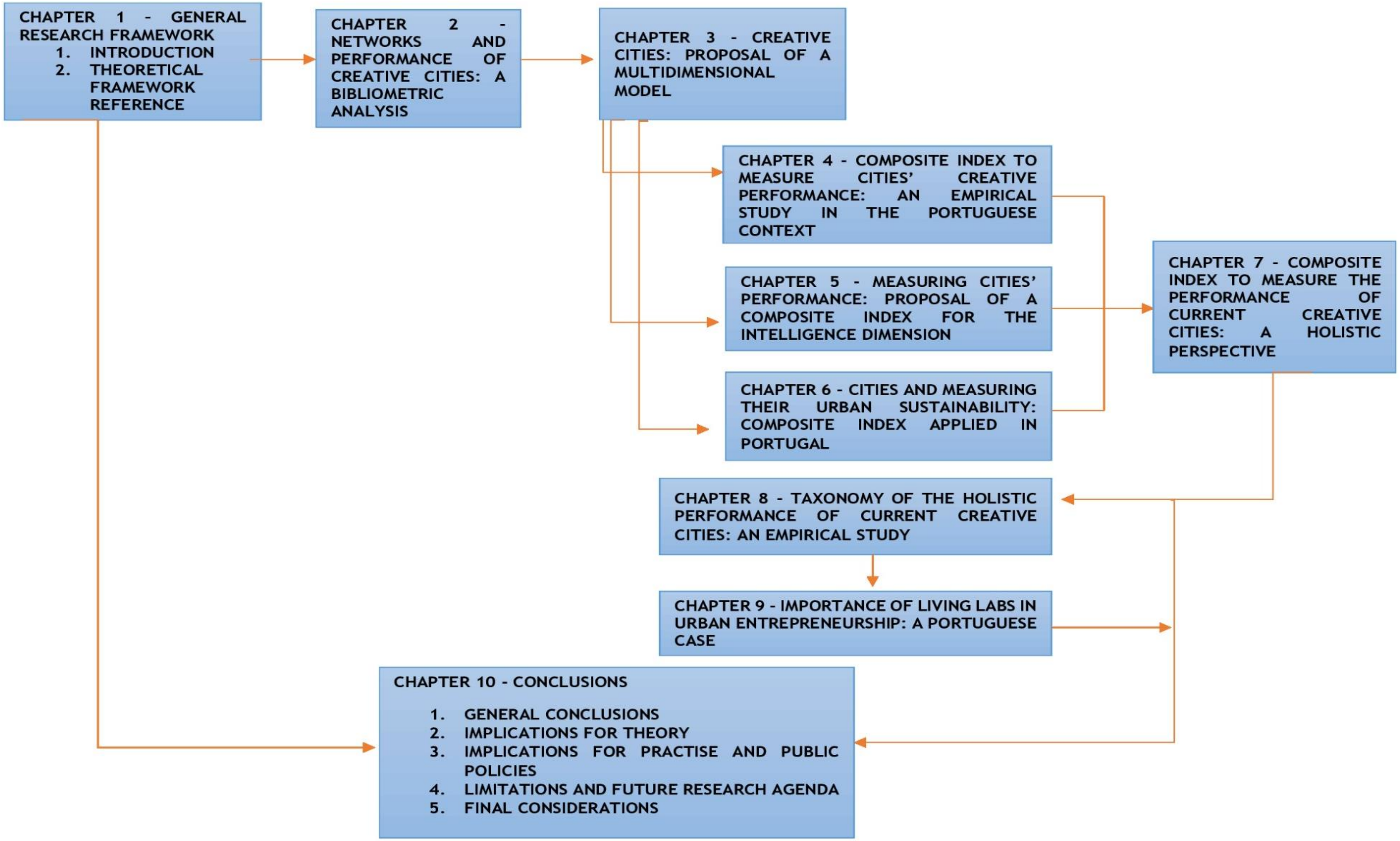

Figure 2 –Research design (**Source:** Own elaboration)

1.4.2. Type of study and methodological procedures

For the purpose of this study, the methodological approach used is mixed, through resorting to different methodological procedures which are explained in the following paragraphs. The main advantage of adopting this methodology lies in the quantitative and qualitative methods being complementary rather than mutually exclusive (Minayo & Sanches, 1993; Patton, 1991; Patton, 2002). Quantitative research also has the advantage of allowing objective and accurate measurement of the phenomena analysed (Firestone, 1987), despite being weak in terms of internal validity and strong in external validity (Serapioni, 2000), as the results obtained can be generalized to the whole population (Firestone, 1987; Serapioni, 2000). Qualitative research, for example the case study method, is a specific way to collect, organise and analyse data, therefore representing an analysis process (Patton, 2002). With this approach, the type of questions asked relate to ***how*** and ***why*** (Yin, 2015). However, it is an approach with high internal validity and weak external validity (Serapioni, 2000). This means that values, beliefs, representations, habits, attitudes and opinions are studied (Minayo & Sanches, 1993) for a particular phenomenon, and so cannot be generalised to the whole population (Firestone, 1987; Serapioni, 2000).

1.4.3. Research context and sample

Geographically, this research was carried out in Portugal, specifically in its 308 (N) towns and cities on the mainland and islands. So, in this case, the population is equal to the sample, which is large in size. But there are only 159 cities in Portugal. However, in this research 308 cities and towns were used, corresponding to the 308 municipalities that currently exist in the context under analysis (N). Since the demographic criterion was not used, but the functional – exixtence of a political-administrative, common municipalities.

The seven regions of Portugal (NUTS II) present a varied population density and topography, and so the development of the towns and cities in each is different and extremely heterogeneous. This means that the associated endogenous and exogenous factors are different for all the towns/cities studied.

Figure 3 shows the distribution of the Portuguese regions, which include the 308 towns and cities studied.

Figure 3 – Geographical context of the research (**Source:** Pordata)

1.4.4. Data collection

The collection of numerical data to produce the studies/articles 3, 4, 5 and 6 (Chapters 4, 5, 6 and 7) is a crucial phase of this research, since the unavailability of data and resorting to various databases are unavoidable factors in the Portuguese context. Therefore, the database was formed by referring to various secondary sources – National Statistics Institute (INE), PORDATA, and the official websites of various entities/institutions (e.g., Tripadvisor,see European Union, 2017) given the lack of a single database. In each article/chapter, all the sources used are detailed.

In these circumstances, the data-collection process began by obtaining the data available in the above-mentioned sources and associating them with the dimensions, sub-dimensions and indicators presented in study/article 2 (Chapter 3). This phase was extremely time-consuming and exhaustive so that the database obtained would be credible, reliable and suitable for appropriate statistical treatment. Furthermore, adaptation of the available data to the indicators and proxies most commonly used by academics and other entities implied an exhaustive search of theoretical and empirical work in various geographical contexts, so that this phase would be duly supported by scientific articles, minimizing the subjectivity inherent to the process. Therefore, the data collected represent quality, reliability and comparability, essential characteristics of a good indicator (Chang et al., 2018). Aware of the need to observe the requirements of a good indicator, it was also necessary to transform the absolute data obtained in relative data (proxy/resident population per*1000 city inhabitants), to allow subsequent comparison between cities, irrespective of their size.

The database formed is unique in Portugal, as official databases are not targeted at studies on cities, and so the result of this data-collection is a bonus for decision-makers in Portugal and can be used for various purposes, besides those defined in this research.

Finally, Article 8, a study of a qualitative nature (Chapter 9), involved work *in loco* to obtain the necessary information for the case study presented, using documentary analysis, official websites and semi-structured interviews.

1.4.5. Data analysis

The data collected were analysed using different research techniques selected according to the objectives defined.

Article 1 (Chapter 2) involved bibliometric analysis, to make a systematic review of the literature (O'Connor & Voos, 1981; Wasserman & Faust, 1994; Powell, Koput, & Smith-Doerr, 1996; White & McCain, 1998; Quinlan, Kane, & Trochi, 2008). The advantages of this type of analysis lie in providing the identification, assessment and analysis of content in specific areas, and also a systematization of concepts, theories and practices (Rowley & Slack, 2004), with the main objective of contributing to the advancement of scientific knowledge of the topic (Mentzer & Kahn, 1995).

Article 2 (Chapter 3) has an exploratory and descriptive purpose, compiling the numerous performance indices and models for cities elaborated by various authors in the academic community and economic development agencies to design a multidimensional model for cities.

For Articles 3, 4, 5 and 6 (Chapters 4, 5, 6 and 7) of an empirical nature, whose intended result is the presentation of a Composite Index for the holistic performance of CCCs, selection of the multivariate statistical technique to use was extremely important, so that the information produced would have the scientific quality and robustness required by this typology of indices. Here, the compilation of all the data in a single base (see section 1.4.3.) revealed various units of measure and periods of reference, and so it was necessary to proceed to normalization, weighting and aggregation to develop that index. Therefore, the manual published by the Organisation for Economic Co-operation and Development (OECD, 2008) was adopted. This organisation (page 14) explains that composite indices *"are much like mathematical or computational models. As such, their construction owes more to the craftsmanship of the modeller than to universally accept scientific rules for encoding."* So two paths can be followed: (1st) determination of weightings based on opinions; or (2nd) determination of scientific weightings from application of Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA) (OECD, 2008).

From the above, the 2nd path was chosen to analyse the data, including a succession of phases as follows: (a) Normalization of all variables to a common scale (Danielis, Rotaris, & Monte, 2018) by applying *Z-scores* (Marôco, 2014); (b) Descriptive analysis (mean, standard deviation, variation coefficient and minimum and maximum values), although normalization of the data transformed the mean in zero and the standard deviation in one (Marôco, 2014; OECD, 2008); (c) Application of Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA), so that the grouping of the data would allow similar interpretation in the sample, as well as determination of the principal components to be retained and ensuring robust data treatment (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Marôco, 2014; Pestana & Gageiro, 2014; Stevens, 1986). This method aims to determine the weights representing the importance of the variables measured by maximum variance (Kubrusly, 2001). This serves to *"summarise a set of individual indicators while preserving the maximum possible proportion of the total variation in the original data set."*, and the, *"largest factor loadings are assigned to the individual indicators that have the largest variation across countries, a desirable property for cross-country comparisons, as individual indicators that are similar across countries are of little interest and cannot possibly explain differences in performance"* (OECD, 2008: 26); (d) To check acceptability of this technique, we applied the Kaiser–Meyer–Olkin (KMO) (Kaiser, 1974) sample suitability measure and the Bartlett sphericity (Marôco, 2014). All this process was applied to all the sub-dimensions analysed and also to the dimensions to determine the scientific weightings and thereby show a Composite Index per dimension analysed.

However, for these indices to indicate cities' holistic performance, the values of the database must be transformed once again, by applying the weightings obtained previously for the sub-dimensions and dimensions, for subsequent repeated application of the techniques mentioned above.

To obain a taxonomical profile for cities (Article 7/Chapter 8) Hierarchical Cluster Analysis (HCA)[1]was applied, to determine groups with homogeneity in relation to the variables studied (Marôco, 2014; Mooi & Sarstedt, 2011).

Finally, in study/Article 8 (Chapter 9), a single case study and the respective content analysis is presented, as recommended by Yin (2015).

[1] To the data obtained from applying the scientific weightings of the previous articles/chapters.

1.4.6. Synthesis

Table 2 summarises the objectives defined, and the methodological procedures followed in the different studies/chapters of this research.

Table 2 – Methodological definition of the chapters of the thesis dimension

Definition	Chapter/Article
Chapter 2/Article 1 - Networks and performance of creative cities: a bibliometric analysis	
Theoretical support	Creative class theory and networks theory
Objectives	(1) Identify the subjects most researched in the academic sphere about the networks and performance of creative cities through a bibliometric review and (2) Identify remaining gaps requiring additional research
Key-words	Creative Cities, Creative Economy, Performance, Networks, Sustainability
Type of study	Theoretical
Research methodology	Systematic review of the literature, using the bibliometric analysis– co-citation analysis, word frequency -
Unit of analysis	Scientific articles (empirical and reviews), proceedings papers
Sample	102 documents analysed
Data collection	*ISI (Web of Science)* and *Scopus*
Treatment of the data	*Vosviewer* software and *Nvivo 11* software
Publication	Under review in *Development and Change*
Chapter3 /Article 2 - Creative cities: proposal of a multidimensional model	
Theoretical support	Creative class theory, network theory and sustainability and circular economy theory
Objective	Present a proposal of a multi-dimensional design for current creative cities and the respective indicators generally used
Key-words:	Cities, Dimensions, Indicators, Performance, Multidimensional Model
Type of study	Theoretical
Research methodology	Qualitative research
Unit of analysis	Performance Index for cities
Publication	Rodrigues, M., & Franco, M. (2018). Measuring the Performance in Creative Cities: Proposal of a Multidimensional Model. *Sustainability*, *10*(11), 1-21.
Presentation	ICABM18 - International Conference of Applied Business and Management in ISAG (European Business Scholl), Porto (Portugal), on the 21stand 22ndof June of 2018
Chapter 4/Article 3 - Composite index to measure cities' creative performance: an empirical study in the Portuguese context	
Theoretical support	Creative class theory and network theory
Objectives	(1) Identify the indicators/indices and sub-dimensions inherent to cities' creative performance and (2) Determine the weight of each sub-dimension in the creativity dimension
Key-words	Cities, Creativity, Indicators, Composite Index and Performance
Type of study	Empirical
Research methodology	Quantitative research
Unit of analysis	City
Sample	308 cities
Data collection	Secondary data from several sources, with different units of measure and reference periods
Treatment of the data	Z-scores, Descriptive Analysis, Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA)
Publication	Rodrigues, M., & Franco, M. (2019). Composite Index to Measure Cities' Creative Performance: An Empirical Study in the Portuguese Context. Sustainability, 11(3), 774.

Table 2 – Methodological definition of the chapters of the thesis dimension (cont.)

Chapter 5/Article 4 - Measuring cities' performance: proposal of a composite index for the intelligence dimension	
Theoretical support	Creative class theory and network theory
Objectives	(1) To determine the sub-dimensions inherent to the intelligence dimension of cities and the respective indices/indicators to measure cities' smart performance; and (2) to present the weight of each sub-dimension of the intelligence dimension
Key-words	Cities, Intelligence, Composite Index, Performance and Networks
Type of study	Empirical
Research methodology	Quantitative research
Unit of analysis	City
Sample	308 cities
Data collection	Secondary data from several sources, with different units of measure and reference periods
Treatment of the data	Z-scores, Descriptive Analysis, Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA)
Publication	Rodrigues, M., & Franco, M. (2019). Measuring cities' performance: proposal of a composite index for the intelligence dimension. Measurement, 139, 112-121.
Chapter 6 /Article 5 - Cities and measuring their urban sustainability: composite index applied in Portugal	
Theoretical support	Network theory and sustainability and circular economy theory
Objectives	(1) To determine the intrinsic sub-dimensions of cities' urban sustainability dimension and the respective indices/indicators to measure cities' sustainable performance; and (2) Present the weight of each sub-dimension in the urban sustainability dimension
Key-words	Cities, Urban sustainability, Composite Index, Performance
Type of study	Empirical
Research methodology	Quantitative research
Unit of analysis	City
Sample	308 cities
Data collection	Secondary data from several sources, with different units of measure and reference periods
Data treatment	Z-scores, Descriptive Analysis, Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA)
Publication	Under review in Organization & Environment
Chapter 7 /Article 6 - Composite index to measure the performance of current creative cities: a holistic perspective	
Theoretical support	Creative class theory, networks theory and sustainability and circular economy theory
Objective	To present scientific and robust weighting of the creativity, intelligence and urban sustainability dimensions in cities' holistic, integrated and global performance
Key-words	Creativity, Intelligence, Urban Sustainability, Composite Index, Performance, Cities
Type of study	Empirical
Research methodology	Quantitative research
Unit of analysis	City
Sample	308 cities
Data collection	Secondary data from several sources, with different units of measure and reference periods
Data treatment	Z-scores, Descriptive Analysis, Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA)
Publication	Under review in *Planning Theory and Practice*
Chapter 8 /Article 7 – Taxonomy of the holistic performance of current creative cities: an empirical study	
Theoretical support	Creative class theory, networks theory and sustainability and circular economy theory
Objective	Presentation of a taxonomy for cities in terms of homogeneity and similarity for the geographical context analysed, Portugal.
Key-words	Composite Index, Creativity, Intelligence, Urban Sustainability, performance, clustering, taxonomy
Type of study	Empirical

Table 2 – Methodological definition of the chapters of the thesis dimension (cont.)

Research methodology	Quantitative research
Unit of analysis	City
Sample	308 cities
Data collection	Secondary data from several sources, with different units of measure and reference periods
Data treatment	Z-scores, Descriptive Analysis, Exploratory Factor Analysis (EFA) and Principal Component Analysis (PCA), Hierarchical Cluster Analysis (HCA)
Publication	Review submitted in *Journal of Urban Planning and Development*
Chapter 9 /Article 8 - Importance of living labs in urban entrepreneurship: A Portuguese case study	
Theoretical support	Network theory
Objective	Analyse how living labs contribute to promoting urban entrepreneurship in towns and cities and their sustainability
Key-words	Cities, Urban entrepreneurship, Green economy, Sustainability, Networks, Living Labs
Type of study	Empirical
Research methodology	Qualitative research
Unit of analysis	City
Sample	Fundão
Data collection	Personal semi-structured, Interviews (primary sources) as well as documents and materials (secondary sources)
Data treatment	Content and interpretative analysis
Publication	Rodrigues, M., & Franco, M. (2018). Importance of living labs in urban entrepreneurship: A Portuguese case study. *Journal of Cleaner Production*, *180*, 780-789.
Presentation	CIEM 2017, 7th Iberian Conference on Entrepreneurship, Esposende (Portugal) on the 8 and 9 june.

Source: Own elaboration

1.5. Structure of the thesis

As already mentioned, this thesis is structured in 8 articles, preceded by the general research framework and followed by the conclusions (see Figure 2). Therefore, the thesis is formed of three different sections. Chapter 1 deals with the general research framework, justifying the motivation for the study, defining the objectives, the research methodologies used and the theoretical support adopted. Chapter 2 and 3 are theoretical articles and the other chapters are 6 empirical articles . Finally, Chapter 10 shows the contributions and implications for theory and practice, the limitations, suggestions for future research and final comments.

2. Theoretical framework of reference

The numerous studies made about cities have used various supporting theories due to the complexity of the very concept. Knowing that other theories could have been used, this research is only supported by Network Theory, Creative Class Theory, Sustainability Theory and the Circular Economy Theory/Model. This systematization of the theoretical reference framework reflects the objectives defined.

2.1. Network theory

In network theory, the bonds, nodes and relationships, trust, legitimacy and connection between the various actors and social capital are the primary attributes for their formation (Donnell et al., 2001; Parkhe, Wasserman, & Ralston, 2006). Therefore, supported on these premises, networks have become a fundamental strategy for cities, since they are understood as flows and relationships that arise in urban spaces and are characterised by formal links between economic actors and geographically spatial units (Camagni & Capello, 2004). Furthermore, due to the globalization phenomenon being articulated with a network-based strategy, as interconnected and integrated nodes, Castells (2010) explained that networks should be associated with cities' competitive advantage. This author also mentions that business networks in cities have a dominant role in generating flows and relationships between cities, as reflected in the EU's 2020 Strategy, and at the regional level these are clearly an important factor to promote sustainable development. Networks are patent in the regional integration model defined by the EU, which includes structures and processes of formal and informal coordination and collaboration, and so this has become a priority for governments (*inter* and *intra* networks) (Siegel, 2016).

This argument had already been defended by Capello (2000) by concluding that implicit in networks are the relationships between all city actors, providing urban externalities, scale economies and other types of synergies, as well as the ability to stimulate economic growth (Meijers, Burger, & Hoogerbrugge, 2016), provided there is active participation, flexibility and open attitudes from the actors involved (Capello, 2000). Corroborating the emphasis on the importance of networks in cities and in harmony with network theory, cities consist of a group of connected actors (Echebarria *et al.*, 2016), who without losing their independence work towards a common aim (Alter & Hage, 1993). In this context, and supported by network theory, *living labs* emerge as an entrepreneurial partnership between firms, governments, citizens and institutions (Ratten, 2017), representing an open business network based on entrepreneurship and innovation (Nyström *et al.*, 2014), generating infrastructure for the purpose of sharing knowledge and learning processes between all the actors involved and giving rise to concrete projects (Meijer & Bolívar, 2015). Here, Amsterdam is underlined as a model city, a reference for this type of partnership (Meijer & Bolívar, 2015; Ratten, 2017).

Therefore, supported by the premises of this theory, networks have become a fundamental strategy for cities, since they are taken to be flows and relationships occurring in urban spaces and characterised by formal links between economic actors and geographically spatial units (Camagni & Capello, 2004).

Explicitly, strategies that adopt network theory as a premise assume that spatiality should be understood in terms of places, flows and network integration, which improves cities' economic performance (Pain et al., 2016), the transfer and share of knowledge *inter* and *intra* cities

(David et al., 2013; Dijkstra, Garcilazo, & Mccann, 2013) and easier access to information (David *et al.*, 2013).

In addition, cities should try to conjugate their endogenous characteristics with exogenous ones (Siegel, 2016), in order to promote a network city from the network theory perspective (Wall & Stavropoulos, 2017), in which the relations established by cities with the various actors should be marked by trust and commitment (Hojda, 2015), i.e., these networks should consider the centrality related to their strategic position, their structure, their autonomy, the density of information and resource flows and the intensity of relations between all actors (Ferreira & Filho, 2010).

Consequently, cities result from the interaction between various actors, from multi-faceted networks including relations between people, organisations, institutions and places (Batty et al., 2012), providing social and environmental benefits and greater resource efficiency (Networked Society City Index, 2016). According to network theory, this conclusion infers that cities are not isolated systems, as they are integrated and organised in networks, and so a city network is a structure. For the same authors, the nodes of this structure are the various cities connected by different types of links and channels, where economic flows are changed by the flows of knowledge through interaction and global governance (Sassen et al., 2008). Finally, this combination of flows allows the creation and spread of knowledge through the urban structure (Boix & Trullén, 2007; Ynalvez & Shrum, 2011), leading to cities becoming increasingly vibrant and connected (Sassen *et al.*, 2008).

2.2. Creative class theory

Creative class theory emerged as a consequence of the resurgence of interest in regional and urban matters. This theory was formulated by Florida (2002, 2005) and is directed to urban structures and economies supported by the creative class – formed of creative and talented individuals -, which is crucial for economic growth. This author argues that this class is intrinsically connected to urban growth and has been one of the most popular theories, particularly in the USA (northern cities), in terms of cities/regions' economic prosperity (Mcgranahan & Wojan, 2007). Various authors have explored the extent of this theory. For example, Hoyman and Faricy (2009) propose that this theory represents a new urban class, an emerging sector in the economy; Romero-Padilla, Navaro-Jurado, and Malvárez-García (2016) defend that this is a contribution to the theory of economic growth and is supported by the creation of knowledge and the emergence of new ideas.

In this connection, Florida (2005) developed a multi-disciplinary and holistic approach aiming to provide answers to the growing interest in regional and urban matters, being founded on the urban structure and economy and giving continuity to the arguments of Marshall (1920) about economic agglomerations, around which cities offer stronger labour markets and multiple knowledge sharing, contributing strongly to increased productivity. Florida (2005) also claimed that the creative class and tolerance are characteristics of so-called creative cities, having been adopted by cities such as Berlin, Liverpool, Detroit and Philadelphia, among others, which are undisputed contemporary references of urban productivity platforms in the economic, social, cultural and creative domains.

Also for Ratiu (2013), the vast literature on creative cities demonstrates that the creative class theory has become an emblematic reference for cities' urban development. This means that creativity has become an imperative in the face of economic, social and cultural globalization, which has caused various problems originating in the phenomenon of growing urbanisation, and so cities focus increasingly on creativity to combat depopulation and economic stagnation in some regions (Kakiuchi, 2016; Ratiu, 2013). This has led to the revitalization of many industrial cities (Ratten, 2017), for example, Silicon Valley, Bavaria Valley (Bavaria), Silicon Glen (Scotland) and Silicon Saxony (Dresden) (Hospers & Pen, 2008). Amin and Thrift (2007) consider that the icons of assertive creative cities are Barcelona, San Francisco and Glasgow, while Romein and Trip (2009) conclude that Rotterdam and Amsterdam are positive examples of long-term development, since they took into consideration the interaction and balance of all their characteristics.

Nevertheless, an efficient response to this challenge depends on cities' capacity to attract, retain and stimulate individual talents (Florida, 2002), and so this author developed a model in which cities' attractiveness is influenced by the 3Ts model – Tolerance, Talent and Technology. Fernandes and Gama (2008) described how tolerance is related to openness, social inclusion and diversity; that talent reflects individuals' level of qualification and education and that technology expresses the level of concentration of innovation and high technology.

Moreover, these 3Ts provide cultural and social diversity (Florida, 2002, 2005; Grant & Kronstal, 2010) and total openness to entrepreneurial ideas and technology, which creates a creative economy and lets cities improve their economic performance, as argued by Florida (2002, 2005). In other words, the core of this model is the creative class, which covers individuals who use their creativity in favour of economic growth, with a tendency to concentrate in attractive places, specifically in cities, as stated by Florida (2002). In addition, concentrating on the creative industries, whose main actors are new entrepreneurs in the area of technology, the media and entertainment (Scott, 2000), is fundamental for better understanding of the spatial dimension of creative work regarding the attractiveness of urban areas, as the existence of effective connectivity (partnerships/networks) is relevant for creative workers (Brennan-Horley, 2010), namely social networks and open collaboration networks to spread knowledge (Przygodzki & Kina, 2015).

2.3. Sustainability theory

Historically, the concepts of sustainable development and sustainability began to be discussed in 1972 in Rome, with the debate remaining topical as seen in the Johannesburg Summit which ended in implementation of Agenda 21[2]. However, the notion of sustainability was only disseminated at the end of the 1980s, leading to numerous communications and related strategies (Bibri & Krogstie, 2017b).

The concept of sustainable development inherent to sustainability is that of Brundtland (1987), given its wide coverage, defining that this *"Is development that satisfies the needs of the present without jeopardizing future generation's ability to satisfy their needs."*, which began to be applied to urban planning from the 1990s (Wheeler & Beatley, 2014), i.e., to cities/regions. This definition emerges from the finding that social and economic development did not include the premise of future generations, reflected in the environmental and social crises that occurred (Bibri & Krogstie, 2017b).

In this context, sustainability theory is based on three indisputable pillars, which are environmental, economic and social sustainability, with a balance between them being necessary so that sustainable development can really exist (Elkington, 2004). In addition, Cavalcanti (1995) considered culture is the future pillar to be considered in sustainability, as it reflects the capacity to preserve the values that ensure society's cultural identity, values that allow the introduction of crucial new values to support the socio-economic transformations emerging in the domain of sustainability. So sustainability theory is based on three pillars – economic, social and environmental, which can be associated with the culture (Baycan, 2011; Çetindamar & Günsel, 2012; Giampietro, Gamboa, & Lobo, 2011; Khan & Zaman, 2018; Ratiu, 2013).

However, these concepts underlying sustainability theory are of a multi-faceted and complex nature regarding their applicability in socio-economic contexts (McManus, 1996; Molnar, Morgan, & Bell, 2001; Bibri, 2015), particularly with respect to cities/regions, meaning that urban sustainability allows reaching the balance between environmental protection and integration, economic development and regeneration, social equity and justice in cities (Bibri & Krogstie, 2017b). In this connection, the same authors argue that this balance is achieved through a strategic process of long-term sustainable development, whereby cities are directed towards the creation of healthy, practical and prosperous human environments, with minimum use of natural resources (e.g., energy and water) and with a minimum impact on the environment (in terms of waste and pollution), creating long-term synergies and defined as long-term endogenous goals for cities (Bibri & Krogstie, 2017b), as framed in the recent

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[2] https://sustainabledevelopment.un.org/outcomedocuments

promotion of the circular economy model/theory for sustainability to truly exist (European Commission, 2015).

2.4. Circular economy theory/model

The EUs' promotion of the circular economy theory/model means that the global sustainability aimed for by cities in Europe and worldwide involves the transition to a sustainable and efficient model, which should use more human capital than natural resources and thereby generate growth (European Commission, 2015). Consequently, the circular economy is crucial for more sustainable development in the present and future (Ghisellini, Cialani, & Ulgiati, 2016; Jones & Comfort, 2017; Lilja, 2015; Staniškis, 2012).

Looking back, theoretical development of the circular economy concept was begun by Boulding (1966), who introduced the concept of the cyclical system, in which the earth's finite resources were recycled and their value optimized. Building on the general premise of this system, Pearce and Turner (1990) approached the concept of the circular economy, arguing that the environment supplies amenities and systems to support life, deposit waste and a resource basis for the economy. In addition, systems theory suggests that the characteristics of the elements involved are understood as a dynamic whole, with the need for connectivity between them (Capra, 1985). Integration of these two concepts suggests that connectivity is crucial for the circular economy to be able to benefit from exogenous and endogenous synergies, the collaborative process between all elements (European Commission, 2015), and finally, network functioning (Jelinski et al., 1992), with individual and collective benefits (Álvarez & Ruiz-Puente, 2016), aiming to contribute to environmental quality and economic prosperity (Kirchherr, Reike, & Hekkert, 2017).

Specifically, this economy proposes the recycling of waste and its re-use, as a substitute for natural resources in order to safeguard future needs and make sustainability more likely (Sauvé, Bernard, & Sloan, 2016). Therefore, practical application of this theory allows one industry's sub-products to be primary raw material for others, that resources can be shared and in this way achieve optimization of resources and their value (McDonough et al., 2003; Sauvé et al., 2016; Smol, Kulczycka, & Avdiushchenko, 2017; Smol et al., 2015). Consequently, the model proposed by this theory promotes conservation of resources, to ensure healthy competition and maximum efficiency in the use of available resources (Geng & Doberstein, 2008).

It is of note that the holistic vision provided by this theory allows its application at different levels, particularly in cities/regions, as in the cases of Amsterdam[3] and Vancouver[4], which conjugated their economic, environmental and social goals by adopting the circular economy

[3] https://www.amsterdam.nl/publish/pages/768044/circular-amsterd.;
[4] http://www.vancouvereconomic.com/programs-initiatives/false-creek-flats/circular-economy/

as the pillar of their sustainability, although China was the first to apply this model (Geng & Doberstein, 2008; Ghisellini et al., 2016; Mathews & Tan, 2011; Sauvé et al., 2016). Expressed differently, Ghisellini *et al.*(2016) concluded that the circular economy means that products and processes are redesigned, recyclable and re-used to maximize their value in the economy, as a way to trigger and maximize economic growth, besides conserving the favourable characteristics supplied by the environment, such as the landscape or species, which add value to people's well-being (Andersen, 2007).

Nevertheless, technological innovation is determinant for the implementation of this model/theory, and so this transition from a linear economy model to a circular economy model represents a relevant change for economic actors, namely governments and consumers (Jones & Comfort, 2017), as shown in the policies of different country blocks, such as the European Union, China, Japan, the United Kingdom, Canada, Sweden, Finland and the Netherlands (Bonciu, 2014; Geng & Doberstein, 2008; Korhonen, Honkasalo, & Seppälä, 2018; Moreau et al., 2017). The policies implemented by these countries aim to stimulate resource efficiency (Mcdowall et al., 2017) through circular flows (Moreau *et al.*, 2017). However, Mathews and Tan (2016) suggest that policies based on the theory of the circular economy are not the same for all regions, given the different contexts between one country and another, or one city and another, for example, regarding the type of governance.

In this connection, Ligorio (2017) showed that the circular economy theory follows three fundamental principles, which are: (i) preserving and improving natural capital, by controlling finite stocks and by balancing the flows of natural resources; (ii) optimizing the income from resources, through circulating the components and materials up to their maximum use; and (iii) adopting a monitoring and assessment system to identify negative aspects.

Even so, it is important to mention that although the circular economy theory was, initially, directed towards natural resources, this has been approached in different scientific areas, highlighting studies on economic performance, among others (Korhonen et al., 2018). These authors underline the importance of this economy for sustainability, in which: 1) environmental sustainability – allows the reduction of raw material and energy inputs; raw inputs are predominantly renewable; 2) economic sustainability – activates a reduction in the amount of raw material and the inherent costs; resources are acquire a greater value, since they are used more than once; this leads to minimum use of costly resources, implying the reduction of costs inherent to environmental legislation, environmental taxes and insurance, image and potential for a green market; and 3) social sustainability – new job opportunities created by the re-use of resources and the community's increased feeling of responsibility. Furthermore, this economy contributes positively to the balance between the economic, social and environmental pillars, and therefore to greater sustainability and improved general well-being (Birat, 2015).

Then again, the circular economy is defined at the micro level (production/industries and consumption), whereas sustainable development considers the macro level (economic, social and environmental in a country, region or city) (Bartelmus, 2013; Ghisellini *et al.*, 2016). However, if the implementation of circular initiatives promotes more satisfactory results for sustainability, then this theory is a tool for sustainable development. Although it prioritizes environmental sustainability, it also recognizes the importance of a favourable economic context, but can neglect the social aspect (Sauvé *et al.*, 2016).

In addition, the circular economy theory represents a practical challenge that requires inter-disciplinarity in theoretical and practical terms, particularly regarding management, besides economy and engineering (Sauvé *et al.*, 2016). However, its implementation implies that consumer habits are redirected regarding how they satisfy their needs (European Commission, 2015; Sauvé et al., 2016). In conclusion, with cities being a crucial determinant factor for countries' economic development, CCCs are the starting point for the circular economy, where urban governance is effectively creative if characterised by dynamic management of their complex urban systems, aiming to achieve economic competitiveness, environmental conservation, reduced social costs, the resilience to stimulate social, cultural and symbolic exchanges on a circular basis in parallel with the processes of creating aggregate value, promoting the community and reducing poverty (Girard, 2011).

References

Acs, Z. J., & Szerb, L. (2007). Entrepreneurship, economic growth and public policy. *Small Business Economics*, *28*(2–3).

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 1–19.

Alkandari, A., Alnasheet, M., & Alshaikhli, I. F. T. (2012). Smart cities: a survey. *Journal of Advanced Computer Science and Technology Research*, *2*(2), 79-90.

Alter, C., & Hage, J. (1993). *Organizations working together* (Vol. 191). Sage Publications, Inc.

Álvarez, R., & Ruiz-Puente, C. (2017). Development of the Tool Symbiosys to Support the Transition Towards a Circular Economy Based on Industrial Symbiosis Strategies. *Waste and Biomass Valorization*, *8*(5), 1521–1530.

Amin, A., Massey, D. B., & Thrift, N. J. (2000). *Cities for the Many not the Few*. Policy Press.

Amin, A., & Thrift, N. (2007). Cultural-economy and cities. *Progress in Human Geography*, *31*(2), 143–161.

Andersen, M. S. (2007). An introductory note on the environmental economics of the circular economy. *Sustainability Science*, *2*(1), 133-140.

Andersson, Å. E., & Andersson, D. E. (2015). Creative Cities and the New Global Hierarchy. *Applied Spatial Analysis and Policy*, *8*(3), 181–198.

Audretsch, D. B., & Keilbach, M. (2004). Entrepreneurship capital and economic performance. *Regional Studies*, *38*(8), 949-959.

Audretsch, D. B., & Keilbach, M. (2005). Entrepreneurship capital and regional growth. *Annals of Regional Science*, *39*(3), 457-469.

Audretsch, D. B., & Lehmann, E. E. (2005). Do University policies make a difference? *Research Policy*, *34*(3), 343-347.

Ballas, D. (2013). What makes a happy city'? *Cities*, *32*, S39-S50.

Bartelmus, P. (2013). The future we want: Green growth or sustainable development? *Environmental Development*, *7*(1), 165–170.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., & Bazzani, A. (2012). Smart cities of the future, *The European Physical Journal Special Topics*, *214*(1), 481-518.

Baycan, T. (2011). Creative cities: Context and perspectives. In Girard, L. F., Baycan, T., & Nijkamp, P. *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (p. 15).
Belitski, M., & Desai, S. (2016). What drives ICT clustering in European cities ? *The Journal of Technology Transfer*, *41*(3), 430–450.
Bibri, S. E. (2015). The Shaping of Ambient Intelligence and the Internet of Things. (Vol. 10). Amsterdam: Atlantis Pres.
Bibri, S. E., & Krogstie, J. (2017a). On the social shaping dimensions of smart sustainable cities: A study in science, technology, and society. *Sustainable Cities and Society*, *29*, 219–246.
Bibri, S. E., & Krogstie, J. (2017b). Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustainable Cities and Society*, *31*, 183–212.
Bifulco, F., Tregua, M., Amitrano, C. (2017). Co-governing smart cities through living labs. Top evidences from EU. *Transylvanian Review of Administrative Sciences*, 13(*50)*, 21–37.
Birat, J.-P. (2015). Life-cycle assessment, resource efficiency and recycling. *Metallurgical Research & Technology*, *112*(2), 2-24.
Boix, R., & Trullén, J. (2007). Knowledge, networks of cities and growth in regional urban systems: theory, measurement and policy implications. *Papers in Regional Science*, *86*(4), 551-574.
Bonciu, F. (2014). The European economy: From a linear to a circular economy. *Romanian Journal of European Affairs*, *14*(4), 78–91.
Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.
Bouk, S. H., Ahmed, S. H., Kim, D., & Song, H. (2017). Named-data-networking-based ITS for smart cities. *IEEE Communications Magazine*, *55*(1), 105-111.
Boulding, K. (1966). The economics of the coming spaceship earth. *New York*.
Brennan-Horley, C. (2010). Multiple Work Sites and City-wide Networks: a topological approach to understanding creative work. *Australian Geographer*, *41*(1), 39–56.
Brorström, S., Argento, D., Grossi, G., Thomasson, A., & Almqvist, R. (2018). Translating sustainable and smart city strategies into performance measurement systems. *Public Money & Management*, *38*(3), 193–202.
Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. *United Nations Commission*, *4*(1), 300.
Cabrita, M. D. R., Cruz-Machado, V., & Cabrita, C. (2013). Managing creative industries in the context of knowledge-based urban development. *International Journal of Knowledge-Based Development*, *4*(4), 318–337.
Camagni, R. (2016). Afterthoughts on urban economic theory and its focus. *Investigaciones regionales: Journal of Regional Research*, *36*, 87–105.
Camagni, R., & Capello, R. (2004). The City Network Paradigm : Theory and Empirical Evidence. In *Urban Dynamics and Growth: Advances in Urban Economics* (pp. 495-529). Emerald Group Publishing Limited.
Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: An economy-environment technology nexus. *Ecological Economics*, *24*(1), 103–118.
Capello, R. (2000). The City Network Paradigm: Measuring Urban Network Externalities. *Urban Studies*, *37*(11), 1925–1945.
Capra, F. (1985). Criteria of systems thinking. *Futures*, *17*(5), 475–478.
Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.
Carrillo, F. J., Yigitcanlar, T., García, B., & Lönnqvist, A. (2014). *Knowledge and the city: Concepts, applications and trends of knowledge-based urban development*. Routledge.
Carta, M. (2009). Culture, communication and cooperation: The three Cs for a proactive creative city. *International Journal of Sustainable Development*, *12*(2–4), 124-133.
Caset, F., & Derudder, B. (2017). Measurement and interpretation of 'global cultural cities' in a world of cities. *Area*, *49*(2), 238–248.
Castells, M. (2010). The Information Age: Economy, Society, and Culture. Volume I: The Rise of the Network Society. Available online: http://www.urbanisztika.bme.hu/wp-content/uploads/2014/05/manuel_castells_the_rise_of_the_network_societybookfi-org.compressed.pdf.
Cavalcanti, C. (1995). *Sustentabilidade da economia: paradigmas alternativos de realização econômica. Desenvolvimento e natureza: estudos para uma sociedade sustentável.* São Paulo: Cortez.

Çetindamar, D., & Günsel, A. (2012). Measuring the Creativity of a City: A Proposal and an Application. *European Planning Studies*, *20*(8), 1301–1318.

Chang, D. L., Sabatini-marques, J., Moreira, E., Selig, P. M., & Yigitcanlar, T. (2018). Knowledge-based, smart and sustainable cities : a provocation for a conceptual framework. *Journal of Open Innovation: Technology, Market, and Complexity*, *4*(5), 1-17.

Coe, A., Paquet, G., & Roy, J. (2001). E-governance and smart communities: A social learning challenge. *Social Science Computer Review*, *19*(1), 80–93.

Cohen, B., Almirall, E., Chesbrough, H. (2016). The City as a Lab: Open innovation meets the collaborative economy. *California Management Review*, *59*(1), 5–13.

d'Ovidio, M., & Cossu, A. (2017). Culture is reclaiming the creative city: The case of Macao in Milan, Italy. *City, Culture and Society*, *8*, 7–12.

Dahiya, B. (2012). Cities in Asia, 2012: Demographics, economics, poverty, environment and governance. *Cities*, *29*(2), S44–S61.

Danielis, R., Rotaris, L., & Monte, A. (2018). Composite indicators of sustainable urban mobility: Estimating the rankings frequency distribution combining multiple methodologies. *International Journal of Sustainable Transportation*, *12*(5), 380–395.

David, Q., Peeters, D., Van Hamme, G., & Vandermotten, C. (2013). Is bigger better? Economic performances of European cities, 1960-2009. *Cities*, *35*, 237–254.

Della Lucia, M., Trunfio, M., & Go, F. M. (2017). Heritage and Urban Regeneration: Towards Creative Tourism. In *Tourism in the City* (pp. 179–191). Springer, Cham.

Della Lucia, M., & Trunfio, M. (2018). The role of the private actor in cultural regeneration: Hybridizing cultural heritage with creativity in the city. *Cities*, 2-10.

Derlukiewicz, N., & Mempel-śnieżyk, A. (2018). European cities in the face of sustainable development. *Ekonomia i Prawo. Economics and Law*, *17*(2), 125-135.

Dijkstra, L., Garcilazo, E., & Mccann, P. (2013). The Economic Performance of European Cities and City Regions : Myths and Realities. *European Planning Studies*,*21*(3), 334-354.

Dizdaroglu, D., & Yigitcanlar, T. (2014). A parcel-scale assessment tool to measure sustainability through urban ecosystem components: The MUSIX model. *Ecological Indicators*, *41*, 115–130.

Dodgson, M., & Gann, D. (2011). Technological Innovation and Complex Systems in Cities. *Journal of Urban Technology*, *18*(3), 101–113.

Donnell, A. O., Gilmore, A., Cummins, D., & Carson, D. (2001). The network construct in entrepreneurship research : a review and critique. *Management Decision*, *39*(9), 749–760.

Dowall, D. E., & Alan Treffeisen, P. (1991). Spatial transformation in cities of the developing world. Multinucleation and land-capital substitution in Bogota?, Colombia. *Regional Science and Urban Economics*, *21*(2), 201–224.

Echebarria, C., Barrutia, J. M., Aguado, I., Apaolaza, V., & Hartmann, P. (2016). Capturing the benefits that emerge from regional sustainability networks: The Castile-La Mancha network of sustainable cities and towns. *Papers in Regional Science*, *95*, S27–S49.

Elkington, J. (1994). Towards the sustainable corporation: win–win–win business strategies for sustainable development. *California Management Review*, *36*(2), 90–100.

Elkington, J. (2004). Enter the triple bottom line. The triple bottom line: Does it all add up. In *Chapter 1* (Vol. 11, pp. 1–16). Available online: http://www.johnelkington.com/archive/TBL-elkington-chapter.pdf.

Erkkilä, T., & Piironen, O. (2018). From Global to Local: Regional-and City-Level Alternatives to Global Rankings. In *Rankings and Global Knowledge Governance* (pp. 177-217). Palgrave Macmillan, Cham.

European Comission. (2015). An EU action plan for the circular economy, 614, 21. Available online: https://ec.europa.eu/growth/industry/sustainability/circular-economy_en.

European Commission, & UN Habitat. (2016). *The state of European cities 2016: Cities leading the way to a better future*. Available online: https://unhabitat.org/books/the-state-of-european-cities-2016-cities-leading-the-way-to-a-better-future/.

European Union. (2017). *The Cultural and Creative Cities Monitor*. European Union: Brussels, Belgium.

Eurostat. (2015). *Smarter, greener, more inclusive?* Available online: https://ec.europa.eu/eurostat/statistics explained/index.php/Smarter,_greener,_more_inclusive_-_indicators_to_support_the_Europe_2020_strategy.

Fernandes, R., & Gama, R. (2008). A Criatividade Territorial Em Portugal: Dos Indicadores Aos Territórios Criativos. Available online: https://core.ac.uk/download/pdf/19133326.pdf.

Ferraris, A., Santoro, G., & Papa, A. (2018). The cities of the future: Hybrid alliances for open innovation projects. *Futures*, 1-23.
Ferreira, T., & Filho, V. (2010). Teoria de redes: uma abordagem social. *Revista Conteúdo*, *3*, 1–19.
Firestone, W. A. (1987). The Rhetoric of Quantitative and Qualitative Research. *Educational researcher*, *16*(7), 16-21.
Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.
Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life)*. (Basic Books, Ed.). New York.
Florida, R. (2005). *Cities and the creative class*. Routledge.
Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'. *International Journal of Sustainable Development & World Ecology*, *15(3)*, 231–239.
Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy : the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11-32.
Giampietro, M., Gamboa, G., & Lobo, A. (2011). The Urban Metabolic Pattern: Dynamics and Sustainability. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (pp. 323–338).
Girard, L. F. (2011). Creativity and the human sustainable city: Principles and approaches for nurturing city resilience. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable city and creativity: Promoting Creative urban initiatives*. (pp. 55–96).
Glaeser, E., & Saiz, A. (2003). *The Rise of the Skilled City* (Nº. 10191). *National Bureau of Economic Research*.
Grant, J. L., & Kronstal, K. (2010). The social dynamics of attracting talent in Halifax. *Canadian Geographer*, *54*(3), 347–365.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Haberstroh, M. M., & Pinkwart, A. (2018). Increasing the Innovative Capacity of European Cities : Making Use of Proven Concepts from the National Level. In H. Springer, Berlin (Ed.), *European Cities in Dynamic Competition* (pp. 19–53).
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Hatuka, T., Rosen-Zvi, I., Birnhack, M., Toch, E., & Zur, H. (2018). The Political Premises of Contemporary Urban Concepts: The Global City, the Sustainable City, the Resilient City, the Creative City, and the Smart City. *Planning Theory and Practice*, *19*(2), 160–179.
Hojda, A. (2015). Tecnologia, informação e atores : conectando as partes da cidade inteligente. In *3º Simpósio Internacional LAVITS: Vigilância, Tecnopolíticas, Territórios* (pp. 276–290).
Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320.
Hospers, G.-J., & Pen, C.-J. (2008). A View on Creative Cities Beyond the Hype. *Creativity and Innovation Management*, *17*(4), 259–270.
Hoyman, M., & Faricy, C. (2009). It Takes a Village A Test of the Creative Class, Social Capital, and Human Capital Theories. *Urban Affairs Review*, *44*(3), 311–333.
Huovila, A., Penttinen, T., Airaksinen, M., Pinto-Seppä, I., Piira, K., & Penttinen, T. (2016). Smart city performance measurement system. In Proceedings of the 41th IAHS World Congress Sustainability Innovation for the Future, Algarve, Portugal, 13–16 September; pp. 1-10.
Jelinski, L. W., Graedel, T. E., Laudise, R. a, McCall, D. W., & Patel, C. K. (1992). Industrial ecology: concepts and approaches. *Proceedings of the National Academy of Sciences*, *89*(3), 793–797.
Jones, P., & Comfort, D. (2017). Towards the circular economy : A commentary on corporate approaches and challenges. J*ournal of Public Affairs*, *17*(4), e1680.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.
Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.
Khan, S., & Zaman, A. U. (2018). Future cities: Conceptualizing the future based on a critical examination of existing notions of cities. *Cities*, *72*, 217–225.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy : An analysis of 114 definitions, *Resources, Conservation & Recycling*, *127*, 221–232.
Kiuru, J., & Inkinen, T. (2017). Predicting innovative growth and demand with proximate human capital : A case study of the Helsinki metropolitan area. *Cities, 64*, 9–17.
Komninos, N. (2002). *Intelligent cities: innovation, knowledge systems, and digital spaces. Taylor & Francis.*
Kong, L. (2014). From cultural industries to creative industries and back? Towards clarifying theory and rethinking policy. *Inter-Asia Cultural Studies*, *15*(4), 593–607.
Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy : The Concept and its Limitations. *Ecological Economics*, *143*, 37–46.
Kourtit, K., Nijkamp, P., & Arribas, D. (2012). Smart cities in perspective – a comparative European study by means of self-organizing maps. *Innovation: The European Journal of Social Science Research*, *25*(2), 229–246.
Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.
Kumar, T. V., & Dahiya, B. (2017). *Smart Economy in Smart Cities*. In *Smart Economy in Smart Cities* (pp. 3-76). Springer, Singapore.
Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.
Lazzeretti, L., Capone, F., & Innocenti, N. (2017). Exploring the intellectual structure of creative economy research and local economic development: a co-citation analysis. *European Planning Studies*, *25*(10), 1693–1713.
Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.
Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.
Ligorio, V. (2017). New economic development pattern: from a linear to a circular economy, a challenge for eu's economy. *Міжнародний Науковий Журнал Інтернаука International Scientific Journal of International Science*, *1*(2), 20–23.
Lilja, R. K. (2015). Policy instruments for promoting material efficiency: case of Finland. *Clean Technologies and Environmental Policy*, 17(7), 2029–2040.
Malecki, E. J. (2007). Cities and regions competing in the global economy : knowledge and local development policies. *Environment and Planning C: Government and policy*. *25*, 638–655.
Mardikyan, S., Yıldız, E., Ordu, M., & Şimşek, B. (2015). Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA*, *2015*, 1–10.
Marôco, J. (2014). *Análise estatística com o SPSS Statistics*.
Marshall, A. (1920). *Principles of Economics*. (Royal Economic Society, Ed.). Available *online:* https://doi.org/10.1093/library/s5-XVII.3.238
Mathews, J. A., & Tan, H. (2011). Progress toward a circular economy in China: The drivers (and inhibitors) of eco-industrial initiative. *Journal of Industrial Ecology*, *15*(3), 435–457.
McDonough, W., Braungart, M., Anastas, P. T., & Zimmerman, J. B. (2003). Peer Reviewed: Applying the Principles of Green Engineering to Cradle-to-Cradle Design. *Environmental Science & Technology*, *37*(23), 434A–441A.
Mcdowall, W., Geng, Y., Huang, B., & Bartekov, E. (2017). Circular Economy Policies in China. *Journal of Industrial Ecology, 21*(3), 651–661.
Mcgranahan, D. & Wojan, T. (2007). Recasting the Creative Class to Examine Growth Processes in Rural and Urban Counties. *Regional Studies*, 41(2), 197-216.
McManus, P. (1996). Contested terrains: Politics, stories and discourses of sustainability. *Environmental Politics*, *5*(1), 48–73.
Meijer, A., & Bolivar, M. P. R. (2016). Governing the smart city : a review of the literature on smart urban governance governance. *International Review of Administrative Sciences*, *82*(2), 392-408.
Meijers, E. J., Burger, M. J., & Hoogerbrugge, M. M. (2016). Borrowing size in networks of cities: City size, network connectivity and metropolitan functions in Europe. *Papers in Regional Science*, *95*(1), 181-198.
Mentzer, J. T., & Kahn, K. B. (1995). A framework of logistics research. *Journal of Business Logistics*, *16*(1), 231–251.
Minayo, M. C. de S., & Sanches, O. (1993). Quantitativo-qualitativo: oposição ou complementaridade? *Cadernos de Saúde Pública*, *9*(3), 237–248.
Miškovičová, A., Vaňová, A., Vitálišová, K., & Borseková, K. (2016). Strategies of creative

potential development in the cities. In *9th Annual Conference of the EuroMed Academy of Business* (pp.1293-1312).
Muñoz, P., & Cohen, B. (2016). The making of the urban entrepreneur. *California Management Review*, *59*(1), 71-91.
Molnar, D , Morgan, A., & Bell, D. (2001) *Defining Sustainability, Sustainable Development and Sustainable Communities: A working paper for the Sustainable Toronto Project*. Available online: https://www.google.com.tw/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwilje3xnLDeAhUKdt4KHTs0DEcQ FjAAegQICBAC&url=http%3A%2F%2Fsites.utoronto.ca%2Fenvstudy%2Fsustainabletoronto%2Fresource s%2FSustainableTorontoDefinitionsPaper-FinalDraft.doc&usg=AOvVaw3FreTQcwerwSBvQ5-MbUc.
Mooi, E., & Sarstedt, M. (2011). Understanding cluster-analysis. *A Concise Guide to Market Research. The Process, Data, and Methods Using IBM SPSS Statistics*, 259-283.
Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research : A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3-27.
Moreau, V., Sahakian, M., Griethuysen, P., & Vuille, F. (2017). Coming Full Circle Why Social and Institutional Dimensions Matter for the. *Journal of Industrial Ecology.*, *21*(3), 497–506.
Musterd, S., & Ostendorf, W. J. M. (2004). Creative cultural knowledge cities; Perspectives and planning strategies. *Built Environment*, *30*(3), 189–193.
Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.
Networked Society City Index (2016). *Cities play key role in sustainable development. Available onlibe: https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.*
Nijkamp, P., & Kourtit, K. (2013). The “New Urban Europe”: Global Challenges and Local Responses in the Urban Century. *European Planning Studies*, *21*(3), 291–315.
Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495.
O’Connor, J., & Shaw, K. (2014). What next for the creative city? *City, Culture and Society*, *5*(3), 165–170.
O’Connor, D. O., & Voos, H. (1981). Empirical Laws, Theory Construction and Bibliometrics.
OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.
Pain, K., Van Hamme, G., Vinciguerra, S., & David, Q. (2016). Global networks, cities and economic performance : Observations from an analysis of cities in Europe and the USA. *Urban Studies*, *53*(6), 1137-1161.
Parkhe, A., Wasserman, S., & Ralston, A. (2006). New frontiers in network theory development. *Academy of Management Review*, *31*(3), 560–568.
Partridge, H. (2004). Developing a Human Perspective to the Digital Divide in the Smart City. *ALIA 2004 Biennial Conference Challenging Ideas*, 1–7. Available on: http://conferences.alia.org.au/alia2004/conference.papers.html.
Patton, M. J. (1991). Qualitative research on college students: Philosophical and methodological comparisons with the quantitative approach. *Journal of College Student Development*, *32*, 389–396.
Patton, M. Q. (2002). Two Decades of Developments in Qualitative Inquiry: A Personal, Experiential Perspective. *Qualitative Social Work*, *1*(3), 261–283.
Pearce, D., & Turner, R. (1990). *Economics of Natural Resources and the Environment.* JHU Press.
Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS.*
Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, *41*(1), 116.
Pozdniakova, A. (2017). Smart sustainable cities: the concept. *Acta Innovations*, *22*, 5–19.
Putnam, R. (2000). Bowling alone: The collapse and revival of American community.

Pratt, A. C. (2008). Creative cities: The cultural industries and the creative class. *Geografiska Annaler, Series B: Human Geography*, *90*(2), 107–117.

Priano. F., & Guerra, C. (2014). A framework for measuring smart cities. In *Proceedings of the 15th Annual International Conference on Digital Government Research,* Aguascalientes, Mexico (pp. 44-54). ACM.

Przygodzki, Z., & Kina, E. (2015). Virtual Community for A Creative City. *Quaestiones Geographicae*, *34*(2), 65–73.

Quinlan, K. M., Kane, M., & Trochim, W. M. K. (2008). Evaluation of large research initiatives: Outcomes, challenges, and methodological considerations. *New Directions for Evaluation*, *2008*(118), 61–72.

Ratiu, D. E. (2013). Creative cities and/or sustainable cities: Discourses and practices. *City, Culture and Society*, *4*(3), 125–135.

Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.

Romein, A., & Trip, J. (2009). Key elements of creative city development: an assessment of local policies in Amsterdam and Rotterdan. *City Futures' 09, 4-6,Madrid*.

Romero-Padilla, Y., Navarro-Jurado, E., & Malvárez-García, G. (2016). The potential of international coastal mass tourism destinations to generate creative capital. *Journal of Sustainable Tourism*, *24*(4), 574–593.

Rowley, J., & Slack, F. (2004). Conducting a literature review. *Management Research News*, *27*(6), 31–39.

Sabadie, J. A., & Johansen, J. (2010). How do national economic competitiveness indices view human capital? *European Journal of Education*, *45*(2), 236–258.

Sassen, S., Taylor, P., Derudder, B., Witlox, F., Rutherford. J., Hoyler, M., … Jackson, D. (2008). Connecting cities: networks. In *the 9th World Congress Of Metropolis*. *Connecting cities*. Metropolis Congress, Sydney, N.S.W.

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy : Alternative concepts for trans-disciplinary research. *Environmental Development*, *17*, 48–56.

Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.

Scott, A. J. (2010). Cultural economy and the creative fields of the city. *Geografiska Annaler: Series B, Human Geography*, *92*(2), 115–130.

Serapioni, M. (2000). Métodos qualitativos e quantitativos na pesquisa social em saúde: algumas estratégias para a integração. *Ciência & Saúde Coletiva*, *5*(1), 187–192.

Shutters, S. T., Muneepeerakul, R., & Lobo, J. (2016). Constrained pathways to a creative urban economy. *Urban Studies*, *53*(16), 3439–3454.

Siegel, K. (2016). Can Regional Cooperation Promote Sustainable Development? In J. Grugel & D. Hammett (Eds.), *The Palgrave Handbook of International Development* (pp. 713–730).

Silcock, B. Y. R. (2001). What is e-Government ? *Parliamentary affairs*, *54*(1), 88-101.

Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy*, *19*(3), 669–678.

Smol, M., Kulczycka, J., Henclik, A., Gorazda, K., & Wzorek, Z. (2015). The possible use of sewage sludge ash (SSA) in the construction industry as a way towards a circular economy. *Journal of Cleaner Production*, *95*, 45–54.

Snow, C. C., Håkonsson, D. D., & Obel, B. (2016). A Smart City Is a Collaborative Community: Lessons from smart Aarhus. *California Management Review*, *59*(1), 92–108.

Staniškis, J. K. (2012). Sustainable consumption and production: How to make it possible. *Clean Technologies and Environmental Policy*, *14*(6), 1015–1022.

Stevens, J. (1986). Chapter 11 - Exploratory and Confirmatory Factor Analysis. In L. E. Associates. (Ed.), *Applied multivariate statistics for the social sciences*. New Jersey. USA.

Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.

UN-HABITAT. (2013). *State of the World's Cities 2012/2013: Prosperity of cities*. Available online:
https://sustainabledevelopment.un.org/content/documents/745habitat.pdf.

Walker, R. M., & Hills, P. (2012). Partnership Characteristics, Network Behavior, and Publicness: Evidence on the Performance of Sustainable Development Projects. *International Public Management Journal*, *15*(4), 479–499.

Wall, R. S., & Stavropoulos, S. (2017). Smart cities within world city networks. *Applied*

Economics Letters, *23*(12), 875–879.
Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications. *Cambridge University Press*, *1*, 116.
Wennekers, S., Van Wennekers, A., Thurik, R., & Reynolds, P. (2005). Nascent entrepreneurship and the level of economic development. *Small Business Economics*, *24*(3), 293–309.
Wheeler, S., & Beatley, T. (2014). *The Sustainable Urban Development Reader*. Routledge.
White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. *Journal of the American Society for Information Science*, *49*(4), 327–355.
World Economic and Social Survey (2013). Sustainable Development Challenges. UNDESA: New York, NY, USA, 2013.
Yin, R. (2015). *Case study research: design and methods - Applied social research methods series*. Thousand Oaks, CA: Sage Publications, Inc.
Ynalvez, M. A., & Shrum, W. M. (2011). Professional networks, scientific collaboration, and publication productivity in resource-constrained research institutions in a developing country. *Research Policy*, *40*(2), 204–216.

CHAPTER 2

NETWORKS AND PERFORMANCE OF CREATIVE CITIES: A BIBLIOMETRIC ANALYSIS

ABSTRACT

This study makes a systematic review of the literature on networks and performance of creative cities, consisting of a bibliometric analysis whose final sample covered 102 publications. The results reveal growing interest in the concept of creative cities, identifying two clusters: (1) Creative cities and their connection with the creative class and culture; and (2) Creative/cultural clusters and networks. Based on the evidence obtained, a gap remains concerning the lack of additional studies on the performance of creative cities and the corresponding determinant factors, such as networks. Some theoretical and practical implications are presented, together with suggestions for future research.

Key Words: Creative Cities, Creative Economy, Performance, Networks, Sustainability

1. Introduction

Most European countries have a long and diversified cultural history, of a multicultural nature that has been emphasized in recent decades for ethnic, religious, linguistic and even migratory reasons (Putnam, 2007). One of the distinctive characteristics of this multicultural diversity is the urbanism associated with some places (Nathan, 2012), which represents a significant challenge for urban regional governance (Syrett & Sepulveda, 2012). This challenge has led to a substantial change in the view of the factors determining economic, social and sustainable development at the global scale, where cities' intangible assets begin to be more and more pillars of endogenous growth all around the world. This means that factors such as creativity and culture are common ways to promote a city's urban growth (d'Ovidio & Cossu, 2017), because this process of changing the principles, vision and strategies of economic growth began in the 1970s, with the human capital of the creative sectors lying in the stock of new entrepreneurs (d'Ovidio & Cossu, 2017), who have the capacity to promote job creation and thereby create wealth in cities (Florida, 2005).

In this context, major dynamics have been seen in terms of regional and local policies to promote creativity and culture in cities to benefit the urban economy, aiming to bring to fruition the regeneration longed for in some neighbourhoods, through culture, art, industry and urban design, in order to form a comfortable urban environment stimulating creativity (Nohara, Okamura, & Kawahara, 2016).

Recent years have seen increased interest in the concept of creative cities, both in the academic community and among entities responsible for economic growth policies (Peck, 2005; Zimmerman, 2008; Murphy & Redmond, 2009; Ponzini & Rossi, 2010), representing the transition to a new economy (Scott, 2006) based on ideals of culture and creativity (Lawton, Murphy, & Redmond, 2010) as specific elements of urban planning and entrepreneurship (Hall & Hubbard, 1996), and where economic growth is founded on urban competitiveness as a way to promote urban regeneration (Kipfer & Keil, 2002).

This emergence of creative cities has generated some controversy regarding their definition, due to the numerous constructs involved and the difficulty in defining the frontier between this concept and other related ones, such as intelligent cities and smart cities. However, this study uses the term of creative city, which was defined by various authors (e.g. Cabrita, Cruz-Machado, & Cabrita, 2013; Carta, 2009; Florida, 2002, 2005; Landry, 2000; Letaifa, 2015; Musterd & Ostendorf, 2004; O'Connor & Shaw, 2014). Consequently, creative cities are defined as pluralist, multi-faceted places, characterised by curiosity, imagination, creativity, culture, knowledge, innovation and cooperation (networks), with this statement guiding the research.

In this connection, cooperation is related to establishing networks inside and outside the city, as a means of sharing and creating synergies, and so these networks are fundamental to obtain competitive advantage (Banks *et al.*, 2000) and for the exchange of symbolic knowledge (Asheim et al., 2007; Asheim, Coenen, & Vang, 2007; Vinodrai, 2006). Those networks are widely used to create and reinforce cities' innovative capacity through the interaction between all their actors, where cities are transformed in a space of collaboration and learning to attain a common, shared objective – knowledge (Ling & Martins, 2015; Laitinen, Osborne, & Stenvall, 2016).

Although current's cities include creativity as a key element of their economic, social, environmental (tripartite sustainability) and cultural growth, in the extensive literature on the subject, studies measuring creative cities' performance are concerned with creativity *per se* and not with all the dimensions inherent to these cities (e.g. Andersson & Andersson, 2015; Caset & Derudder, 2017; Florida, 2002; Kourtit, Nijkamp, & Arribas, 2012; Miškovičová et al., 2016). There is a scarcity of studies assessing the holistic impact of creativity on cities' economic performance (Shutters, Muneepeerakul, & Lobo, 2016), exploring how the creative city contributes to sustainability (Cabrita et al., 2013; d'Ovidio & Cossu, 2017; Nevens et al., 2013), increasing understanding of how networks are essential in creative, sustainable cities (Echebarria et al., 2016; Virta & Lowe, 2017). This gap should be filled by adopting a holistic approach, i.e., through research into the relationship between networks and creative cities' performance, and thereby assessing the chain effect of these three constructs. Moreover, the scientific literature on this topic does not include any systematic literature review addressing the three constructs simultaneously, corroborating Lazzeretti, Capone, and Innocenti (2017) who concluded on the lack of this type of study of the subject.

It is consequently considered relevant to compile that literature systematically, and so the aims of this study are to: (i) identify the subjects most researched in the academic sphere about the networks and performance of creative cities through a bibliometric review; and (ii) identify remaining gaps requiring additional research efforts.

Summarizing, this study aims to address the gaps identified through exploration and systematization of the main topics to contribute to enriching the literature on creative cities, as well as highlighting the little-explored constructs in the conceptual and theoretical structure of the various studies selected, which in turn give indications for future research.

2. Methodology

In order to respond to the main objective of this article, i.e., identify the subjects most studied regarding creative cities' networks and performance, through the corresponding bibliometric analysis, it was decided to make a systematic review of the literature (O'Connor & Voos, 1981; Wasserman & Faust, 1994; Powell, Koput, & Smith-Doerr, 1996; White & McCain, 1998; Quinlan, Kane, & Trochim, 2008).

Table 1 – Description of the bibliometric analysis

1.	Identification, assessment, content analysis in specific areas, as well as systematization of concepts, theories and practices (Rowley & Slack, 2004).
2.	Add critical aggregate value by summarizing the literature on the topic studied, identifying gaps and indications for future research (Mentzer & Kahn, 1995).
3.	Allow a standardized descriptive analysis (e.g., authors, scientific journals, citations and co-citations, key-words) (Prasad & Tata, 2005; Treinta et al., 2014) and conceptual contents (Seuring & Mu, 2008).
4.	Through a methodical and structured research design, defining criteria and key-words of the research to delimit the process of searching the literature (Bandara, Miskon, & Fielt, 2011; Treinta et al., 2014).

Source: Own elaboration

The research methodology of bibliometric analysis followed in this study – co-citation analysis, word frequency – took as the unit of analysis scientific articles (empirical and reviews), books, book chapters and proceedings papers, aiming to group the documents with the same objective and central issue (Grácio, 2016). The methodological procedures defined by Tranfield, Denyer, and Smart (2003) were also followed, i.e., planning, development and presentation of the results.

The research was carried out in March 2018 and Table 2 presents the synthesis of the items and search criteria.

Table 2 – List of items and search criteria

Items	Criteria
Period:	No chronological filter
Online databases:	*ISI (Web of Science)* and *Scopus*
Key-words:	*(network* and creative cit* or creative economy and perform* and sustainab*)*
Systematization by search category:	Urban studies or Management or Planning Development or Business
Systematization by document type:	Articles, Proceedings Papers and Reviews
Software used:	Endnote X8 and Microsoft Excel 2016
Documents identified: Duplicate documents and others excluded: Documents analysed:	121 -19 102

Source: Own elaboration

After obtaining the final version of the document database, the next step was to define the sequential stages to follow in carrying out the bibliometric analysis.

3. Sequence of data analysis and research rigour

The sequential stages to analyse the data obtained from the 102 publications gathered in the final version of the database are described in Table 3. This table presents the methodological procedures adopted in the different stages of developing this analysis.

Table 3 – Methodological procedures

Stage	Criterion
1st	Extracting files from the online databases to make the descriptive analysis.
2nd	Exporting the 102 files in **.pdf* format to *Nvivo 11*, to quantify the frequency of the keywords used in the search.
3rd	Use of *Vosviewer* software to identify and analyse the co-citation network, network density and clusters. The aim is to identify research streams, construct and visualize the bibliographic networks of the 102 documents (Gmür, 2003; Jeong, Song, & Ding, 2014; Small, 1973; van Eck & Waltman, 2010; Waltman, van Eck, & Noyons, 2010).
4th	Identification of the most studied topics in the 102 documents, according to the clusters obtained, and their contributions. Content analysis aims to systematize the most studied topics in the academic field, i.e., the clusters obtained in the 3rd stage; this analysis is systematic to overcome the inherent subjectivity, for it to be reliable and duly validated, as well as providing the holistic sequencing of the literature in question (Becker, Bryman, & Ferguson, 2012; Ryan, Scapens, & Theobold, 2002; Spens & Kovács, 2006; Tranfield et al., 2003; Yin, 2015).

Source: Own elaboration

4. Results and discussion

4.1. Descriptive Analysis

According to the selection of 102 documents to include in this study, scientific articles (76) are found to predominate in the literature on the theme, representing 74% of the total in the final database, of which four are written in a language other than English.

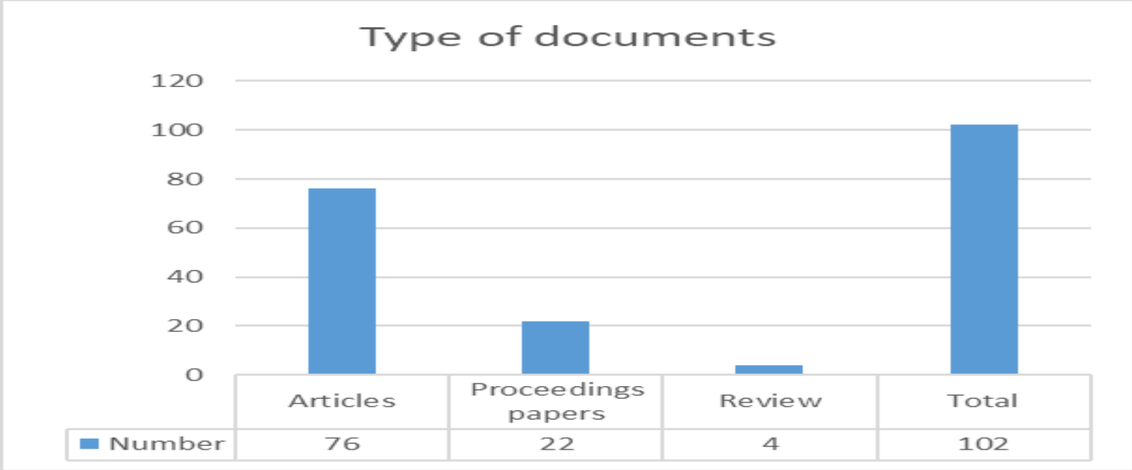

Figure 1 - Type of documents on networks and performance of creative cities, adapted from the *Web of Science* and *Scopus* databases

From the immensity of publications on this subject (which includes articles, chapters of books, books, presentations of lectures, etc.), only articles, proceedings papers and reviews (Pelletier et al., 2013) were methodologically serialized. Under these circumstances, the the search identified four review articles, and the first systematic literature review was published in 2012 *Nathan, M.: "After Florida: Towards an economics of diversity" European Urban and Regional Studies, 22(1), 3-19.* and the most recent in June 2017, by *Lazzeretti, L., Capone, F., & Innocenti, N.: "Exploring the intellectual structure of creative economy research and local economic development: a co-citation analysis." European Planning Studies, 25(10), 1693-1713*, with fourteen citations and zero citations respectively.

The first document on this topic was published by Batten, D. (1995), entitled: *"Network Cities - creative urban agglomerations for the 21st-century"* in the *Urban Studies* journal of quartile 1 with an impact factor (SJR) of 1.648. The last article published (until 16 March 2018) is by He, J., Huang, X. and Xi, G. entitled *"Urban amenities for creativity: An analysis of location drivers for photography studios in Nanjing, China"*, published in the *Cities* journal of quartile 1 from 2009 to the present, whose impact factor (SJR) is 1.332.

Figure 2 shows the evolution of publications from 1995 to March 2018, with the peak of publications on this subject being the 16 documents published in 2015.

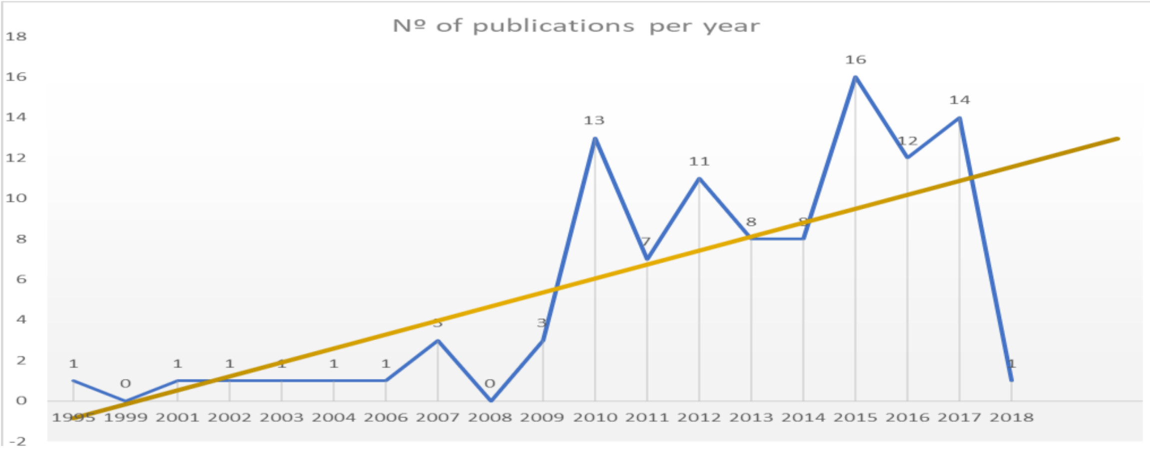

Figure 2 - Evolution of publications on networks and performance of creative cities, adapted from the Web of Science and Scopus databases

Figure 2 reveals that the most productive years for research on networks and performance of creative cities were between 2010 and 2017, as seen by the linear slope, demonstrating that after the economic and financial crisis, this subject aroused the interest of the academic community, stimulated by politicians' interest in finding new strategies for the economic development of countries, regions and cities. In other words, a transformation is found in the vision of how economic growth could be raised and sustained, which led to elaboration and implementation of the 2020 Strategy by the European Union in 2010. In more recent years, numerous publications have appeared on the interpretation and assessment of intelligent, sustainable and inclusive growth of so-called creative cities, signalling the subject's great potential.

For the individualization of the countries that contributed the most with publications on this topic, the nationalities of the first authors of the 102 articles selected were verified. Thus, Table 4 presents the distribution of publications by country.

Table 4 – Publication by country

Country	*Nº of publications*	*Country*	*Nº of publications*
United States of America	18	*Belgium*	4
United Kingdom	15	*Spain*	4
Australia	6	*Sweden*	4
Canada	6	*Finland*	3
Italy	6	*Indonesia*	3
Netherlands	6	*Poland*	3
China	6	*Austria*	2
Germany	5	*Denmark*	2
Romania	5	*Estonia*	2
Taiwan	5	*France*	2

Source: Adapted from the *Web of Science* and *Scopus* databases (N=102)

In the classification presented in Table 4, the United States of America (USA), the United Kingdom and Australia stand out. The prevalence of research in the US is linked to the theory of the creative class by Richard Florida, whose studies focus mainly on American cities.

However, the other countries are found to have applied this theory in the empirical studies made.

Table 5 presents the main journals publishing the documents selected, as well as the areas of research studies have dealt with.

Table 5 – Publications by source titles

Source title	Nº of publications	Impact factor (SJR)	Quartile	Country	Search category
European Planning Studies	16	0.976	Q 1	UK	*Planning and Development*
Urban Studies	14	1.648	Q 1	UK	*Urban Studies*
International Journal of Urban and Regional Research	7	2.775	Q 1	UK	*Urban Studies*
Cities	5	1.332	Q 1	UK	*Urban Studies*
European Urban and Regional Studies	5	1.346	Q 1	USA	*Urban Studies*
Urban Geography	3	1.391	Q 1	UK	*Planning and Development, Urban Studies*
Journal of Urban Affairs	2	1.167	Q 1	UK	*Urban Studies*
Journal of Planning Education and Research	2	1.047	Q 1	USA	*Planning and Development, Urban Studies*
Others<1	45				
Total	102				

Source: Adapted from *ISI Web of Science, Scopus* and *SJR Impact Factor*

The *European Planning Studies* journal presents the greatest number of publications, where the most quoted article is by Turok (2003), with 72 citations, while the *Urban Studies* journal includes the article by Batten (1995), which was subject to 150 citations. However, the most quoted article (852 citations) is published in the *Journal of Urban Affairs* (see Table 6), which only includes two publications from the selected database (N=102). The predominance of those two journals is explained by the editorial lines followed, as well as the objectives and range of topics covered. The former analyses and assesses past and present urban development and management as a reflection of effective, ineffective and non-existent planning policies, as well as promoting the implementation of appropriate urban policies; the latter emphasizes urban and regional research through a multi-disciplinary approach to analyse the social and economic contributions of urban and regional planning.

Table 6 presents the most quoted authors, based on compilation of the reports from the two databases used (*ISI Web of Science* and *Scopus*).

Table 6 – *Citations by author/article (Top 20)*

Author(s)/ Year	*Nº of publications*	*Total citations*	*Journal*
Scott (2006)	1	852	*Journal of Urban Affairs*
Batten (1995)	1	150	*Urban Studies*
Bettencourt, Lobo and Strumsky (2007)	1	104	*Research Policy*
Pratt (2009)	1	83	*Urban Studies*
Turok (2003)	1	72	*European Planning Studies*
Ponzini and Rossi (2010)	1	65	*Urban Studies*
Comunian (2011)	1	65	*Urban Studies*
Yeoh and Chang, (2001)	1	63	*Urban Studies*
Krätke (2010),	1	59	*International Journal of Urban and Regional Research*
Krätke (2004)	1	55	*International Journal of Urban and Regional Research*
Cohendet, Grandadam and Simon (2010)	1	36	*Industry and Innovation*
Lewis and Donald (2010)	1	33	*Urban Studies*
Grodach (2011)	1	32	*Journal of Planning Education and Research*
Currid and Williams (2010)	1	29	*Journal of Planning Education and Research*
Davis, Creutzber and Arthurs, (2009)	1	24	*Innovation-Management Policy & Practice*
Martínez (2007)	1	22	*Urban Studies*
Mayer and Knox (2010)	1	22	*European Planning Studies*
Méndez and Moral (2011)	1	22	*European Planning Studies*
Borén and Young (2013)	1	21	*International Journal of Urban and Regional Research*

Source: Adapted from *ISI Web of Science and Scopus*

Analysis of the information contained in Table 6 presented above reveals that the most quoted article is that of Scott (2006) and 2010 is the year with the greatest number of articles (6), this being the reflection of the paradigmatic change in the vision of the city by political and economic actors. The author S. *Krätke* stands out with 2 documents, and 114 citations, both of them published in the *International Journal of Urban and Regional Research* with an impact factor of 2.775 (Table 5). A. Scott obtained a total of 852 citations for a single publication. Regarding the sources of publications, 12 of the articles by authors appearing in Table 6 were published in journals included in the Top 10 (Table 5), for example, *Urban Studies*, which includes 7 of those articles.

The majority of the most quoted articles present empirical evidence obtained from case studies (qualitative methodology) (e.g., Davis et al., 2009; Lewis & Donald, 2010; Turok, 2003), while studies based on quantitative methodology are scarce (Currid & Williams, 2010; Neal, 2012) with the theoretical framework being dominated by the theory of Florida (2002) (e.g., Bettencourt et al., 2007; Comunian, 2011; Krätke, 2010; Neal, 2012) and the units of analysis being cities (e.g., Batten, 1995; Krätke, 2004; Yeoh & Chang, 2001) and culture (e.g., Currid & Williams, 2010; Grodach, 2011; Pratt, 2009); while the sub-topics most studied are creative/cultural industries (e.g., Davis et al., 2009; Grodach, 2011; Turok, 2003), creative clusters (e.g., Cohendet et al., 2010; Pratt, 2009), urban development and creative city networks (inter and intra) (e.g., Bettencourt et al., 2007; Mayer & Knox, 2010; Ponzini & Rossi, 2010).

Summarizing, this descriptive analysis shows the tendencies of the 102 documents selected in relation to various types of bibliographic information and the main contributions of the most cited authors. Nevertheless, this analysis should be complemented by identification of documents (articles/books) with the greatest number of co-citations of authors included in the final database selected, and so the next section proceeds accordingly, using cluster analysis.

4.2. Lexical and Cluster Analysis

The final version of the file of publications was exported to *Nvivo 11* software, for analysis of key-word frequency (see Table 7) and to draw up the corresponding cloud of words used in the search made of the databases: *ISI Web of Science* and *Scopus* (see Figure 3).

Table 7 – Lexical analysis of key-words of the final document database

Key-words	*Similar words*	*Frequency count*
Creativ'*	creativ, creative, 'creative, creative', creatively, creatively', creativeness, creatives, creatives', creatives', creativities, creativity, creativity', creat, creat', create, created, creates, creating	9.055
*Cit**	citied, cities, cities', cities', city, city', city', city''april, city'sofficial	8.093
*Network**	network, 'network, network', networked, networker, networkers, networking, networking', networks, networks', networks''	4.171
*Econom**	economie, economies, economies', economy, economy', economy''	2.592
*Perform**	perform, perform', performance, performance', performances, performances', performative, performed, performer, performers, performers', performing, performs	2.304
*Sustain**	sustain, sustainabilities, sustainability, sustainability', sustainable, sustainable', sustainably, sustained, sustaining, sustainment, sustains	1.689

Source: *Nvivo* 11

Figure 3 – Word cloud resulting from the lexical analysis

Table 7 and Figure 3 clearly show the incidence of the key-words guiding the research on the topic analysed and the pertinence of the final documents selected.

By exporting the final version of the file containing all 102 documents selected, from *Endnote X8* software to *Vosviewer* software, it was possible to obtain outputs regarding the co-citation network and the corresponding density (see Figure 4). We went on to identify composite networks, using the level of analogy of the bibliographic references included in the final version of the database. Therefore, the so-called bibliographic connection of those documents was performed, with the filters referred to in Table 1, which also allowed analysis of recent work so far not quoted (Rehn & Kronman, 2008). Afterwards, the two clusters obtained show the existence of theoretical and practical differences between the documents forming the clusters and simultaneously a link in terms of the general subject (Egghe & Rousseau, 2002).

This reflects the need to respond to the objective guiding this article, i.e., to identify the flows by key-search (clusters) by using *Vosviewer* (version 1.6.4) software, to construct and view the bibliometric networks (van Eck & Waltman, 2010) from the co-citation approach. This software allows the conception and visualization of bibliometric maps of the authors most cited and co-cited by researchers in the final base of selected documents, with the respective identification of clusters and co-citation reference networks (van Eck & Waltman, 2010; Waltman et al., 2010), allowing us to check the frequency with which two documents are quoted. This means that co-citation analysis is focused on the frequency with which two documents are cited and on the weight of the co-citations in those documents when they are cited by an additional document (Small, 1973), reflecting the academic world's perception of a field of research (Gmür, 2003) and the clustering by co-citations in the scientific literature (Jeong et al., 2014). Additionally, Small (1973) further explained that co-occurrence of two documents cited in the same document is a co-citation, allowing the analysis, identification and description of the correlation structure in a given scientific field (Bayer, Smart, & McLaughlin, 1990). This means that the frequency with which the events occur is directly related to the small authors and their interest in the published documents (Marshakova, 1981). As a synthesis, Grácio and Oliveira (2013) explained that the analysis of citations demonstrates *"... the researchers with the greatest impact in the area, pointing out their paradigms, pertinent methodological procedures, as well as cutting-edge researchers who build new knowledge in the field."*

To enhance the bibliometric analysis through incorporating content analysis of the final selection of 102 documents, in order to systematize the research topics most studied by the scientific community and which gave rise to the two clusters (Spens & Kovács, 2006; Seuring & Gold, 2012). This content analysis is prone to some subjectivity, given its qualitative nature, but this does not detract from the validity of its inferences or its rigour (Becker *et al.*, 2012), and so a structured, systematic approach was adopted to overcome this limitation, as recommended by Tranfield *et al.* (2003) and Seuring and Gold (2012). So the reliability and validity of the information included in this analysis was achieved by using the two online databases and by holistic linking of that information (Ryan *et al.*, 2002; Yin, 2015).

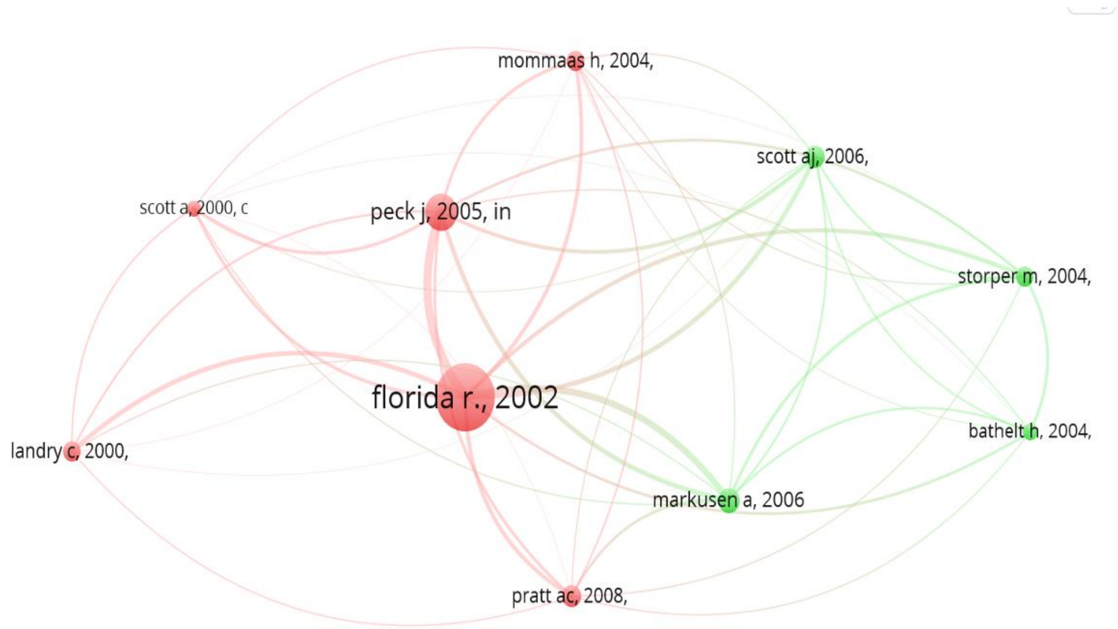

Figure 4 – Co-citation network of references (*Vosviewer*)

The most prominent nodes in Figure 4 show the relative importance of the number of citations of each study, while the proximity or distance between documents forming the network reveals the size of the connection between documents linked bibliographically. For example, the study by Florida (2002), entitled: "*The Rise of the Creative Class*" (red cluster, most relevant) presents quite a significant similarity/connection with the study by Markusen (2006), entitled: "*Urban development and the politics of a creative class: evidence from a study of artists*" (green cluster, less relevant), and so the references of these articles include bibliography cited by both, providing revealing evidence of the bibliographic connection, through co-citation, which confirms the different levels of importance of these two references in the scope of the research carried out so far on the topic of creative cities.

Two clusters with a total number of 10 documents were obtained, where the connection between them is relevant, as a consequence of the connectivity between the themes investigated in the 102 documents selected, corroborating the word frequency shown previously and the corresponding cloud (see Table 7 and Figure 3 above).

This bibliometric analysis is followed by content analysis of the documents in the clusters – micro level (10 articles) and the 102 documents generating them – macro level, to be able to identify the contributions and suggestions for future research.

4.3. Results and Discussion

As already mentioned, the clusters were obtained from the analysis of co-citations of the documents, whose nucleus of analysis corresponds to the set of references cited in the 102 final documents. Tables 8 and 9 show the individual information from the 10 documents divided in 2 clusters, being complemented by the lexical analysis of all of them, obtained using *Nvivo 11* software (Figure 5).

Therefore, Figure 5 shows the total frequency of key-words in the documents included in the clusters and the corresponding lexical analysis.

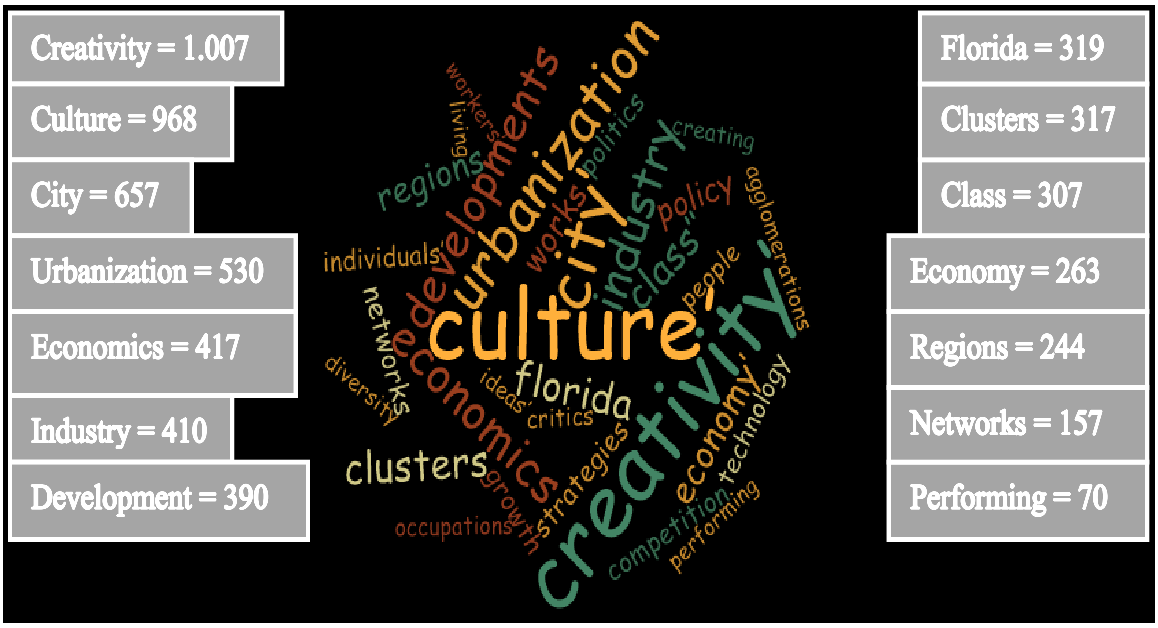

Figure 5– Lexical analysis and word cloud (*Nvivo 11*)

It is of note that this lexical analysis shows the low frequency of the words *Performing* (70) and *Networks (157)*, which indicates possible suggestions for future research.

This is followed by presentation of content analysis of the two clusters obtained which originated the lexical analysis of Figure 5, designated as: Cluster 1 – Creative cities and their connection with the creative class and culture; and Cluster 2 - Creative/cultural clusters and networks (see Tables 8 and 9). This analysis is followed by its discussion.

Table 8- Cluster 1 – Creative cities and their connection with the creative class and culture

Author (s) Year	Citations (ISI)	Co-citations (Vosvie-wer)	Type of document	Type of study/ Methodology	Key-words	Unit of analysis	Theoretical framework	Content analysis
Florida (2002)	0	45	Book	Review/ Empical/ Qualitative	Creativity, Creative Class, Cities, Regional Economy, Creative Occupations	Creative class, Creative city (USA)	Bell (1973)	• Introduced the theory of the creative class as inducing economic growth; • Highlighted the importance of cultural diversity in cities; • Developed the 3Ts model – tolerance, talent and technology – to measure creativity in cities.
Peck (2005)	1936	24	*International Journal of Urban and Regional Research*	Review	Creativity, creative class	Creative class	Florida (2002, 2005)	• Emblematic reference in criticism of the theory of the creative class; • Argued that urban policies are subtly nuclearized by creativity; • The return on creativity in cities is ambiguous.
Pratt (2008)	446	*14*	*Geografiska Annaler Series B-Human Geography*	Review	Creative class, culture and creative industries	Creative cities	Florida (2002, 2005)	• Criticized creativity's inherence to urban regeneration; • The association of these two constructs needs a review regarding their effect on the economy.
Landry (2000)	0	*13*	*Book*	Review/ Empirical/ Qualitative	Cities, Urban creativity, Urban Planning	Cities	Jacobs (1961); Landry & Bianchini (1995)	• Explained that urban creativity is the pillar of the new paradigmatic vision of cities; • Argued that creativity makes the city more attractive and vibrant.
Momm aas (2004)	537	13	Article	Empirical/ Qualitative	Cultural urban policy, Cultural clusters	Cultural clusters (Netherl ands)	Zukin, Lash, & Friedman (1992); Zukin (1982, 1991)	• Studied the impact of the location factor in cultural clusters; • Refuted the emergence of reviewing the theoretical and practical implications of culture's role in urban development.

Table 8- Cluster 1 – Creative cities and their connection with the creative class and culture (cont.)

Scott (2000)	681	10	Book	Empirical/ Qualitative	Cultural economy, Cities	Cities (USA)	Albertsen (1988); Robertson (1992)	• Studied culture, creativity and innovation in cities and the • Respective impact on their economic growth; • Concluded that culture is business in the context of urban regeneration.

Table 9 - Cluster 2 – Creative/cultural clusters and networks

Author(s)/ Year	Citations (ISI)	Co-citations (Vosviewer)	Type of document	Type of study/ Methodology	Key-words	Unit of analysis	Theoretical framework	Content analysis
Markusen (2006)	756	16	Article	Empirical/ Qualitative	Urban development, Culture, Creative class	Artists	Florida (2002)	• Emphasized the role of artists and their clusters; • Argued that these can be the leaders of urban social transformation.
Scott (2006)	852	14	Article	Review	Creative city, Urbanization, New economy	Creative city	Albertsen (1988); Boyer (1986); Chamberlin (1933); Florida (2002)	• Defended the existence of a new economy; • Understood that the theory of the creative class is limiting; • Concluded that this should also include productive, labour and social factors for the effective attractiveness of cities.
Storper & Venables (2004)	2054	13	Article	Review and quantitative	Agglomeration, Clustering, Urban Economics, Face-to-Face	Face to Face contact	Florida (2002); Nonaka (1994)	• Highlighted the importance of face-to-face contact (proximity) in contexts of clustering for partnerships.
Bathelt, Malmberg & Maskell (2004)	3297	11	Article	Review	Knowledge Creation, Clusters, Buzz, Pipelines, Absorptive Capacity	Creative cluster and Local Networks	Cohen & Levinthal (1990); Van den Bosch, Volberda & de Boer (1999)	• Showed the foundation of local networks for creative clusters; • Clarified that these should be associated with urban buzz and urban pipelines.

Source: Own elaboration

Cluster 1 reflects the research carried out on creative cities associated with urbanism, about the relevance of the creative class and about their relationship with culture. The topics addressed are the growing role of creativity in the economy and creative cities (Florida, 2002; Landry, 2000), critical discussion of the creative city concept (Peck, 2005; Pratt, 2008; Scott, 2000), culture's connection to urban spaces and consequent gentrification, as well as cultural clusters associated with creative industries and cultural creativity in the urban context (Mommaas, 2004; Scott, 2000).

The studies in the final database (102) originating this cluster are predominantly focused on investigating and contributing to understanding of the creative city associated with culture and economic growth. So the sub-topics studied here include the growing role of culture in urban regeneration, which can be operationalized through strategies focused on the creative industry, the creative or entrepreneurial class, but none of them show the critical factors associated with them, such as gentrification and destructive creativity (Rahbarianyazd & Doratli, 2017). This means that the transition to a creative economy involves transformations requiring diversified strategies (Shutters et al., 2016). These transformations involve complementing culture with cities' tangible and intangible assets, for this to stimulate economic, social and environmental growth – sustainability – and a participative context that aims to create value and raise competitiveness, where culture takes on a structural role in relation to creativity (Sacco et al., 2013), which in its various forms is a resource for cities' economic and urban vitality (Borén & Young, 2013). Furthermore, this vitality implies the increasing role of local amenities in promoting cities' economic growth and attracting the creative class (talents) (He et al., 2018). Added to this are the successive criticisms of the theory of Florida (2002), where some authors (e.g., Cooke, 2014; Curran, 2010; Gornostaeva & Campbell, 2012; McAuliffe, 2013; Méndez & Moral, 2011; Mould, Vorley, & Liu, 2014; Ponzini & Rossi, 2010) show its negative aspects, such as gentrification and socio-economic inequality, which cause the loss of excluded individuals' commitment to the place and the community, corroborating the conclusions of Markusen (2006) and Peck (2005).

Cluster 2 shows more clearly the connection between creative cities and culture and the arts, namely through studies made about the contribution of artists, the arts and creative/cultural industries to regional economic growth. Here, the units of analysis of this cluster are the creative occupations studied through case studies and statistical models in the field of creative cities and the clusters formed in them. These studies were found to show the connectivity provided by the existence of networks in the city (Bathelt et al., 2004; Scott, 2006). Markusen (2006) criticized the creative class notion of Florida (2002), by studying artists' contribution to creative cities, as well as Storper and Venables (2003) introducing the importance of proximity in creative industries. This means that the discussion of the work giving rise to this cluster is centred on creative industries and their clusters, addressing the determinants to classify the cluster types (Komorowski, 2017), for example, if they are cultural or technological (Davis et al., 2009), to summarize the factors leading to their formation (Sinozic & Tödtling, 2015), to show they create value for the city (Krätke, 2004), whether technological or creative/cultural (Chang & Feng, 2016; Foord, 2012). Other studies (Huang et al., 2016; Liu & Silva, 2015; Ren & Sun, 2012; Thiel, 2017; Turok, 2003; Williams & Currid-Halkett, 2011) have shown the importance of these creative industries as drivers of these clusters, for example, regarding their flexible adaptation to continuous market changes (Turok, 2003), the benefits of operating as a network when inserted in a cluster (Wenting, Atzema, & Frenken, 2011) and cities' need to be attractive for creative, talented workers (Krätke, 2010) who are at the core of those industries (Liu & Silva, 2015).

There is a perceptible link between the subjects addressed in the 2 clusters regarding the themes, units of analysis, concepts and theories approached, inasmuch as the sub-topics are closely related. Other studies supported by the two clusters discussed above focus on a broader conceptual and empirical analysis, highlighting the effect of social networks (Konrad, 2013) of an economic, technological (Yeoh & Chang, 2001) and cultural nature (Heidenreich & Plaza, 2015; Plaza & Haarich, 2015) on establishing creative/cultural industries involving intra and inter-relationships (Yeoh & Chang, 2001) and the creation of a value network for all the actors involved (Virta & Lowe, 2017), and the role played by creativity in cities in stimulating entrepreneurship (Yagoubi & Tremblay, 2015; Yeoh & Chang, 2001). Network formation between cities has also been subject to research (Batten, 1995; Namyślak, 2014; Nijkamp & Kourtit, 2013; Tölle, 2016) and the formation of creative partnerships in cities between the private and public sector (Cabrita & Cabrita, 2010).

Considering the previous research efforts analysed, in systematic terms, in the scope of this review it is retained that regions/cities should concentrate on the creativity associated with network formation and culture and the emergence of this association reflecting on assessment of cities' performance, especially that of creative cities. This is justified for two reasons. Firstly, it can revitalize urban economies and improve citizens' quality of life, and secondly, it can attract more people and investment, thereby improving cities' performance.

5. Contributions and future agenda

5.1. Contributions of the Study

One of the contributions concerns elaborating a pioneering mapping of the literature on this subject (Figures and Tables), showing the topics that have aroused greatest interest in the academic community. This bibliometric mapping identified that approaches to creative cities and the creative class in Florida's view continue to be applied in studying cities so that they can become creative, despite some perspectives criticizing these approaches. This implies that some researchers continue to carry out studies for this theory to become more wide-ranging and not only limited to the question of the creative class, so that cities' urban policies can increasingly encourage sustainable economic, social and cultural growth. This should create greater cohesion and social mobility, less gentrification of localities and residents' collective and inclusive participation.

The discussion elaborated highlighted the topics that continue to arouse researchers' interest, namely those that are more controversial, concerning the applicability of the creative class theory as a standard model in cities, which has been subject to some criticism, since cities' creative policies should consider their specific characteristics. The importance of a dynamic model is transversal in the academic community, since the formulation of local policies can be adjusted to places' resources and competences, without ignoring the goals of promoting technological change and innovation and considering the importance of urban planning for the success of those policies.

Another outstanding contribution lies in showing that urban entrepreneurship/urban creativity begins to have an important role in creative cities, through the positive relationship it has with platforms built by cities to sustain their growth endogenously. This means that levels of supra-regional and regional governance, or inter-municipal and municipal communities are considered fundamental for the formation of local business networks and social networks, in order to attract and promote qualified human capital and investment, to allow urban regeneration of cities to be implemented through successful redevelopment and occupation of existing sites, in order to avoid the restrictions associated with the localization of people and businesses, as well as the added needs for public and private finance.

It also contributed to identifying that the performance of creative cities is a research topic lacking empirical studies based on the compilation of indices, rather than one index alone. This means that performance requires additional research efforts, inasmuch as it is essential for policies implemented at the local/regional level to be able to stimulate economic growth and that they are duly monitored and assessed, in order to implement urgent measures for cities/regions to improve substantially their sustainable, long-term growth.

The analysis and discussion carried out allowed construction of a framework revealing the state-of-the-art of the literature on creative cities and how their formation/construction is mediated by determinant factors, which reflect the premises of European entities (European Union, for example) responsible for defining and implementing measures to overcome the decline/stagnation in the growth of countless cities/regions and promote urban regeneration. Figure 6 shows, in a summarized form, the implicit dimensions of a creative city in this century, as well as the social aspects (values, attitudes, tolerance, openness and diversity, social inclusion and well-being) cultural aspects (cultural and historical identity, tourism, festivals, concerts), *hard* amenities (basic transport services, water, lighting, health, safety, logistics, environment) and *soft* amenities (flexibility of the labour market, urban climate, clusters and incubators) these cities should offer to their current and potential inhabitants.

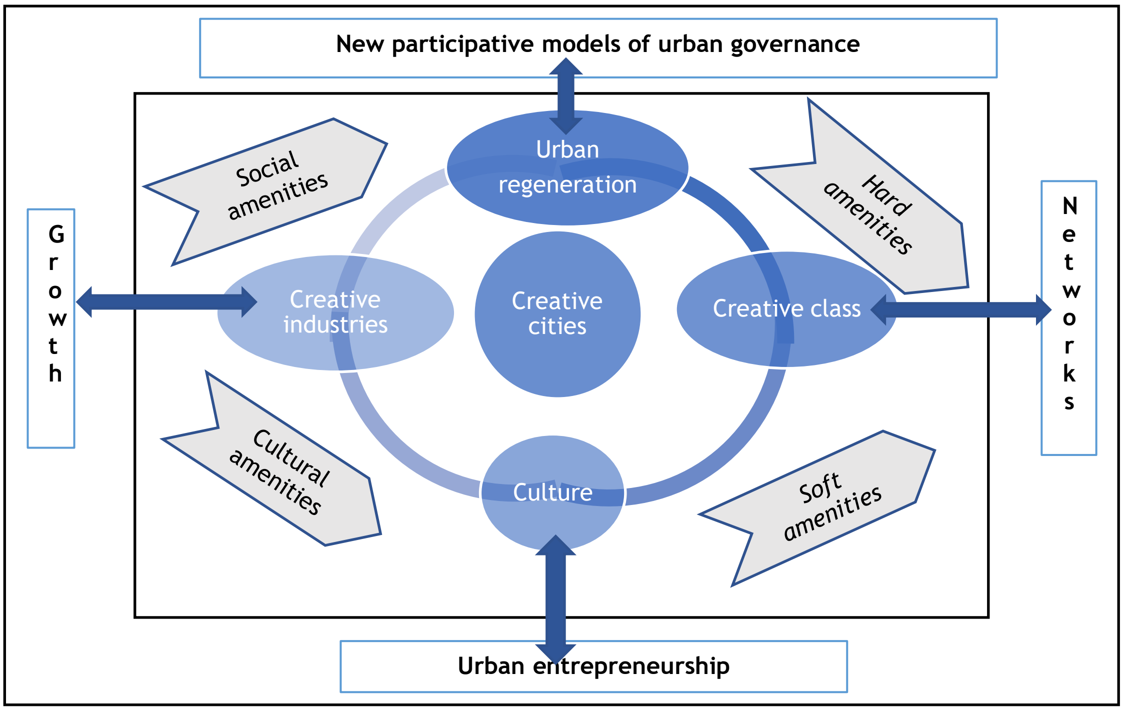

Figure 6 – Framework of creative cities

5.2. Agenda for Future Research

Based on the literature review elaborated in the previous sections, topics identified as pertinent and topical themes for future research are highlighted.

Mayer and Knox (2010) suggested that the discourse on creative cities should consider cities' specific characteristics *per se*, namely, if they are small cities with low population density, or densely populated major urban centres, as well as the focus on urban entrepreneurial strategies (urban entrepreneurship) having different implications for small and large cities, which leads to indications for research. In this connection, Lewis and Donald (2010) argued that indices/indicators to measure the performance of cities' economic growth showed little applicability to smaller cities, suggesting a second line of research to follow.

It is relevant and urgent to study the growth capacity of creative cities and their inherent networks, and so it is essential to compile these indices with economic (supply/demand), social and cultural indicators so that their performance can be monitored and assessed. In this way, urban policies can be improved (Borén & Young, 2013) to promote cities' sustainable long-term growth, given the need to reconsider creative cities in the 21st century (Comunian, 2011) and their relationship with economic growth at the micro and macro level (Suciu, Suciu, & Schawlowski, 2013).

Summarizing, those formulating the urban policies of creative cities have to recognize the importance of networks (connection, sharing, creativity partnerships) for the performance of creative cities based on a holistic vision, irrespective of their population density. In fact, creative cities are an integral part of European Union policies to revitalize the economy of the different member-states, forming an alternative approach to the implementation and improvement of strategies of intelligent specialization in Europe. Finally, the gaps identified in the first section of this study concerning these constructs (networks, performance and creative cities) have not yet been filled, and so this subject is open to future research.

6. Conclusions

In response to the objective defined, it is concluded that the subject studied here continues to arouse great interest among researchers and political decision-makers, since the recent financial crisis led to economic decline and stagnation in many cities, regions and countries, culminating in the adoption of Strategy 2020, throughout Europe, whose goal of economic progress includes intelligent and sustainable growth based on creative economies. This interest is shown in the two clusters obtained using *Vosviewer*, and in the literature included in this study. It was also confirmed that the limitations identified in the publications included in these clusters have been subject to research, as this is an appealing and pertinent topic in the area of management and other social and human sciences, and engineering, given the range of concepts, practices and theories involved.

It is worth underlining that the results obtained and discussed are relevant in understanding and perceiving that creativity is dynamic and covers all domains of civil society, requiring the active participation of all stakeholders, whether public or private entities or citizens. In addition, creativity is taken to be a driver of urban entrepreneurship and innovation, by stimulating collaboration and network formation processes. All these aspects are crucial drivers of the longed-for sustainable and intelligent growth of cities in the era of knowledge, technology and the emphasized role of culture, social inclusion and social and environmental responsibility, as pillars of an inclusive society in the present and in the future. However, the governance of current cities, as creative spatial units, should focus on revitalizing urban economies, by identifying the resources and competences those cities possess as distinctive factors which allow them to combine their *soft* and *hard* amenities to attract qualified human resources and investment in different areas. In addition, this capturing of tangible and intangible resources lets collaboration processes be established, in the form of business, social and cultural networks and/or clusters, which are increasingly associated with entrepreneurship in the urban context aiming to stimulate tripartite urban revitalization (economic, social and environmental), and thereby, through creativity and innovation, achieve sustained economic growth and consequently significant improvement in economic performance.

Like any study, this one is not without limitations, and so restricting the search to only the *ISI Web of Science* and *Scopus* databases can be seen as one of them, despite these being two of the databases most recognized by the scientific community.

Finally, the bibliometric analysis carried out and its content analysis are contributions to advancing scientific knowledge about creative cities, since this systematization opened the path for future research, besides systemizing holistically the work already done and identifying the central authors on the subject, who continue to be an important reference for research in this area. Certainly, other methods of bibliometric analysis could have been used, but it is pointed out that the use of various types of analysis allowed a description, systematization and sequencing of content, considering the diversity of the most studied topics.

References

Albertsen, N. (1988). Postmodernism, post-Fordism, and critical social theory. *Environment and Planning D: Society and Space*, 1*(8)*, 339-365.

Andersson, Å. E., & Andersson, D. E. (2015). Creative Cities and the New Global Hierarchy. *Applied Spatial Analysis and Policy*, *8*(3), 181–198.

Asheim, B., Coenen, L., Moodysson, J., & Vang, J. (2007). Constructing knowledge-based regional advantage: implications for regional innovation policy. *International Journal of Entrepreneurship and Innonvation Management*, *7*(2–5), 140–155.

Asheim, B., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670.

Bandara, W., Miskon, S., & Fielt, E. (2011). A Systematic, Tool-Supported Method for Conducting Literature Reviews in IS. *Information Systems Journal*, 1–14.

Banks, M., Lovatt, A., O'Connor, J., & Raffo, C. (2000). Risk and Trust in the Cultural Industries. *Geoforum* , *31*(4), 453–464.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, *28*(1), 31–56.

Batten, D. F. (1995). Network Cities: Creative Urban Agglomerations for the 21st Century. *Urban Studies*, *32*(2), 313–327.

Bayer, A. E., Smart, J. C., & McLaughlin, G. W. (1990). Mapping intellectual structure of a scientific subfield through author cocitations. *Journal of the American Society for Information Science*, *41*(6), 444–452.

Becker, S., Bryman, A., & Ferguson, H. (2012). *Understanding research for social policy and social work: themes, methods and approaches.* (Policy Press, Ed.).

Bell, D. (1973). *The coming of post-industrial society: a venture in social forecasting.* (Basic Books, Ed.). New York.

Bettencourt, L. M. A., Lobo, J., & Strumsky, D. (2007). Invention in the city: Increasing returns to patenting as a scaling function of metropolitan size. *Research Policy*, *36*(1), 107–120.

Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.

Boyer, R. (1986). *La Théorie de la Régulation: Une analyse critique.* (La Découverte, Ed.). Paris.

Cabrita, M., & Cabrita, C. (2010). The Role of Creative Industries in Stimulating Intellectual Capital in Cities and Regions Emotional. In *2nd European Conference on Intellectual Capital* (pp. 171–179).

Cabrita, M. D. R., Cruz-Machado, V., & Cabrita, C. (2013). Managing creative industries in the context of knowledge-based urban development. *International Journal of Knowledge-Based Development*, *4*(4), 318–337.

Carta, M. (2009). Culture, communication and cooperation: The three Cs for a proactive creative city. *International Journal of Sustainable Development*, *12*(2–4), 124–133.

Caset, F., & Derudder, B. (2017). Measurement and interpretation of 'global cultural cities' in a world of cities. *Area*, *49*(2), 238–248.

Chamberlin, E. (1933). *The theory of monopolistic competition.* (Harvard University, Ed.). Cambridge.

Chang, Y., & Feng, L. (2016). Exploring The Differences of Value Creation Process Between Creative Clusters and Technological Ones. In *8th International Symposium on Management of Technology (ISMOT '16)* (pp. 160–163).

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity : A New Perspective on and Innovation Learning. *Adminstrative Science Quarterly*, *35*(1), 128–152.

Cohendet, P., Grandadam, D., & Simon, L. (2010). The anatomy of the creative city. *Industry and Innovation*, *17*(1), 91–111.

Comunian, R. (2011). Rethinking the Creative City: The Role of Complexity, Networks and Interactions in the Urban Creative Economy. *Urban Studies*, *48*(6), 1157–1179.

Cooke, T. J. (2014). Metropolitan growth and the mobility and immobility of skilled and creative couples across the life course. *Urban Geography*, *35*(2), 219–235.

Curran, W. (2010). In defense of old industrial spaces: Manufacturing, creativity and innovation in Williamsburg, Brooklyn. *International Journal of Urban and Regional Research*, *34*(4), 871–885.

Currid, E., & Williams, S. (2010). Two cities, five industries: Similarities and differences within and between cultural industries in New York and Los Angeles. *Journal of Planning Education and Research*, *29*(3), 322–335.

d'Ovidio, M., & Cossu, A. (2017). Culture is reclaiming the creative city: The case of Macao in Milan, Italy. *City, Culture and Society*, *8*, 7–12.

Davis, C. H., Creutzberg, T., & Arthurs, D. (2009). Applying an innovation cluster framework to a creative industry: The case of screen-based media in Ontario. *Innovation: Management, Policy and Practice*, *11*(2), 201–214.

Echebarria, C., Barrutia, J. M., Aguado, I., Apaolaza, V., & Hartmann, P. (2016). Capturing the benefits that emerge from regional sustainability networks: The Castile-La Mancha network of sustainable cities and towns. *Papers in Regional Science*, *95*, S27–S49.

Egghe, L., & Rousseau, R. (2002). Co-citation, bibliographic coupling and a characterization of lattice citation networks. *Scientometrics*, *55*(3), 349–361.

Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life).* (Basic Books, Ed.). New York.

Florida, R. (2005). *Cities and the creative class.* Routledge.

Foord, J. (2012). The new boomtown? Creative city to Tech City in east London. *Cities*, 33, 51-60.

Gmür, M. (2003). Co-citation analysis and the search for invisible colleges: A methodological evaluation. *Scientometrics*, *57*(1), 27–57.

Gornostaeva, G., & Campbell, N. (2012). The creative underclass in the production of place: Example of Camden Town in London. *Journal of Urban Affairs*, *34*(2), 169–188.

Grácio, C. M. C. (2016). Acoplamento bibliográfico e análise de cocitação : revisão teórico-conceitual. *Encontros Bibli*, *21*(47), 82–99.

Grácio, M. C. C., & Oliveira, E. F. T. (2013). Análise de cocitação de autores : um estudo teórico-metodológico dos indicadores de proximidade aplicados ao GT7 da ANCIB. *Liinc Em Revista*, *9*(1), 196–21.

Grodach, C. (2011). Art spaces in community and economic development: Connections to neighborhoods, artists, and the cultural economy. *Journal of Planning Education and Research*, 31(1), 74-85.

Hall, T., & Hubbard, P. (1996). The entrepreneurial city: new urban politics, new urban geographies? *Progress in Human Geography*, *20*(2), 153–171.

He, J., Huang, X., & Xi, G. (2018). Urban amenities for creativity: An analysis of location drivers for photography studios in Nanjing, China. *Cities*, *74*, 310–319.

Heidenreich, M., & Plaza, B. (2015). Renewal through Culture? The Role of Museums in the Renewal of Industrial Regions in Europe. *European Planning Studies*, *23*(8), 1441–1455.

Huang, K.-C., Hu, T.-S., Wang, J.-Y., Chen, K.-C., & Lo, H.-M. (2016). From fashion product industries to fashion: upgrading trends in traditional industry in Taiwan. *European Planning Studies*, *24*(4), 762–787.

Jacobs, J. (1961). the Death and Life of Great American Cities, 3–25.

Jeong, Y. K., Song, M., & Ding, Y. (2014). Content-based author co-citation analysis. *Journal of Informetrics*, *8*(1), 197–211.

Kipfer, S., & Keil, R. (2002). Toronto Inc? Planning the Competitive City in the New Toronto. *Antipode*, *34*(2), 227–264.

Komorowski, M. (2017). A novel typology of media clusters. *European Planning Studies*, *25*(8), 1334–1356.

Konrad, E. D. (2013). Cultural entrepreneurship: The impact of social networking on success. *Creativity and Innovation Management*, *22*(3), 307–319.
Kourtit, K., Nijkamp, P., & Arribas, D. (2012). Smart cities in perspective – a comparative European study by means of self-organizing maps. Innovation. *The European Journal of Social Science Research*, *25*(2), 229–246.
Krätke, S. (2004). City of talents? Berlin's regional economy, socio-spatial fabric and "worst practice" urban governance. *International Journal of Urban and Regional Research*, *28*(3), 511–529.
Krätke, S. (2010). "Creative cities" and the rise of the dealer class: A critique of Richard Florida's approach to urban theory. *International Journal of Urban and Regional Research*, *34*(4), 835–853.
Laitinen, I., Osborne, M., & Stenvall, J. (2016). Complex regional innovation networks and HEI engagement – the case of Chicago. *International Journal of Knowlege-Based Development*, *7*(2), 184–201.
Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.
Landry, C., & Bianchini, F. (1995). *The creative city* (Vol. 12). Demos.
Lawton, P., Murphy, E., & Redmond, D. (2010). Examining the role of "creative class" ideas in urban and economic policy formation: the case of Dublin, Ireland. *International Journal of Knowledge-Based Development*, *1*(4), 267-286.
Lazzeretti, L., Capone, F., & Innocenti, N. (2017). Exploring the intellectual structure of creative economy research and local economic development: a co-citation analysis. *European Planning Studies*, *25*(10), 1693–1713.
Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.
Lewis, N. M., & Donald, B. (2010). A New Rubric for "Creative City" Potential in Canada's Smaller Cities. *Urban Studies*, *47*(1), 29–54.
Ling, S., & Martins, J. T. (2015). Learning and innovation in network: online communicative practices of a local enterprise partnership sector group. *Regional Studies, Regional Science*, *2*(1), 170–183.
Liu, H., & Silva, E. A. (2015). Creative industries urban model: Structure and functioning. *Proceedings of the Institution of Civil Engineers: Urban Design and Planning*, *168*(2), 88–100.
Markusen, A. (2006). Urban Development and the Politics of a Creative Class : Evidence from the Study of Artists. *Environment and planning A 38*(10), 1921–1940.
Marshakova, I. V. (1981). Citation networks in information science. *Scientometrics*, *3*(1), 13–25.
Martínez, J. G. (2007). Selling avant-garde: How Antwerp became a fashion capital (1990-2002). *Urban Studies*, *44*(12), 2449–2464.
Mayer, H., & Knox, P. (2010). Small-town sustainability: Prospects in the second modernity. *European Planning Studies*, *18*(10), 1545–1565.
McAuliffe, C. (2013). Legal Walls and Professional Paths: The Mobilities of Graffiti Writers in Sydney. *Urban Studies*, *50*(3), 518–537.
Méndez, R., & Moral, S. S. (2011). Spanish cities in the knowledge economy. *European Urban and Regional Studies*, *18*(2), 136–155.
Mentzer, J. T., & Kahn, K. B. (1995). A framework of logistics research. *Journal of Business Logistics*, *16*(1), 231–251.
Miškovičová, A., Vaňová, A., Vitálišová, K., & Borseková, K. (2016). Strategies of creative potential development in the cities. In *9th Annual Conference of the EuroMed Academy of Business* (pp.1293-1312).
Mommaas, H. (2004). Cultural clusters and the post-industrial city: towards the remapping of urban cultural policy. *Urban Studies*, *41*(3), 507–532.
Mould, O., Vorley, T., & Liu, K. (2014). Invisible Creativity? Highlighting the Hidden Impact of Freelancing in London's Creative Industries. *European Planning Studies*, *22*(12), 2436–2455.
Muñoz, P., & Cohen, B. (2016). The making of the urban entrepreneur. *California Management Review*, *59*(1), 71-91.
Murphy, E., & Redmond, D. (2009). The role of 'hard' and 'soft' factors for accommodating creative knowledge: insights from Dublin's 'creative class. '*Irish Geography*, *42*(1), 69–84.
Musterd, S., & Ostendorf, W. J. M. (2004). Creative cultural knowledge cities; Perspectives and planning strategies. *Built Environment*, *30*(3), 189–193.

Namyślak, B. (2014). Cooperation and Forming Networks of Creative Cities: Polish Experiences. *European Planning Studies*, *22*(11), 2411–2427.

Nathan, M. (2012). After Florida: Towards an economics of diversity. *European Urban and Regional Studies*, *22*(1), 3–19.

Neal, Z. (2012). Creative Employment and Jet Set Cities: Disentangling Causal Effects. *Urban Studies*, *49*(12), 2693–2709.

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: Co-creating transformative action for sustainable cities. *Journal of Cleaner Production*, *50*, 111–122.

Nijkamp, P., & Kourtit, K. (2013). The "New Urban Europe": Global Challenges and Local Responses in the Urban Century. *European Planning Studies*, *21*(3), 291–315.

Nohara, T., Okamura, y. & Kawahara, S. (2016). Research for a comprehensive and active planning method in an industrial-residential mixed area - focused on ota creative town vision in ota ward, tokyo. *Journal of the Malaysian Institute of Planners*, (Iv), 369–382.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation Dynamic Theory Knowledge of Organizational Creation. *Organization Science*, *5*(1), 14–37.

O'Connor, J., & Shaw, K. (2014). What next for the creative city? *City, Culture and Society*, *5*(3), 165–170.

O'Connor, D. O., & Voos, H. (1981). Empirical Laws, Theory Construction and Bibliometrics.

Peck, J. (2005). Struggling with the creative class. *International Journal of Urban and Regional Research*, *29*(4), 740–770.

Pelletier, J. S., Gill, R. S., Shi, X., Birch, D. W., & Karmali, S. (2013). Robotic-assisted hepatic resection: a systematic review. *The International Journal of Medical Robotics and Computer Assisted Surgery*, *9*(3), 262–267.

Plaza, B., & Haarich, S. N. (2015). The Guggenheim Museum Bilbao: Between Regional Embeddedness and Global Networking. *European Planning Studies*, *23*(8), 1456–1475.

Ponzini, D., & Rossi, U. (2010). Becoming a Creative City: The Entrepreneurial Mayor, Network Politics and the Promise of an Urban Renaissance. *Urban Studies*, *47*(5), 1037–1057.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, *41*(1), 116.

Prasad, S., & Tata, J. (2005). Publication patterns concerning the role of teams/groups in the information systems literature from 1990 to 1999. *Information and Management*, *42*(8), 1137–1148.

Pratt, A. C. (2008). Creative cities: The cultural industries and the creative class. *Geografiska Annaler, Series B: Human Geography*, *90*(2), 107–117.

Pratt, A. C. (2009). Urban regeneration: From the arts "feel good" factor to the cultural economy: A case study of Hoxton, London. *Urban Studies*, *46*(5–6), 1041–1061.

Putnam, R. D. (2007). E pluribus unum: Diversity and community in the twenty-first century the 2006 Johan Skytte prize lecture. *Scandinavian Political Studies*, *30*(2), 137–174.

Quinlan, K. M., Kane, M., & Trochim, W. M. K. (2008). Evaluation of large research initiatives: Outcomes, challenges, and methodological considerations. *New Directions for Evaluation*, *2008*(118), 61–72.

Rahbarianyazd, R., & Doratli, N. (2017). Assessing the contribution of cultural agglomeration in urban regeneration through developing cultural strategies. *European Planning Studies*, *25*(10), 1714–1733.

Rehn, C., & Kronman, U. (2008). Bibliometric handbook for Karolinska Institutet. Retrieved from http://ki.se/content/1/c6/01/79/31/bibliometric_handbook_karolinska_institutet_v1.05.pdf.

Ren, X., & Sun, M. (2012). Artistic Urbanization: Creative Industries and Creative Control in Beijing. *International Journal of Urban and Regional Research*, *36*(3), 504–521.

Robertson, R. (1992). *Globalization: Social theory and global culture*. Sage.

Rowley, J., & Slack, F. (2004). Conducting a literature review. *Management Research News*, *27*(6), 31–39.

Ryan, B., Scapens, R. W., & Theobold, M. (2002). Research Methods and Methodology in Finance and Accounting.

Sacco, P. L., Ferilli, G., Blessi, G. T., & Nuccio, M. (2013). Culture as an Engine of Local Development Processes: System-Wide Cultural Districts II: Prototype Cases. *Growth and Change*, *44*(4), 571-588.

Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.

Scott, A. J. (2006). Creative cities: Conceptual issues and policy questions. *Journal of Urban Affairs, 28*(1), 1-17.

Seuring, S., & Gold, S. (2012). Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management: An International Journal*, *17*(5), 544–555.

Seuring, S., & Mu, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, *16*, 1699–1710.

Shutters, S. T., Muneepeerakul, R., & Lobo, J. (2016). Constrained pathways to a creative urban economy. *Urban Studies*, *53*(16), 3439–3454.

Sinozic, T., & Tödtling, F. (2015). Adaptation and Change in Creative Clusters: Findings from Vienna's New Media Sector. *European Planning Studies*, *23*(10), 1975–1992.

Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the Association for Information Science and Technology*, *24*(4), 265-269.

Spens, K. M., & Kovács, G. (2006). A content analysis of research approaches in logistics research. *International Journal of Physical Distribution & Logistics Management*, *36*(5), 374–390.

Storper, M., & Venables, A. J. (2004). Buzz : Face-To-Face Contact and the Urban Economy *Journal of Economic Geography*, *4*(4), 351-370.

Suciu, C., Suciu, N., & Schawlowski, D. (2013). Creative Entrepreneurship and Urban Vitality as Key Determinants for a Smart, Sustainable and Inclusive Development. In *21st International-Business-Information-Management-Association Conference on Vision 2020: Innovation, Development Sustainability, and Economic Growth*. (pp. 1595–1611).

Syrett, S., & Sepulveda, L. (2012). Urban governance and economic development in the diverse city. *European Urban and Regional Studies*, *19*(3), 238–253.

Thiel, J. (2017). Creative cities and the reflexivity of the urban creative economy. *European Urban and Regional Studies*, *24*(1), 21–34.

Tölle, A. (2016). Transnationalisation of development strategies in East Central European cities: A survey of the shortlisted Polish European Capital of Culture candidate cities. *European Urban and Regional Studies*, *23*(3), 374–388.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, *14*(3), 207–222.

Treinta, F. T., Farias Filho, J. R., Sant'Anna, A. P., & Rabelo, L. M. (2014). Metodologia de pesquisa bibliográfica com a utilização de método multicritério de apoio à decisão. *Production*, *24*(3), 508–520.

Turok, I. (2003). Cities, clusters and creative industries: The case of film and television in Scotland. *European Planning Studies*, *11*(5), 549–566.

Van den Bosch, F. A. J., Volberda, H. W., & de Boer, M. (1999). Coevolution of Firm Absorptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities. *Organization Science*, *10*(5), 551–568.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538.

Vinodrai, T. (2006). Reproducing Toronto's Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. *Economic Geography*, *82*(3), 237–263.

Virta, S., & Lowe, G. F. (2017). Integrating media clusters and value networks: Insights for management theory and research from a case study of Mediapolis in Finland. *Journal of Management and Organization*, *23*(1), 2–21.

Waltman, L., Van Eck, N. J., & Noyons, E. C. M. (2010). A unified approach to mapping and clustering of bibliometric networks. *Journal of Informetrics*, *4*(4), 629–635.

Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications. *Cambridge University Press*, *1*, 116.

Wenting, R., Atzema, O., & Frenken, K. (2011). Urban Amenities and Agglomeration Economies? *Urban Studies*, *48*(7), 1333–1352.

White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. *Journal of the American Society for Information Science*, *49*(4), 327–355.

Williams, S., & Currid-Halkett, E. (2011). The Emergence of Los Angeles as a Fashion Hub: A Comparative Spatial Analysis of the New York and Los Angeles Fashion Industries. *Urban*

Studies, *48*(14), 3043–3066.

Yagoubi, A., & Tremblay, D.-G. (2015). Culture, Innovation and Entrepreneurship: Challenges in the Fashion Industry. *Ifkad 2015: 10Th International Forum on Knowledge Asset Dynamics: Culture, Innovation and Entrepreneurship: Connecting the Knowledge Dots*, (June), 1225–1236.

Yeoh, B. S. A., & Chang, T. C. (2001). Globalising Singapore: Debating transnational flows in the City. *Urban Studies*, *38*(7), 1025–1044.

Yin, R. (2015). *Case study research: design and methods - Applied social research methods series*. Thousand Oaks, CA: Sage Publications, Inc.

Zimmerman, J. (2008). From brew town to cool town: Neoliberalism and the creative city development strategy in Milwaukee. *Cities*, *25*(4), 230–242.

Zukin, S., Lash, S., & Friedman, J. (1992). *Postmodern urban landscapes: mapping culture and power*.

Zukin, S. (1982). Loft living as "historic compromise" in the urban core: the New York experience. *International Journal of Urban and Regional Research*, *6*(2), 256–267.

Zukin, S. (1991). *Landscapes of power: from Detroit to Disney World*. Berkeley, CA.

CHAPTER 3

CREATIVE CITIES: PROPOSAL OF A MULTIDIMENSIONAL MODEL

ABSTRACT

Cities are essential vectors for economic and sustainable development worldwide, as a consequence of globalization and the recent economic, financial, social and environmental crises. In this connection, urban creativity, intelligence and sustainability are inseparable dimensions of those cities, which in harmony with the networks they originate can be predictors of their improved performance. Therefore, this study aims to propose a conceptual and multidimensional model for cities, which shows their implicit dimensions and general indicators so that their performance can be measured in a holistic way, as well as forming some implications for theory and practice. Finally, the conclusion shows the study's contribution and limitations together with suggestions for future research.

Key-words: Cities, Dimensions, Indicators, Performance, Multidimensional Model

1. Introduction

Given the phenomenon of globalization and the recent economic, financial and social crisis, the view of cities' role in global economic growth has undergone a paradigmatic change, in which their tangible resources have become associated with intangible ones as a crucial differentiating factor to overcome the decline and economic stagnation experienced by many cities in Europe and the rest of the world. This means we have a new generation of cities (Cohen, 2012) possessing an intelligent philosophy/ideology and centred on creating bridges with creativity to solve the problems they face, and also focused on integration of cultural, social, environmental and economic dimensions as a whole (Ratten, 2017). Consequently, these cities intend to be innovative/creative (Ballas, 2013) and adopt strategies aiming for their sustainable economic, social and environmental development (Albino, Berardi, & Dangelico, 2015), in an intelligent way (Amin, Massey, & Thrift, 2000; Hollands, 2008; Tranos & Gertner, 2012), to improve the quality of life provided to their inhabitants (Albino et al., 2015). However, for effective and intelligent operationalization of these strategies, information and communication technologies (ICT) must be an integral part of them (Aurigi, 2005; Lee, Phaal, & Lee, 2013), since their incorporation transforms the different ways city residents live and work, and also contributes to improved collaboration processes (networks) and to the use of institutions to stimulate sustainability (Ratten, 2017).

Due to the ambiguity existing in the concepts on the typology of cities, it is worth noting that in this theoretical study the definitions adopted are: (1) creative cities are those that advocate socio-cultural, economic and political changes (Romein & Trip, 2009) they are characterized by diversity, openness, tolerance, the existence of a creative class and high cultural dynamism (Florida, 2002, 2005; Grant & Kronstal, 2010); (2) intelligent cities are based on a participatory governance that is embedded in an urban ecosystem supported by information and communication technologies (Letaifa, 2015) and which invests in social and human capital and own resources to improve the quality of life of its citizens and promote their economic growth (Caragliu, Del Bo, & Nijkamp, 2011); e (3) sustainable cities as a broader concept which integrates social development, economic development, environmental management and urban governance, which refers to the management and investment decisions taken by municipal authorities in coordination with national authorities and institutions (World Economic and Social Survey, 2013); this means that in this study it is assumed these integrated settings and holistically.

On the other hand, rapid urban development has caused social and environmental concerns, besides economic ones, that jeopardize human well-being and sustainability (Pérez-Urrestarazu, Fernández-Cañero, & Franco-Salas, 2017), which are reflected in the European Union's 2020 Strategy (intelligent, sustainable and inclusive growth). This means that the design of currents cities must have the pillars of urban creativity, intelligence and sustainability, understood as a link between so-called creative cities, intelligent cities and sustainable cities. This link between the different city typologies was shown by various authors (e.g., Letaifa, 2015; Musterd & Ostendorf, 2004; O'Connor & Shaw, 2014; Ratten, 2017), arguing that intelligent cities are also creative, due to how residents are involved in them, the sharing of knowledge, culture, entrepreneurship and social relations and due to focusing on innovation and integration of technology with culture (Ratten, 2017).

It has been widely discussed in the academic and political domains that intelligent cities and creative cities must be sustainable. Therefore, all city actors must understand the importance of urban sustainability and act cohesively as a whole (Ratiu, 2013), have the capacity to attract talented human capital (creative class/creativity) to build an intelligent platform (ICT, governance) and stimulate growth based on multiple, interconnected and dynamic activities, implying that when business, technology, culture and creativity interact, this generates innovations and contributes to urban sustainability (Cohendet & Zapata, 2009; Florea, 2015).

In addition, the formation of networks is a factor included in the competitive advantage of currents cities, particularly creative cities, since cities function as intangible spaces of innovation, knowledge, sharing, learning and collaboration (Ratten, 2017). The same author considers that networks induce cities' growth and simultaneously turn them into an intelligent, cultural space stimulating the development of new ideas (creativity/innovation) and entrepreneurship in its various forms (for example, urban).

Based on these arguments, the recommended approach to cities should be multi-disciplinary (Landry, 2006), where the paradigmatic change occurring in the role they play in building a sustainable society, based on creativity, innovation, technology and networks, has directed the interest of the academic community and the political class worldwide towards the study of creative, intelligent and sustainable cities (Girard, Baycan, & Nijkamp, 2011). However, in the extensive literature on these cities, gaps in need of research remain, specifically measuring their performance based on a conceptually designed model as a methodological instrument. Corroborating the lack of this type of study, Malecki (2007) showed the need to define indicators to measure cities' performance; Pain et al (2016) concluded there is still a shortage of studies associating cities' connections/networks with their performance; Lee, Hancock and Hu (2014) claimed it is essential to elaborate a scale for cities' different dimensions to measure their performance.

More recently, Bibri and Krogstie (2017a) concluded strongly on the absence of integrated/holistic conceptual models of cities and the respective index to assess their performance and contributions. No less important are the gaps identified in relation to the many existing indices for cities, i.e., it is crucial to compile existing indices and converge them in a single index (Borén & Young, 2013; Flores & Teixeira, 2017). In the same line of thought, Priano and Guerra (2014) concluded that the process of measuring cities requires standardization of existing models and Huovila et al. (2016) stated the clear need for a holistic and integrating model and index to measure cities' performance.

Supported by the gaps identified justifying the relevance of studying the performance of creative cities and how this can be measured by intelligence and sustainability, without neglecting the essence of creativity that supports them and the network influence, this study aims to present a proposal of a multi-dimensional design for current creative cities and the respective indicators generally used, despite being scattered over various types of index, to measure their performance. To achieve this objective, the following research question is formulated: *What are the dimensions underlying the current multi-dimensional and holistic vision of creative cities?* Therefore, this study's contribution is related to the proposed model including the premises defined so that cities' present and future performance is integral and supported by the pillars of creativity, intelligence and sustainability, which is measured by the positive effects of networks.

2. Literature review

2.1. Cities' performance

Cities' performance should be measured in all its dimensions from a multi-dimensional and holistic perspective (Girard et al., 2011; Networked Society City Index, 2016), since currents cities have a fundamental role in the global economy as places of connectivity (networks), creativity and innovation associated with social and economic progress, culture, diversity and the environment (European Commission, 2011). Cities' performance includes dimensions inherent to their tangible and intangible resources, as argued by Anthopoulos (2017).

Furthermore, the measurement of cities' performance has undergone a transformation inherent to the paradigmatic change in the vision of the role they play in economic growth, which does not mean the traditional variables of measurement should be discarded, for example Gross Domestic Product (GDP), the inflation rate and the unemployment rate (New Economics Foundation, 2015). However, these variables should be considered intermediary and as complementing citizens' current interests to reach other social and economic objectives, as explained in that report. It is perceived, therefore, that cities face the challenge to grow sustainably and intelligently, and also with creativity, added to which is their residents' satisfaction, aiming to show high tangible and intangible performance (Kourtit et al., 2014; Kourtit, Nijkamp, & Steenbruggen, 2017). So the determinant dimensions for this urban transformation, particularly in Europe, are society, the economy, governance, transport and the land (Lennert et al., 2010). Cities' performance is the result of integrating policies indicating appropriate directions for economic growth and urban development, as in the case of Munich, which adopted the pillars of creativity, intelligence and sustainability (Davoudi & Sturzaker, 2017).

Caragliu et al. (2011) also concluded that cities' urban performance depends not only on their physical capital but increasingly on their human and social capital to improve their competitive advantage. Camagni (2011) also argued that cognitive capital (cities' competences and their capacity to change), relational capital (openness, tolerance, cooperation, interaction and synergies) and environmental capital (transport, quality of life and lifestyle, cultural legacy) should be fundamental variables for current cities. This means that currents cities should be innovative to be able to attract new firms and talent. To stimulate existing opportunities, entrepreneurship should be an effective strategy, allowing attainment of the desired economic growth reflected in these cities' improved performance (Caragliu et al., 2011).

In addition, it is important that these premises are supported by a growth strategy (Caragliu et al., 2011) that reflects intelligent organization of tangible and intangible facilities/amenities strengthened by the inclusion of ICT, creativity and innovation. Conjugated with cities' urban design, this promotes their economic viability (performance) (Neirotti, et al., 2014; Networked society city index, 2016), network connections and sustainability (Networked society city index, 2016).

In this context, the literature on cities' design/dimensions is extensive and includes numerous conceptual models with different dimensions and indices/indicators to measure the performance of different city typologies, such as creative (e.g., Florida, 2002, 2005; Landry, 2000; Romein & Trip, 2009; Saisana & Montalto, 2016; Stano & Węziak-Białowolska, 2017; Wu et al., 2008), intelligent (e.g., Arroub et al., 2016; Caragliu et al., 2011; Cohen, 2012; Giffinger et al., 2007; Lazaroiu & Roscia, 2012; Neirotti et al., 2014; Piro et al., 2014; Viale-Pereira et al., 2017), sustainable (e.g., Addanki & Venkataraman, 2017; Ahmad & Mehmood, 2015; Dizdaroglu, 2017; Skrede, 2016; United Nations, 2013), creative and intelligent (e.g. Esteban et al., 2008) and intelligent and sustainable (e.g., Pozdniakova, 2017; Ratiu, 2013; Scott, 2006, 2007).

This dispersion is justified by the complexity of managing a city holistically (Albino et al., 2015), despite all of them aiming to improve citizens' quality of life (Shapiro, 2006). However, the most studied dimensions are ICT, the economy, mobility, environment, people, governance, sustainability, creativity and open networks (Albino et al.,2015; Barrionuevo, Berrone, & Costa, 2012; Chourabi et al., 2012; Eger, 2009; Giffinger et al., 2007; Kourtit & Nijkamp, 2012; Mahizhnan, 1999; Nam & Pardo, 2011; Thuzar, 2011), whose points in common are network infrastructure, creative activities, inclusion, urban growth and a sustainable environment. Inherent to each of these are various proxies that allow measurement of their specific weight in cities' performance through appropriate measurement indices (Albino et al., 2015).

In other words, this performance is assessed by a set of indicators, which are understood as a tool, and so the United Nations (2015) recommends the implementation in cities of concrete measures of this, to demonstrate their progress (Lynch & Mosbah, 2017) with simultaneous monitoring. This means that analysis of the indicators used lets political decision-makers identify cities' opportunities/threats so that their performance can be continuously and sustainably improved (United Nations, 2015).

Given the multiple indices for measuring cities' performance in its many dimensions, Hartley, Potts, and MacDonald (2012) compiled the most commonly used general indicators, as shown in Figure 1.

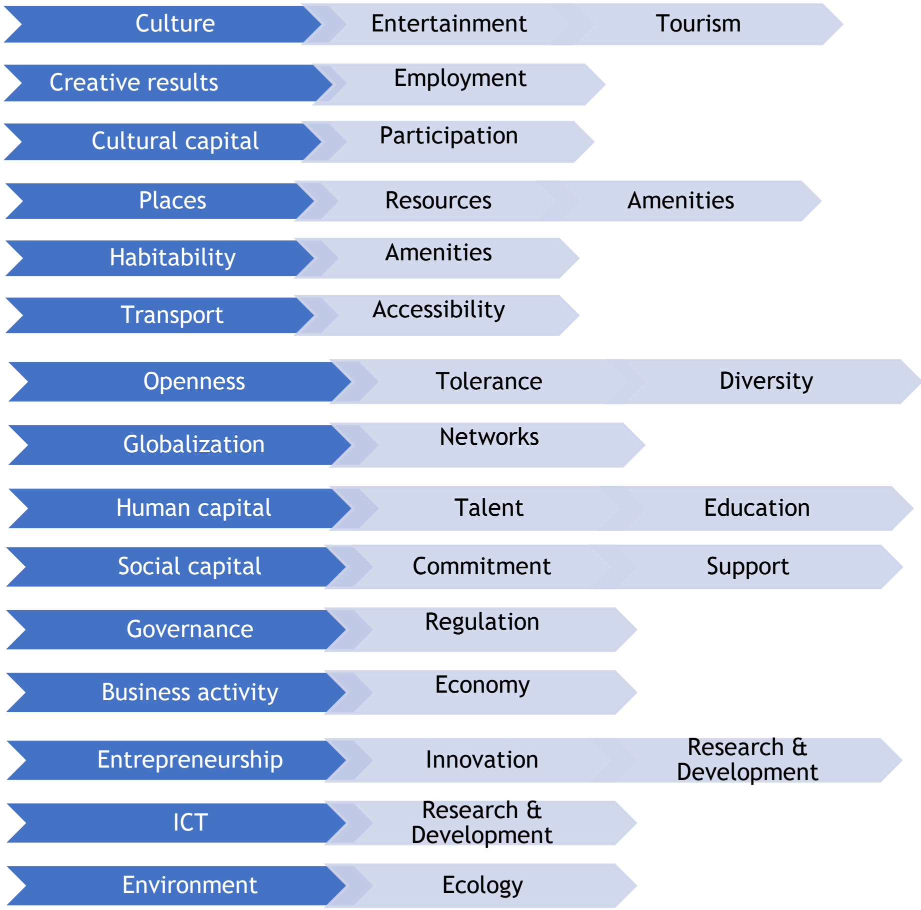

Figure 1 – Sub-dimensions of cities, adapted from Hartley et al. (2012)

In addition, the compilation of the indicators is shown in Figure 1, according to the studies by Giffinger et al. (2007) and Carli, Dotoli, and Pellegrino (2018), there are many others studies that are also important ones, but these are not mentioned in this study. Thus, Giffinger et al. (2007) identified six characteristics of smart cities according to the broad literature on this topic, which are: economy, people, governance, mobility, environment, and living. These six characteristics were considered to be the relevant group characterizing a smart city. They can be broken down into 31 relevant factors, which reflect the most important aspects of every smart characteristic. Finally, every factor of a smart characteristic has been defined empirically through a group of corresponding indicators. In total, 74 indicators were defined and used for operationalizing and aggregating the relevant factor. Therefore, these authors empirically studied 70 European cities. Carli et al. (2013) carried out an empirical study in Italy (city of Bari) to evaluate and manage the performance of smart cities, and also developed a framework for classifying the performance indicators of a smart city. This author used two dimensions: (1) the degree of objectivity of observed variables, and (2) the level of technological advancement for data collection. However, other studies (Carli et al., 2018; Nardo et al., 2005) recognize the limitations of composite indices and focus on sub-dimensions per se (e.g., energy, governance). Finally, Carli et al. (2018) proposed the use of an analytical hierarchy process (AHP) multi-criteria decision-making technique for application in the smart metropolitan city context, with the aim of analyzing the sustainable development of energy, water, and environmental systems, through a set of objective performance indicators. Specifically, the 35 indicators defined for the Sustainable Development of Energy, Water, and Environment Systems Index framework were used.

On the other hand, the sub-dimensions shown in Figure 1 are included in the dimensions of creativity, intelligence and urban sustainability, and to summarize, it is argued that cities are intelligent places whose performance is assessed based on their creative class and their level of education, environment, mobility and technology (Caragliu et al., 2011), and so are considered critical nodes (networks) to apply the creative changes required (Ratten, 2017), to stimulate social cohesion and economic productivity, conserve natural resources and their historical identity and culture (Flores & Teixeira, 2017).

In this context, creativity is an alternative pillar of sustainable economic growth (Giampietro, Gamboa, & Lobo, 2011) and creative cities provide multiple opportunities (Gertler, 2004), since they promote innovations and solutions to current urban problems (Bradford, 2004; Landry, 2000), namely to improve productivity/performance (Florida, 2002; Gertler, 2004). The next section presents the dimensions of creative cities of the 21st century – Current Creative Cities (CCCs) – and the indicators generally used by academics and political decision-makers to measure their performance.

2.2. Dimensions and Indicators of Performance in Current Creative Cities (CCCs)

2.2.1. Creativity

This dimension became popular in the United States of America following the study by Florida (2002, 2005), who introduced the theory of the creative class (creative, talented individuals) as indispensible for cities' economic prosperity, and recently, Romero-Padilla, Navaro-Jurado, and Malvárez-García (2016) argued that this contributes to the theory of economic growth, as it stimulates the creation of new creative ideas. In this context, the vast literature on creative cities is persuasive with regard to creativity having become an emblematic solution to growing urban development (Ratiu, 2013), as a consequence of the various problems caused by the phenomenon of globalization (e.g., the decline and stagnation of some cities) (Kakiuchi, 2016; Ratiu, 2013). Clear examples of creative cities are *Silicon Valley*, *Bavaria Valley* (Bavaria), *Silicon Glen* (Scotland), *Silicon Saxony* (Dresden) (Hospers & Pen, 2008); Barcelona, San Francisco, Glasgow (Amin & Thrift, 2007) and Rotterdam and Amsterdam (Romein & Trip, 2009). These examples refer to different urban areas, however, studies elaborated on these (Amin & Thrift, 2007; Hospers & Pen, 2008; Romein & Trip, 2009) show that cities can be reinvented by adopting a cultural economy (Amin & Thrift, 2007), local governments can increase the chance that urban creativity emerges by providing the appropriate framework conditions (Hospers &

Pen, 2008) and that it is important to assess the success factors of different cities (Romein & Trip, 2009).

Implicit to creativity is tolerance, talent and technology (3Ts), defined by Florida (2002) as determinants to attract, retain and stimulate the creative class in cities and to create a favourable climate for this, i.e., an environment characterized by socio-cultural diversity (Florida, 2002, 2005; Grant & Kronstal, 2010), by openness to entrepreneurial ideas and the technology to achieve high economic performance, whose driver is creativity from the perspective of the creative economy (Florida, 2002, 2005; Furtado & Alves, 2012). Here, the cities themselves promote the necessary changes (Romein & Trip, 2009) for this to generate added value (Nelson & Winter, 2002) and raise entrepreneurship and innovation (Boden, 2004).

In this domain, creative cities show an intelligent strategy by joining their economic and urban strategies with culture (Power & Scott, 2011), i.e., with creative industries as drivers to create economic values (Kakiuchi, 2016; Ratten, 2017), including high-technology, cultural and media firms (Scott, 2006). Consequently, the association between culture, the economy and creativity ensures that cities' cultural and historical legacy is not neglected (Kakiuchi, 2016; Ratten, 2017). Another benefit of this association is related to stimulating urban partnerships/networks and new dynamics in cities (Lazrak et al., 2011), which attracts the creative class and entrepreneurs (Ratten, 2017). In this way, these creative industries join together in creative clusters in cities, as urban socio-cultural spaces (Landry, 2000; Pratt, 2000) which attract creative talents and new investment (Florida, 2002). From another perspective, various authors (e.g., Bisello et al., 2017; Pratt, 2008; Ratten, 2017; Scott, 2000) explained that these clusters are used to stimulate urban regeneration in cities through generally being located geographically in redeveloped infrastructure (e.g., London, Berlin and Barcelona) (He, 2014), which means they are considered urban, creative environments (Scott, 2006), being operationalized by urban entrepreneurship and maximization of local networks (Carta, 2009; Kong, 2014).

Explicitly and according to network theory (Castells, 2010; Donnell et al., 2001; Parkhe, Wasserman, & Ralston, 2006), local networks are a fundamental strategy for cities, allowing the formation of formal links between all the actors involved in their space (Camagni & Capello, 2004), and consequently, have a positive effect on cities' improved economic performance (Capello, 2000; Meijers, Burger, & Hoogerbrugge, 2016; Pain et al., 2016), on inter and intra-city knowledge transfer/sharing (Dijkstra, Garcilazo, & Mccann, 2013) and on better access to information (David et al.,2013). However, these benefits result from creative cities being rooted in the interaction between culture, communication and networks with the aim of stimulating regeneration (Carta, 2009). Therefore, new forms of connectivity should be established between public and private bodies and citizens, such as *living labs* (Schaffers et al., 2011), as public-private partnerships that promote urban entrepreneurship as a form of creativity in cities (Jessop & Sum, 2000; Ratten, 2017), with the example of reference being Amsterdam (Meijer & Bolívar, 2016; Ratten, 2017).

Summarizing, in the creativity dimension, implicit in CCCs are certain factors determining performance, and so this has been subject to measurement by various authors and public and private entities/institutions by defining creativity indices, to allow improvement of the strategies and policies defined and implemented in cities in the European Union, according to the 2020 Strategy. Table 1 presents indicators of creativity.

Table 1 – Creativity index

Sub-dimension	General indicator	Source
Culture	Places of culture and facilities	Bosch et al. (2017); Durmaz, Platt and Yigitcanlar (2010); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Kakiuchi, 2016; Lombardi et al.(2012)
	Cultural participation and attractiveness	
Creative economy	Creativity and employment	Bosch et al. (2017); Caragliu et al. (2011); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Joss, Cowley, and Tomozeiu (2013); Kakiuchi (2016); Landry (2013); Lombardi et al. (2012); Panal and Yáñez (2012); Skavronska (2017)
	Intellectual property and innovation	
Favourable climate	Human capital and education	Caragliu et al. (2011); Dhingra and Chattopadhyay (2016); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Landry (2013); Skavronska (2017); United States Environment Protection Agency (2016)
	Openness, tolerance and trust	
	Local and international connections	
	Governance	

Source: Own elaboration

The above indicators reflect the importance of joining creative class theory (Florida, 2002, 2005) with networks and the influence of creative individuals in their formation (Lawton, Murphy, & Redmond, 2010).

2.2.2. Intelligence

For Ratten (2017), the dimension of intelligence is present in the vector of creativity, i.e., in CCCs. This author explained that intelligent cities are also designated as creative cities, due to the way citizens are involved in them, through the share of knowledge, culture, entrepreneurship and social relations (Letaifa, 2015; Musterd & Ostendorf, 2004; O'Connor & Shaw, 2014), as well as their focus on innovation and integrating technology with culture (Ratten, 2017). Supported by these conclusions, Boulton, Brunn and Devriendt (2011), Nam and Pardo (2011) and Ryser (2014) argued that the creative class can be used intelligently, and so cities' intelligence covers human capital, social capital, relational capital, education, environmental concerns, and evidently ICT as a means to provide political and economic efficiency (Komninos, 2002) and social, cultural and urban development (Hollands, 2008). In addition, in CCCs, creativity and innovation (Ratten, 2017), networks, creative clusters, technology absorption (Fernandes & Gama, 2008), amenities, social equity and quality of life (Esteban et al., 2008), are axes of intelligence that cannot do without technology (ICT) (Vanolo, 2008).

In this context, cities' vitality and economic growth is the reflection of individuals' creative capacity to adapt to technological progress (Kakiuchi, 2016; Ratten, 2017), since connectivity in cities, at various levels, is only possible by integrating ICT in the urban scenario (Bouk et al., 2017). As a sub-dimension of intelligence, ICT is a driver of improved city performance (Gouvea, Kapelianis, & Kassicieh, 2017), as it is understood to stimulate innovation and the nature of social, environmental and economic relationships (Hanclova et al., 2014; Mardikyan et al., 2015). In addition, ICT promotes the formation of public-private partnerships, with community involvement, to stimulate entrepreneurship in its various forms and network cooperation/formation (Batty et al., 2012; Gouvea et al., 2017; Odendaal, 2003; Paskaleva, 2009) and e-governance (Torres, Pina, & Acerete, 2006). Finally, ICT allows cities' urban infrastructure to be increasingly intelligent, this being another benefit of adopting intelligent vectors in cities (Finger & Razaghi, 2016).

No less important is the role of ICT in CCCs' form of governance, which appears in the form of communication, the relation with residents and the transfer of knowledge between all the actors involved, i.e., e-governance (Torres et al., 2006). Consequently, the use of ICT means the policies implemented for cities' economic growth (performance) must stimulate governance that is leading and visionary as well as strategic (Paskaleva-Shapira, 2007).

It is therefore perceived that ICT is a sub-dimension of intelligence with the potential to increase global economic growth in the present and future, supported by the positive performance of cities worldwide as a consequence of their new holistic vision (Networked society city index, 2016). Given the benefits ICT transfers to CCCs, various conceptual models include this as a major pillar so that they can become intelligent and improve their performance in the long term (Arroub, et al., 2016; Chourabi et al., 2012; Giffinger et al., 2007; Neirotti et al., 2014; Piro et al., 2014; Viale-Pereira et al., 2017; Wu et al., 2008). Nevertheless, whatever the model of intelligence adopted, there is a need to monitor and measure it in cities, so that they can become more efficient operationally in terms of performance (Carli et al., 2013). Many cities' capacity for prosperity is dependent on integrating ICT in their urban development strategy (Bibri & Krogstie, 2017a).

Given the importance of measuring this dimension, various indices/indicators have emerged allowing this to be carried out, and the most commonly used ones are presented in Table 2.

Table 2- Intelligence index

Sub-dimension	General indicator	Source
Governance	Implementation	Landry (2013); United Nations (2015);
	Strategy	Angelidou (2017); Bosch et al. (2017); Landry (2013); Madeira, Guimarães, and Mendes (2016);
	Democratic	Angelidou (2017); Bloom Consulting (2017); Garau, Balletto, and Mundula (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Lombardi et al. (2012)
ICT infrastructure and networks	Telecommunications	Ernst and Young(2016); Networked society city index (2016)
	Transport	Ernst and Young (2016)
	Energy	
	Environment	
	Sensors	
ICT accessibility	Tariffs	Networked society city index (2016)
	Mobility	Ernst and Young (2016)
Use of ICT	of technology	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
	Individual	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
	Public	Bloom Consulting (2017); Caragliu et al. (2011); Giffinger et al. (2007); Lombardi et al. (2012); Madeira et al. (2016); Ernst and Young (2016); Networked society city index (2016)
Vitality	Individual and public	Ernst and Young (2016)

Source: Own elaboration

This set of indicators shows that urban openness, innovative services, networks, urban pro-activeness, integration of infrastructure and governance (Lee et al., 2014) have ICT in common (Bibri & Krogstie, 2017b), directed towards creating bridges with creativity and solving residents' current problems (Dodgson & Gann, 2011; Ratten, 2017). It has also been pointed out that ICT makes intelligent governance viable (Nam & Pardo, 2011) and the adoption of collaboration/partnership processes to take advantage of diversity and to create efficient cities that are pleasant to live and work in with quality (Dodgson & Gann, 2011). Consequently, this considerably improves cities' intelligent performance, also in CCCs.

It should also be noted that ICT produces a large number of data in the city, so it is important not to overlook the phenomenon of BIG DATA and OPEN DATA (Klein & Todesco, 2017), which is compatible with intelligence (Caragliu et al. al., 2011), with sustainability (Bibri & Krogstie, 2017a,b) and with creativity (Ratten, 2017).

2.2.3. Urban sustainability

Urban sustainability is another dimension of cities that has been widely researched, since it represents the interconnection between physical, social and economic axes (Camagni, Capello, & Nijkamp, 1998; Tranos & Gertner, 2012). Nevertheless, exponential urban growth has created social and environmental concerns that jeopardize that sustainability (Pérez-Urrestarazu et al., 2017), due to major migratory flows to cities (Keiner & Schmid, 2006), which requires structural, process and cultural changes in governing institutions (Mendes, 2008).

Urban sustainability means the balance between economic, social and environmental pillars (Bibri & Krogstie, 2017a; Brundtland, 1987; Elkington, 2004; Wheeler & Beatley, 2014), and its implementation in cities reflects their leaders' competences (Pozdniakova, 2017), for improved quality of life associated with growth to take place efficiently (Telecommunication & ITU, 2014). However, Cavalcanti (1995) considers there is a fourth pillar named cultural sustainability, mirroring the ability to conserve places' cultural identity and allowing the introduction of new values to support socio-economic transformations. Summarizing, urban sustainability includes 4 vectors: 1) economic; 2) social; 3) environmental and 4) cultural.

Furthermore, this sustainability should be intelligent, i.e., its approach should include the use of ICT, since this facilitates solutions to current concerns inherent to the challenge of making cities sustainable (Hodja, 2015; Jain, 2011; Ono, Lida, & Yamazaki, 2017; Phearson et al., 2016), specifically because ICT has been recognized as determinant in promoting performance in the context of the circular economy (Porras et al., 2017). Consequently, the aim is for cities' economy to be efficient and sustainable in the present and the future, through adopting the circular economy, in order to maximize the use of human capital and minimize that of natural resources (Alwan, Jones, & Holgate, 2017; European Commission, 2015; Ghisellini, Cialani, & Ulgiati, 2015; Lilja, 2015; Staniškis, 2012).

So the applicability of the three pillars of sustainability in cities and in their socio-economic contexts is seen to be multifaceted and complex (Bibri, 2015; McManus, 1996; Molnar, Morgan, & Bell, 2001), which means that urban sustainability affects the balance between environmental protection and integration, economic growth and urban regeneration, and social equity and justice in cities (Bibri & Krogstie, 2017a).

In addition, and as networks are crucial for competitive advantage (Banks *et al.*, 2000) and for the exchange of symbolic knowledge (Vinodrai, 2006; Asheim, Coenen, & Vang, 2007), it is evident that at the regional level these are an important factor in promoting sustainable development, which is clear in the model of regional integration defined by the EU. This model includes formal and informal structures, coordination and collaboration processes, and so this begins to be a priority for governments (*inter* and *intra*-networks) (Siegel, 2016). Sharma and Kearins (2011) suggested that through the collaboration process, the actors involved obtain better understanding of the economic, social and environmental questions that affect their regions' sustainability, and therefore alter their behaviour to obtain added legitimacy. However, the type of strategic behaviour adopted by cities to respond to the challenge to improve performance and quality of life involves different actors, priorities, resources and policies (Schaffers *et al.*, 2011), according to their geographical context and urban morphology (Wey & Hsu, 2014).

Summarizing, joining sustainability with creativity (Baycan, 2011; Girard, 2011), ICT (Bifulco et al.,2016; Forte, 2011; Funk, 2015; Wang, Chen, & Benitez-Amado, 2015; Wu & Raghupathi,

2015) and networks (Pflieger & Rozenblat, 2010) stimulated by the existence of a collaborative community, such as living labs (Snow, Håkonsson, & Obel, 2016) and urban entrepreneurship (Cohen & Muñoz, 2016; Osorio & Cordero, 2014) gives rise to cities' improved performance.

The great complexity involved in urban sustainability justifies assessment of the weight of this dimension in cities' performance, through indices. Therefore, Table 3 shows a set of indicators relevant for that measurement, to be followed through by application at a more detailed level of these and implicit proxies. It is emphasized, however, that the following indices/indicators only refer to economic, social and environmental sustainability, since those referring to the axes of ICT (intelligence) and creativity/culture are presented in Section 2.2.1 and 2.2.2, respectively.

Table 3- Index of urban sustainability

Sub-dimension	General indicator	Source
Economic	Competitiveness	Adnan, Hamzah, and Alias (2016;) Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Caragliu et al. (2011); Devol, Ratnatunga, and Bedroussian (2016); Giffinger et al.(2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
	Economic activity	Angelidou (2017); Bloom Consulting (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)
Social	Population	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Trivellato (2016); United States Environment Protection Agency (2016)
	Education	Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
	Inclusion and cohesion	Bosch et al. (2017); Giffinger et al. (2007); Trivellato (2016)
	Social infrastructure	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)
Environmental	Basic infrastructure	Batten (2016); Bosch et al. (2017); Lombardi et al. (2012); Networked society city index (2016)
	Emission and production of atmospheric pollution	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Joss et al. (2013); Lombardi et al. (2012); Networked society city index (2016)
	Circular economy	Ligorio (2017); Smol, Kulczycka, and Avdiushchenko (2017)
	Urbanism	Artmann et al. (2017); Batten (2016); Bloom Consulting (2017); Dhingra and Chattopadhyay (2016); Lombardi et al. (2012); Networked society city index (2016); United States Environment Protection Agency (2016)

Source: Own elaboration

Table 3 above shows that the premises of the general indicators most commonly used to measure cities' sustainability are the improved well-being of citizens and society as a whole, which implies that urban planning and management should be integral, to take advantage of the benefits in the present and future (Suzuki et al., 2010).

2.3. Proposal of a Conceptual and Multidimensional Model for CCCs

Supported by the literature review, it is argued that cities must be perceived holistically. In other words, cities should have creative/favourable environments for the interaction of talented people and to obtain cultural synergies, articulated with the co-creation of economic value and with a catalyst effect to promote urban regeneration, and thereby achieve urban sustainability (Furtado & Alves, 2012). In addition, Caragliu et al. (2011) explained that it is crucial to add to these driving forces the benefits of intelligence, so that cities are attractive and encourage entrepreneurship.

In this context, CCCs have creativity by focusing on the role of culture as a catalyst, which means that the restoration and regeneration of cultural heritage is a determinant leading the economy, by stimulating synergies, networks and partnerships between all stakeholders, in order to gain an economic return in the present and future (Girard, 2011); intelligence, by supporting cycles of value exchange through the process of the circular economy and through participative and creative governance (Girard, 2011) organized around technological resources (Neirotti et al., 2014); and urban sustainability, by recognizing the importance of their tangible and intangible amenities as predictors of their quality of life and performance (Neirotti et al., 2014).

So responding to the objective and the research question defined, Figure 2 presents a model of a multidimensional and holistic design for CCCs. This model shows that networks promote CCCs' holistic performance, whereby flows generated by creativity, intelligence and urban sustainability have a joint effect on continuously improving performance.

This coherence between the three dimensions of CCCs must be reflected in cities' strategies and policies. This means that political decision-makers must not neglect the influence of their tangible (e.g., basic, social infrastructure of education, security and protection) and intangible assets (e.g., collaboration processes, natural resources, citizenship, cultural heritage, identity and cultural values, individual and collective competences), which should be managed and benefited from in a balanced way so that their return is reflected in cities' competitive advantage and performance. Consequently, the model proposed in Figure 2 allows this balance and its reflection in the three-dimensional economic growth of CCCs.

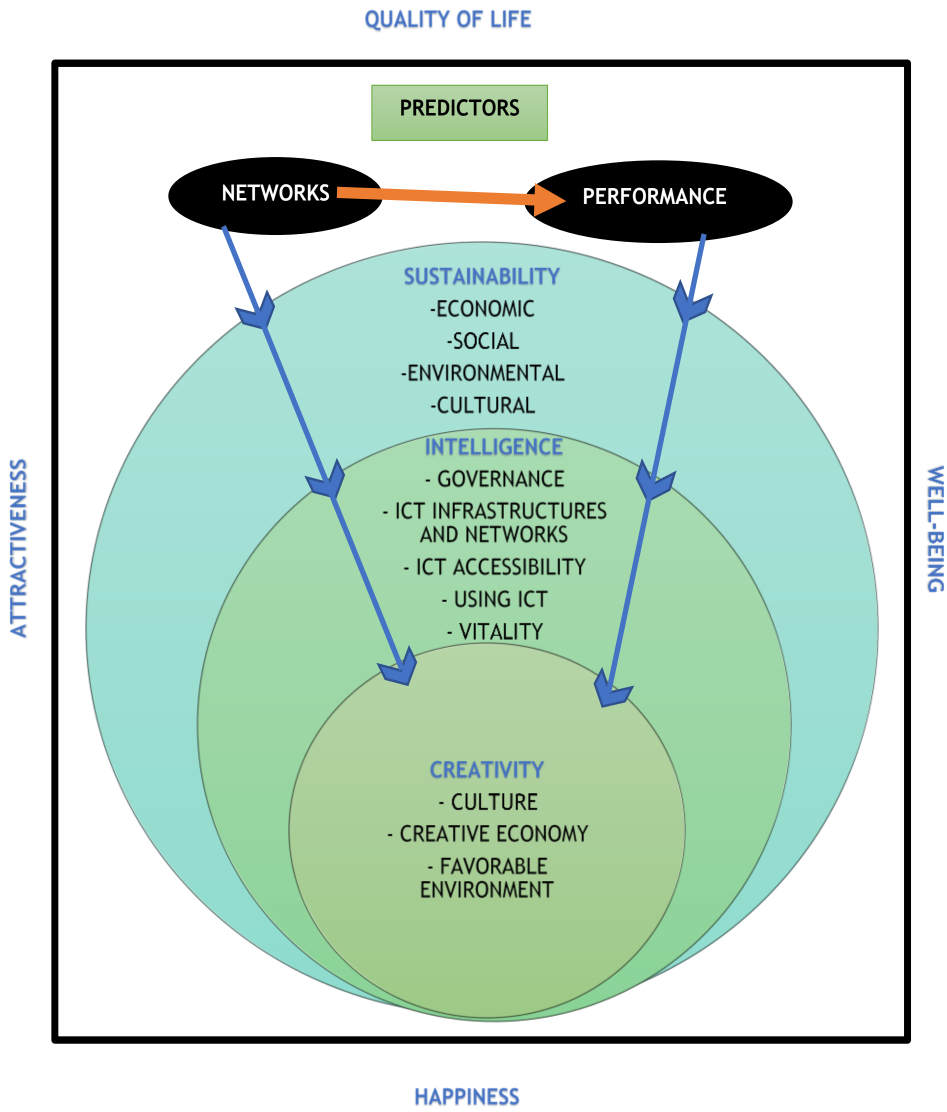

Figure 2 –Design of a multi-dimensional model for CCCs (**Source:** Own elaboration)

The model proposed shows that creativity is a new pillar of sustainability – cultural sustainability (Cavalcanti, 1995) – whose primary economic value is the generation of wealth, employment and local networks (Cohendet & Zapata, 2009); with intelligence meaning that cities can become efficient and more pleasant to live and work in (Dodgson & Gann, 2011); with urban sustainability allowing improved quality of life (Birat, 2015; Suzuki et al., 2010). Operationalization of this model in CCCs means that the strategies and policies defined should consider their demographic charateristics, infrastructure, inclusion and cohesion, natural resources, collaboration processes and citizenship to bring about improved performance. In addition, this model considers the importance of human, cognitive and relational capital (Camagni, 2011) in the three dimesions of CCCs, since their holistic combination has a positive impact on the performance offered by adopting open and participative governance and by conserving cultural identity.

Briefly, the current paradigm around cities does not allow creativity and intelligence to be ignored in cities' present strategies, and so urban sustainability should be measured by culture, by the creative economy and by a climate that favours them, where this connectivity and integration stimulates and promotes network formation and urban entrepreneurship, which in turn improves sustainability in social, economic and environmental terms, and consequently cities' economic growth. Implicitly, this model means adoption of a participative and intelligent model of governance interlinked with culture and the urban *buzz,* and in this way promotes urban regeneration as a driver of high CCCs performance. In addition, this model shows the social capital that values the relations/connections between people, since these provide the formation of social networks in the cities (Gülümser, Baycan-Levent, & Nijkamp, 2010), which is also important in CCCs (Mayer & Knox, 2010).

3. Final considerations

From the 1970s, cities were faced with economic and social stagnation and decline, with many of them suffering the negative effects of a fall in population and dilapidated infrastructure and buildings. In this context, a paradigmatic change is found in the vision of the role and future of cities, stimulated by the phenomenon of globalization. This new vision meant that cities' economic and political importance grew quickly and that political decision-makers understood these help to solve their everyday problems of a social, economic and environmental nature. This vision is shared by the Networked Society City Index (2016) where the aim is for cities to become more inclusive, safe, resilient, creative, intelligent and sustainable, supported by the use of ICT and network connectivity, and by adopting a more sustainable consumption model - circular economy.

The first contribution of this theoretical study lies in presenting a model of a multidimensional design for CCCs, based on a wide-ranging view including creativity, intelligence and urban sustainability at the same level, with their dissemination being joint and inseparable. This model incorporates the objectives and premises defined by the EU's 2020 Strategy (intelligent, sustainable and inclusive growth) to combat the negative externalities of exponential urban development and migratory flows to large urban areas. Finally, the proposed model fills the gaps identified in the literature, since it compiles the individual models developed for each of its dimensions, preceded by compilation of the relevant general indicators to measure cities' performance, besides considering networks as an instrument predicting this. It is also shown that urban sustainability can be promoted through cities' intelligence and creativity.

The second contribution lies in the originality of integrating networks in the model as one of cities' endogenous characteristics and understood as a determinant factor for increased performance. These networks are considered as cities' intangible assets, where the city presents its main node and residents, being creative and entrepreneurial, are its core, and they can also be conceived around public-private-people partnerships (4Ps), for example, living labs as open innovation networks that can be associated with urban entrepreneurship directed to vitalizing cities' urban environment.

It is also highlighted that the proposed model shows cities' tangible and intangible resources as endogenous characteristics and city amenities that are the starting point for formulating and implementing strategies aiming to stimulate growth by obtaining synergies and co-creation of added value for the city and its current and future residents.

Furthermore, this model allows some practical considerations to be made, i.e., cities cannot aspire only to grow economically, as traditional economic indicators are out of date. This means that cities' intangible nature is increasingly becoming the path to their holistic growth, by allowing the returns obtained to be re-invested in other critical areas of the city, and in this way generate a cycle of continuous growth and with its own resources generated by creativity and stimulated by intelligence, whose benefits can contribute to urban sustainability.

As with any study, this one is not without limitations. The first concerns the theories used, with some subjectivity being implicit in the choice, since others could have been used. The second limitation concerns the indices/indicators presented, with the knowledge that many more could be used. The model here proposed does not include mobility as a dimension. However, it is seen as a crucial axis. For some authors (e.g., Dixon et al., 2018), performance must be measured by an index of mobility apart from other dimensions, which reports the third limitation and an area of potential future research. It should be noted once again that the general indicators here presented are the ones that stood out most from the literature reviewed in this study; however, we are aware that others could be used. This selection of indicators is a fourth limitation, since it involves the subjectivity of the researchers. Finally, another limitation concerns the unavailability of a single official database when the unit of analysis is the cities, which suggests that the investigator himself will have the ability to turn this lack of aggregate information.

Despite this being a topical issue, some fields still require future study. In this connection, suggested for future research is empirical validation of the model proposed here, in cities of different sizes and geographical contexts, through presenting an inclusive index to measure their performance in each dimension presented. Thus, a quantitative approach and multiple case studies in several cities are suggested. In this way, it is suggested, for example, to determine the weighting coefficients of each dimension in a composite index following the methodology of the OECD (2008) to evaluate the performance of cities by size, with the appropriate adaptations. Another suggestion is to carry out a comparative study between cities to elaborate a ranking. Finally, it is suggested that later studies could include the construction of a composite index that, in the urban sustainability dimension, includes the sub-dimension of urban design in accordance with Bay (2010) and Chermayeff and Tzonis (1971).

References

Adnan, Y. M., Hamzah, H., & Alias, A. (2016). An initiatives-based framework for assessing smart city. *Planning Malaysia Journal*, *14*(5), 13-22.

Addanki, S. C., & Venkataraman, H. (2017). Greening the economy: A review of urban sustainability measures for developing new cities. *Sustainable cities and society*, *32*, 1-8.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 1–19.

Alwan, Z., Jones, P., & Holgate, P. (2017). Strategic sustainable development in the UK construction industry, through the framework for strategic sustainable development, using building information modelling. *Journal of Cleaner Production*, *140*, 349–358.

Ahmad, N., & Mehmood, R. (2015). Enterprise systems: are we ready for future sustainable cities. *Supply Chain Management: An International Journal*, *20*(3), 264-283.

Amin, A., Massey, D. B., & Thrift, N. J. (2000). *Cities for the Many not the Few*. Policy Press.

Amin, A., & Thrift, N. (2007). Cultural-economy and cities. *Progress in Human Geography*, *31*(2), 143–161.

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 4–28.

Anthopoulos, L. (2017). Smart utopia VS smart reality : Learning by experience from 10 smart city cases. *Cities*, *63*, 128–148.

Arroub, A., Zahi, B., Sabir, E., & Sadik, M. (2016). A literature review on Smart Cities: Paradigms, opportunities and open problems. *Proceedings - 2016 International Conference on Wireless Networks and Mobile Communications, WINCOM 2016: Green Communications and Networking*, 180–186.

Artmann, M., Kohler, M., Meinel, G., Gan, J., & Loja, I. (2017). How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecological Indicators*, (June), 1–13.

Asheim, B., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670.

Aurigi, A. (2005). *Making the digital city: the early shaping of urban internet space*. Routledge.

Ballas, D. (2013). What makes a happy city'? *Cities*, *32*, S39-S50.

Banks, M., Lovatt, A., O'Connor, J., & Raffo, C. (2000). Risk and Trust in the Cultural Industries. *Geoforum* , *31*(4), 453–464.

Barrionuevo, J. M., Berrone, P., & Ricart Costa, J. E. (2012). Smart Cities, Sustainable Progress: Opportunities for Urban Development. *IESE Insight*, (14), 50–57.

Batten, J. (2016). Sustainable Cities Index 2016. *Arcadis Global*, 10. Available online: https://www.arcadis.com/media/0/6/6/%7B06687980-3179-47AD-89FD-F6AFA76EBB73%7DSustainable Cities Index 2016 Global Web.pdf.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., & Bazzani, A. (2012). Smart cities of the future, *The European Physical Journal Special Topics*, *214*(1), 481-518.

Bay, J. H. (2010). Towards a Fourth Ecology: Social and Environmental Sustainability with Architecture and Urban Design. *Journal of Green Building*, *5*(4), 176–197.

Baycan, T. (2011). Creative cities: Context and perspectives. In Girard, L. F., Baycan, T., & Nijkamp, P. *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (p. 15).

Bibri, S. E. (2015). The Shaping of Ambient Intelligence and the Internet of Things. (Vol. 10). Amsterdam: Atlantis Pres.

Bibri, S. E., & Krogstie, J. (2017a). On the social shaping dimensions of smart sustainable cities: A study in science, technology, and society. *Sustainable Cities and Society*, *29*, 219–246.

Bibri, S. E., & Krogstie, J. (2017b). Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustainable Cities and Society*, *31*, 183–212.

Bifulco, F., Tregua, M., Amitrano, C. C., & D'Auria, A. (2016). ICT and sustainability in smart cities management. *International Journal of Public Sector Management*, *29*(2), 132–147.

Birat, J.-P. (2015). Life-cycle assessment, resource efficiency and recycling. *Metallurgical Research & Technology*, *112*(2), 2-24.

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Co-benefits of Smart and Sustainable Energy District Projects: An Overview of Economic Assessment Methodologies. In P. Bisello, A., Vettorato, D., Stephens, R., & Elisei (Ed.), *Smart and Sustainable Planning for Cities and Regions* (pp. 127–164).

Bloom Consulting. (2017). Portugal ConsultingCity Brand Ranking 2016 - Municípios Portugueses. *Bloom Consulting Countries Regions and Cities*, 1–56. Available online: http://www.bloom-consulting.com.

Boden, M. A. (2004). *The Creative Mind: Myths and Mechanism*. Routledge.

Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.

Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.

Bouk, S. H., Ahmed, S. H., Kim, D., & Song, H. (2017). Named-data-networking-based ITS for smart cities. *IEEE Communications Magazine*, *55*(1), 105-111.

Boulton, A., Brunn, S. D., & Devriendt, L. (2011). *18 cyberinfrastructures and 'smart'world cities: physical, human and soft infrastructures. International handbook of globalization and world cities, 198.*

Bradford, N. (2004). Creative Cities: Structured Policy Dialogue Backgrounder. Ottawa: Canadian Policy Research Networks.

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development. *United Nations Commission*, *4*(1), 300.

Camagni, R. (2011). Camagni, R. Creativity, Culture and Urban Milieux. In Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (pp. 183–189).

Camagni, R., & Capello, R. (2004). The City Network Paradigm : Theory and Empirical Evidence. In *Urban Dynamics and Growth: Advances in Urban Economics* (pp. 495-529). Emerald Group Publishing Limited.

Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: An economy-environment technology nexus. *Ecological Economics*, *24*(1), 103–118.

Capello, R. (2000). The City Network Paradigm: Measuring Urban Network Externalities. *Urban Studies*, *37*(11), 1925–1945.

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.

Carli, R., Dotoli, M., & Pellegrino, R. (2018). Multi-criteria decision-making for sustainable metropolitan cities assessment. *Journal of Environmental Management*, *226*(January), 46-61.

Carli, R., Dotoli, M., Pellegrino, R., & Ranieri, L. (2013). Measuring and managing the smartness of cities: A framework for classifying performance indicators. *Proceedings - 2013 IEEE International Conference on Systems, Man, and Cybernetics, SMC 2013*, (October), 1288–1293.

Carta, M. (2009). Culture, communication and cooperation: The three Cs for a proactive creative city. *International Journal of Sustainable Development*, *12*(2–4), 124–133.

Castells, M. (2010). The Information Age: Economy, Society, and Culture. Volume I: The Rise of the Network Society. Available online: http://www.urbanisztika.bme.hu/wp-content/uploads/2014/05/manuel_castells_the_rise_of_the_network_societybookfi-org.compressed.pdf.

Cavalcanti, C. (1995). *Sustentabilidade da economia: paradigmas alternativos de realização econômica. Desenvolvimento e natureza: estudos para uma sociedade sustentável*. São Paulo: Cortez.

Chermayeff, A.; Tzonis (1971). Shape of Community: Realization of Human Potential. Available online: https://archive.org/details/shapeofcommunity00cher.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., ... & Scholl, H. J. (2012, January). Understanding smart cities: An integrative framework. In *System Science (HICSS), 2012 45th Hawaii International Conference on* (pp. 2289-2297). IEEE.

Cohen, B. (2012). What exactly is a smart city. *Available online:* https://www.fastcompany.com/1680538/what-exactly-is-a-smart-city.

Cohen, B., & Muñoz, P. (2015). Toward a Theory of Purpose-Driven Urban Entrepreneurship. *Organization & Environment*, *28*(3), 264-285.

Cohendet, P., & Zapata, S. (2009). Innovation and Creativity : Is there economic significance to the creative city ? *Management International*, *13*, 23–26.

David, Q., Peeters, D., Van Hamme, G., & Vandermotten, C. (2013). Is bigger better? Economic performances of European cities, 1960-2009. *Cities*, *35*, 237–254.

Davoudi, S., & Sturzaker, J. (2017). Resources , Conservation and Recycling Urban form , policy packaging and sustainable urban metabolism. *Resources, Conservation & Recycling 120*, 55–64.
Devol, R., Ratnatunga, M., & Bedroussian, A. (2016). Best Performing Cities. *Milken Institute*. Available online: https://assets1c.milkeninstitute.org/assets/Publication/ResearchReport/PDF/BPC-2016-FINAL-WEB.pdf.
Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563.
Dijkstra, L., Garcilazo, E., & Mccann, P. (2013). The Economic Performance of European Cities and City Regions : Myths and Realities. *European Planning Studies*,*21*(3), 334-354.
Dixon, B. S., Irshad, H., Pankratz, D. M., & Bornstein, J. (2018) The Deloitte City Mobility Index Gauging global readiness for the future of mobility. Available online: https://www2.deloitte.com/content/dam/insights/us/articles/4331_Deloitte-City-Mobility-Index/4331_city-mobility-index_OVERVIEW.pdf.
Dizdaroglu, D. (2017). The role of indicator-based sustainability assessment in policy and the decision-making process: A review and outlook. *Sustainability*, *9*(6), 1018.
Dodgson, M., & Gann, D. (2011). Technological Innovation and Complex Systems in Cities. *Journal of Urban Technology*, *18*(3), 101–113.
Donnell, A. O., Gilmore, A., Cummins, D., & Carson, D. (2001). The network construct in entrepreneurship research : a review and critique. *Management Decision*, *39*(9), 749–760.
Durmaz, B., Platt, S., & Yigitcanlar, T. (2010). Creative, culture tourism and place-making : Istanbul and London film industries. *International Journal of Culture, Tourism and Hospitality Research*, *4*(3), 198–213.
Eger, J. M. (2009). Smart Growth, Smart Cities, and the Crisis at the Pump A Worldwide Phenomenon. *I-Ways*, *32*(1), 47–53.
Elkington, J. (2004). Enter the triple bottom line. The triple bottom line: Does it all add up. In *Chapter 1* (Vol. 11, pp. 1-16). Available online: http://www.johnelkington.com/archive/TBL-elkington-chapter.pdf.
Ernst & Young. (2016). Rapporto Smart city index. Available online: www.ey.com/...smart...index-2016/.../2016-EY-smart-city-index.
Esteban, M. S., Ugalde, I., Rodríguez, A., & Altuzarra, A. (2008). *Territorios Inteligentes: Dimensiones y experiencias internacionales.* Netbiblio: Bern, Germany.
European Comission. (2015). An EU action plan for the circular economy, *614*, 21. Available online: https://ec.europa.eu/growth/industry/sustainability/circular-economy_en.
European Commission. (2011). Cities of tomorrow - Challenges, visions, ways forward. Available online: ec.europa.eu/.../citiesoftomorrow/citiesoftomorrow_final.pdf.
European Union. (2017). *The Cultural and Creative Cities Monitor*. European Union: Brussels, Belgium.
Fernandes, R., & Gama, R. (2008). A Criatividade Territorial Em Portugal: Dos Indicadores Aos Territórios Criativos. Available online: https://core.ac.uk/download/pdf/19133326.pdf.
Finger, M., & Razaghi, M. (2016). Conceptualizing “Smart Cities”. *Informatik-Spektrum*. *40*(1), 6-13.
Florea, C. A. (2015). Creative and Innovative Cities–A New Perspective for Sustainable Development. *Network Intelligence Studies*, (5), 49-54.
Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.
Florida, R. (2002). *The Rise of the Creative Class (and How It’s Transforming Work, Leisure, Community and Everyday Life).* (Basic Books, Ed.). New York.
Florida, R. (2005). *Cities and the creative class.* Routledge.
Forte, F. (2011). City Design, Creativity, Sustainability. In Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives.* (pp. 289–321).
Funk, J. L. (2015). IT and sustainability: New strategies for reducing carbon emissions and resource usage in transportation. *Telecommunications Policy*, *39*(10), 861–874.
Furtado, G., & Alves, S. (2012). Cidades criativas em Portugal e o papel da arquitetura : Mais uma estratégia a concertar. *Revista Crítica de Ciências Sociais*, (99), 125-140.

Garau, C., Balletto, G., & Mundula, L. (2017). A Critical Reflection on Smart Governance in Italy: Definition and Challenges for a Sustainable Urban Regeneration. In E. P. Bisello A., Vettorato D., Stephens R. (Ed.), *Smart and Sustainable Planning for Cities and Regions. SSPCR 2015. Green Energy and Technology* (p. 435).

García Suárez, J. A., & Pulido Fernández, J. I. (2015). Creacity , una propuesta de índice para medir la creatividad turística . Aplicación en tres destinos urbano-culturales españoles. *Revista de Estudios Regionales*, (13), 69–108.

Gertler, M. S. (2004). *Creative cities: What are they for, how do they work, and how do we build them?* (pp. 1-13). Ottawa: Canadian Policy Research Networks.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy : the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11-32.

Giampietro, M., Gamboa, G., & Lobo, A. (2011). The Urban Metabolic Pattern: Dynamics and Sustainability. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (pp. 323–338).

Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf*.

Girard, L. F., Baycan, T., & Nijkamp, P. (2011). *Sustainable City and Creativity: Promoting Creative Urban Initiatives*. Ashgate Publishing.

Girard, L. F. (2011). Creativity and the human sustainable city: Principles and approaches for nurturing city resilience. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable city and creativity: Promoting Creative urban initiatives.* (pp. 55–96).

Gouvea, R., Kapelianis, D., & Kassicieh, S. (2017). Assessing the nexus of sustainability and information & communications technology. *Technological Forecasting and Social Change*, *130*, 39-44.

Grant, J. L., & Kronstal, K. (2010). The social dynamics of attracting talent in Halifax. *Canadian Geographer*, *54*(3), 347–365.

Gülümser, A. A., Baycan-Levent, T., & Nijkamp, P. (2010). Measuring Regional Creative Capacity : A Literature Review for Rural-Specific Approaches. *European Planning Studies*, *18*(4).

Hanclova, J., Doucek, P., Fischer, J., & Vltavska, K. (2014). Does ICT capital affect economic growth in the EU-15 and EU-12 countries? *Journal of Business Economics and Management*, *16*(2), 387–406.

Hartley, J., Potts, J., & MacDonald, T. (2012). The CCI creative city index 2012. *Cultural Science Journal*, *5*(1), 1-38.

He, J. (2014). From the New Economy to Creative City. In *Creative Industry Districts* (pp. 5-42). Springer, Cham.

Hojda, A. (2015). Tecnologia, informação e atores : conectando as partes da cidade inteligente. In 3º Simpósio Internacional LAVITS: Vigilância, Tecnopolíticas, Territórios (pp. 276–290).

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320.

Hospers, G.-J., & Pen, C.-J. (2008). A View on Creative Cities Beyond the Hype. *Creativity and Innovation Management*, *17*(4), 259–270.

Huovila, A., Penttinen, T., Airaksinen, M., Pinto-Seppä, I., Piira, K., & Penttinen, T. (2016). Smart city performance measurement system. In Proceedings of the 41th IAHS World Congress Sustainability Innovation for the Future, Algarve, Portugal, 13–16 September; pp. 1–10.

Jain, H. (2011). Green ICT Organizational Implementations and Workplace Relationships. In *Handbook of Research on Green ICT: Technology, Business and Social Perspectives* (pp. 146-168). IGI Global.

Jessop, B. & Sum, N. L. (2000). An Entrepreneurial City in Action: Hong Kong's Emerging Strategies in and for (Inter) Urban Competition. *Urban Studies*, *37*(12), 2287–2313.

Joss, S., Cowley, R., & Tomozeiu, D. (2013). Towards the "ubiquitous eco-city": An analysis of the internationalisation of eco-city policy and practice. *Urban Research and Practice*, *6*(1), 54–74.

Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.

Keiner, M., & Schmid, W. A. (2006) On the way to Gigapolises : can global urban development

become sustainable ? *WIT Transactions on Ecology and the Environment*, *93*, 169-178.
Komninos, N. (2002). *Intelligent cities: innovation, knowledge systems, and digital spaces. Taylor & Francis.*
Kong, L. (2014). From cultural industries to creative industries and back? Towards clarifying theory and rethinking policy. *Inter-Asia Cultural Studies*, *15*(4), 593–607.
Kourtit, K., & Nijkamp, P. (2012). Smart cities in the innovation age. *Innovation*, *25*(2), 93–95.
Kourtit, K., Nijkamp, P., Franklin, R. S., & Rodríguez-Pose, A. (2014). A blueprint for strategic urban research: the urban piazza. *The Town Planning Review*, *85*(1), 97–126.
Kourtit, K., Nijkamp, P., & Steenbruggen, J. (2017). The significance of digital data systems for smart city policy. *Socio-Economic Planning Sciences*, *58*, 13–21.
Klein, V. B., & Todesco, J. L. (2017). Um modelo conceitual para uso de Big Data e Open Data para Smart Cities. *International Journal of Knowledge Engineering and Management (IJKEM)*, *6*(14), 28-50.
Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.
Landry, C. (2006). *The Art of City Making*. London: Earthscan Publications Ltd.
Landry, C. (2013). Creative city index; comfortable or captivating, assessment report of Palmerstone North. Available online: https://www.pncc.govt.nz/media/2096880/creative_city_index_report__web_document_.pdf.
Lawton, P., Murphy, E., & Redmond, D. (2010). Examining the role of "creative class" ideas in urban and economic policy formation: the case of Dublin, Ireland. *International Journal of Knowledge-Based Development*, *1*(4), 267-286.
Lazaroiu, G. C., & Roscia, M. (2012). Definition methodology for the smart cities model. *Energy*, *47*(1), 326–332.
Lazrak, F., Nijkamp, P., Rietveld, P., & Rouwendal, J. (2011). Cultural heritage and creative cities: an economic evaluation perspective. In P. Girard, L. F., Baycan, T., & Nijkamp (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives*. (pp. 225–243).
Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.
Lee, J. H., Phaal, R., & Lee, S. H. (2013). An integrated service-device-technology roadmap for smart city development. *Technological Forecasting and Social Change*, *80*(2), 286–306.
Lennert, M., Van Hamme, G., Patris, C., Smętkowski, M., Płoszaj, A., Gorzelak, G., ... & Szul, R. (2010). FOCI Future Orientation for Cities (ESPON). Available online: https://www.espon.eu/sites/default/files/.../FOCI_draft_final_report_ScientificReport.
Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.
Ligorio, V. (2017). New economic development pattern: from a linear to a circular economy, a challenge for eu's economy. *Міжнародний Науковий Журнал Інтернаука International Scientific Journal of International Science*, *1*(2), 20–23.
Lilja, R. K. (2015). Policy instruments for promoting material efficiency: case of Finland. *Clean Technologies and Environmental Policy*, 17(7), 2029–2040.
Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation*, *25*(2), 137–149.
Lynch, A. J., & Mosbah, S. M. (2017). Improving local measures of sustainability : A study of built-environment indicators in the United States. *JCIT*, *60*, 301–313.
Madeira, G., Guimarães, T., & Mendes, L. (2016). Assessing some models for city e-government implementation : a case study. *Electronic Government, An International Journal*, *12*(1), 86–105.
Mahizhnan, A. (1999). Smart cities. *Cities*,*16*(1), 13–18.
Malecki, E. J. (2007). Cities and regions competing in the global economy : knowledge and local development policies. *Environment and Planning C: Government and policy*. *25*, 638–655.
Mardikyan, S., Yıldız, E., Ordu, M., & Şimşek, B. (2015). Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA*, *2015*, 1–10.
Mayer, H., & Knox, P. (2010). Small-Town Sustainability: Prospects in the Second Modernity. *European Planning Studies*, *18*(10), 1545–1565.
McManus, P. (1996). Contested terrains: Politics, stories and discourses of sustainability. *Environmental Politics*, *5*(1), 48–73.
Meijer, A., & Bolivar, M. P. R. (2016). Governing the smart city : a review of the literature on

smart urban governance governance. *International Review of Administrative Sciences*, *82*(2), 392-408.

Meijers, E. J., Burger, M. J., & Hoogerbrugge, M. M. (2016). Borrowing size in networks of cities: City size, network connectivity and metropolitan functions in Europe. *Papers in Regional Science, 95*(1), 181-198.

Mendes, W. (2008). Implementing social and environmental policies in cities: The case of food policy in Vancouver, Canada. International Journal of Urban and Regional Research, 32(4), 942-967.

Molnar, D , Morgan, A., & Bell, D. (2001) *Defining Sustainability, Sustainable Development and Sustainable Communities: A working paper for the Sustainable Toronto Project*. Available online: https://www.google.com.tw/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwilje3xnLDeAhUKdt4KHTs0DEcQ FjAAegQICBAC&url=http%3A%2F%2Fsites.utoronto.ca%2Fenvstudy%2Fsustainabletoronto%2Fresource s%2FSustainableTorontoDefinitionsPaper-FinalDraft.doc&usg=AOvVaw3FreTQcwerwSBvQ5-MbUc.

Musterd, S., & Ostendorf, W. J. M. (2004). Creative cultural knowledge cities; Perspectives and planning strategies. *Built Environment*, *30*(3), 189–193.

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis*, *EUR 21682* (December), 134.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). *Current trends in smart city initiatives: Some stylised facts. Cities* 38, 25-36.

Nelson, R. R., & Winter, S. G. (2002). Evolutionary Theorizing in Economics. *Journal of Economic Perspectives*, *16*(2), 23–46.

Networked Society City Index (2016). *Cities play key role in sustainable development. Available onlibe: https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.*

New Economics Foundation (NEF). (2015). *Five headline indicators of national success - A clearer picture of how the UK is performing. London, UK.*

O'Connor, J., & Shaw, K. (2014). What next for the creative city? *City, Culture and Society*, *5*(3), 165–170.

Odendaal, N. (2003). Information and communication technology and local governance : understanding the difference between cities in developed and emerging economies. *Computers, Environment and Urban Systems*, *27*(6), 585-607.

OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.

Ono, T., Lida, K., & Yamazaki, S. (2017). Achieving Sustainable Development Goals (SDGs) through ICT Services. *Fujitsu Scientific & Technical Journal*, *53*(6), 17–22.

Osorio, A. E., & Cordero, J. A. (2014). Entrepreneurship Education in Practice: The Development of a Hybrid Training Model in an Urban Environment. In *Innovative Pathways for University Entrepreneurship in the 21st Century* (pp. 171-208). Emerald Group Publishing Limited.

Pain, K., Hamme, G. Van, Vinciguerra, S., & David, Q. (2016). Global networks, cities and economic performance : Observations from an analysis of cities in Europe and the USA. *Urban Studies*, *53*(6), 1137-1161.

Panal, G., & Yáñez, C. (2012). Industrias culturales en ciudades españolas . Un primer acercamiento . Cultural industries in Spanish cities . A first approach. *Revista de Estudios*, *94*, 71–103.

Parkhe, A., Wasserman, S., & Ralston, A. (2006). New frontiers in network theory development. *Academy of Management Review*, *31*(3), 560–568.

Paskaleva-Shapira, K. A. (2007). E-city Europe: Status, propositions, and opportunities. In *Proceedings of the International Conference 'Intelligent Environments*, Ulm, Germany, 24–25 September.

Paskaleva, K. (2009). Enabling the smart city : the progress of city e-governance in Europe. *International Journal of Innovation and Regional Development*, *1*(4), 405–422.

Pérez-Urrestarazu, L., Fernández-Cañero, R., & Franco-Salas, A. (2017). Vertical Greening

Systems and Sustainable Cities. Vertical. *Journal of Urban Technology*, *22*(4), 65-85.
Pflieger, G., & Rozenblat, C. (2010). Urban networks and network theory : the city as the connector of multiple networks. *Urban Studies*, *47*(13), 2723–2735.
Phearson, T. M., Pickett, S. T. A., Grimm, N. B., Niemelä, J., Alberti, M., Elmqvist, T., … Qureshi, S. (2016). Advancing Urban Ecology toward a Science of Cities. *BioScience*, *66*(3), 198–212.
Piro, G., Cianci, I., Grieco, L. A., Boggia, G., & Camarda, P. (2014). Information centric services in Smart Cities. *Journal of Systems and Software*, *88*(1), 169–188.
Porras, J., Palacin-Silva, M., Drögehorn, O., & Penzenstadler, B. (2017). Developing a model for evaluation of sustainability perspectives and effects in ICT projects. In *International sustainable Ecological Engineering Design for Society (SEEDS) Conference* Leeds Beckett University, UK, 13–14 September.
Power, D., & Scott, A. J. (2011). Culture, creativity, and urban development. In J. Pike, A., Rodríguez-Pose, A. & Tomaney (Ed.), *Handbook of Local and Regional Development*. (pp. 162–171).
Pozdniakova, A. (2017). Smart sustainable cities: the concept. *Acta Innovations*, *22*, 5–19.
Pratt, A. C. (2000). New media, the new economy and new spaces. *Geoforum*, *31*(4), 425–436.
Pratt, A. C. (2008). Creative cities: The cultural industries and the creative class. *Geografiska Annaler, Series B: Human Geography*, *90*(2), 107–117.
Priano. F., & Guerra, C. (2014). A framework for measuring smart cities. In *Proceedings of the 15th Annual International Conference on Digital Government Research,* Aguascalientes, Mexico (pp. 44-54). ACM.
Ratiu, D. E. (2013). Creative cities and/or sustainable cities: Discourses and practices. *City, Culture and Society*, *4*(3), 125–135.
Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.
Romein, A., & Trip, J. (2009). Key elements of creative city development: an assessment of local policies in Amsterdam and Rotterdan. *City Futures' 09, 4-6,Madrid.*
Romero-Padilla, Y., Navarro-Jurado, E., & Malvárez-García, G. (2016). The potential of international coastal mass tourism destinations to generate creative capital. *Journal of Sustainable Tourism*, *24*(4), 574–593.
Ryser, J. (2014). reviewed paper Planning Smart Cities ... Sustainable, Healthy, Liveable, Creative Cities ... Or Just Planning Cities? Judith Ryser. Plan Smart Cities, *8*, 447–456.
Saisana, M., & Montalto, V. (2016). *The Cultural and Creative Cities Monitor (C3 Monitor) 2016 Edition*. Available online: https://www.politico.eu/wp-content/uploads/2017/07/CulturalCreativeCitiesIndex.pdf October 2016.
Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg.
Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.
Scott, A. J. (2006). Creative cities: Conceptual issues and policy questions. *Journal of Urban Affairs, 28*(1), 1-17.
Scott, A. J. (2007). Capitalismo y urbanización en una nueva clave? La dimensión cognitivo-cultural. Tabula Rasa, (6), 195–217.
Shapiro, J. M. (2006). Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital. *The Review of Economics and Statistics*, *88*(2), 324–335.
Sharma, A., & Kearins, K. (2011). Interorganizational collaboration for regional sustainability: What happens when organizational representatives come together? *Journal of Applied Behavioral Science*, *47*(2), 168–203.
Siegel, K. (2016). Can Regional Cooperation Promote Sustainable Development? In J. Grugel & D. Hammett (Eds.), *The Palgrave Handbook of International Development* (pp. 713–730).
Skavronska, I. (2017). Creative industries in ukraine: Analysis and prospects of the development. *Economics and Sociology*, *10*(2), 87–106.
Skrede, J. (2016). What may culture contribute to urban sustainability? Critical reflections on the uses of culture in urban development in Oslo and beyond. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *9*(4), 408-425.
Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy*, *19*(3), 669–678.
Snow, C. C., Håkonsson, D. D., & Obel, B. (2016). A Smart City Is a Collaborative Community:

Lessons from smart Aarhus. *California Management Review*, *59*(1), 92–108.
Staniškis, J. K. (2012). Sustainable consumption and production: How to make it possible. *Clean Technologies and Environmental Policy*, *14*(6), 1015–1022.
Stano, P. M., & Węziak-Białowolska, D. (2017). Measuring Cultural and Creative Activities in European Cities: Challenges and Practical Problems with Existing Indices. *Creativity Research Journal*, *29*(3), 292–303.
Suzuki, H., Dastur, A., Moffatt, S., Yabuki, N., & Maruyama, H. (2010). *Eco2 Cities Ecological Cities as Economic Cities*. *The world bank*: Washington, WA, USA.
Telecommunication, S., & ITU, O. (2014). An overview of smart sustainable cities and the role of information and communication technologies. Available online: https://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2015/SSC/S3-DrSekharKondepudi.pdf.
Thuzar, M. (2011). Urbanization in SouthEast Asia: Developing Smart Cities for the Future? *Regional Outlook*, 96–100.
Torres, L., Pina, V., & Acerete, B. (2006). E-Governance Developments in Eu Cities. Reshaping Government Relation To Citizens. *Governance*, *19*(2), 277–302.
Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.
Trivellato, B. (2016). How can ‘ smart ’ also be socially sustainable ? Insights from the case of Milan. *European Urban and Regional Studies*, 24(4), 337-351.
United Nations. (2013). An Integrated Strategy for Sustainable Cities, No 40. United Nations: New York, NY, USA.
United Nations. (2015). *Smart Sustainable Cities Indicators*. United Nations: New York, NY, USA.
United States Environment Protection Agency. (2016). *Framework for Creating a Smart Growth Economic Development Strategy : a Tool for Small Cities and Towns*. Available online: https://www.epa.gov/smartgrowth/framework-creating-smart-growth-economic-development-strategy.
Vanolo, A. (2008). The image of the creative city: Some reflections on urban branding in Turin. *Cities*, *25*(6), 370–382.
Viale-Pereira, G., Cunha, M. A., Lampoltshammer, T. J., Parycek, P., & Testa, M. G. (2017). Increasing collaboration and participation in smart city governance: a cross-case analysis of smart city initiatives. *Information Technology for Development*, 23(3), 526-553.
Vinodrai, T. (2006). Reproducing Toronto’s Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. *Economic Geography*, *82*(3), 237–263.
Wang, Y., Chen, Y., & Benitez-Amado, J. (2015). How information technology influences environmental performance: Empirical evidence from China. *International Journal of Information Management*, *35*(2), 160–170.
Wey, W., & Hsu, J. (2014). New Urbanism and Smart Growth : Toward achieving a smart National Taipei University District. *Habitat International*, *42*, 164–174.
World Economic and Social Survey (2013). Sustainable Development Challenges. UNDESA: New York, NY, USA, 2013.
Wheeler, S., & Beatley, T. (2014). *The Sustainable Urban Development Reader*. Routledge.
Wu, M. C., Wen, C. T., Wu, S. H., & Lin, B. (2008). The social context of creativity at third places: an exploratory study. *International Journal of Management and Enterprise Development*, *5*(1), 30.
Wu, S. J., & Raghupathi, W. (2015). The Strategic Association between Information and Communication Technologies and Sustainability: A Country-Level Study. *Journal of Global Information Management*, *23*(3), 92–115.

CHAPTER 4

COMPOSITE INDEX TO MEASURE CITIES' CREATIVE PERFORMANCE: AN EMPIRICAL STUDY IN THE PORTUGUESE CONTEXT

ABSTRACT

This study aims to identify the indicators/indices for measuring current cities' creative performance and the individual weight of each in that performance. To do so, a review and compilation of theoretical and empirical indices already developed was undertaken, showing culture, the creative economy and a favourable environment as inseparable sub-dimensions of creativity. This compilation allowed construction of a Composite Index for Creativity, using a quantitative methodology, which revealed 17 factors determining cities' creative performance. The results illustrate that Portugal follows the European tendency of including creativity in its strategies as an economic factor determining growth. With scientific rigour and quality, the weights of each sub-dimension studied in the Composite Index were determined, this being the study's main contribution. Other implications for theory and practice and an agenda for future research are also presented.

Key-words: Cities, Creativity, Indicators, Composite Index and Performance

1. Introduction

Increasing interest in cities' creativity has recently been shown by the academic community and by entities responsible for economic growth policies (Murphy & Redmond, 2009; Peck, 2005; Ponzini & Rossi, 2010; Zimmerman, 2008). This interest accompanies the transition to a new economy (Scott, 2006) based on creativity, which includes culture, creative and cultural industries, the creative class and the city environment as fundamental conditions (Lawton, Murphy, & Redmond, 2010). Currently, these conditions are part of cities' urban planning and are commonly associated with urban entrepreneurship (Hall & Hubbard, 1996). This means that the tangible and intangible flows generated by creativity (Florida, 2002) promote urban economic growth, cities' competitiveness and their regeneration and vitality (Kipfer & Keil, 2002). Furthermore, these flows attract talents and their specific interests (Peck & Tickell, 2014), as the human capital implicit in creativity.

In this context, major dynamics are found in terms of regional and local policies to promote cities' creativity and culture with benefits for the urban economy, aiming to achieve the longed-for regeneration of urban centres. These policies should, however, include various axes, namely culture, art, industry and urban design, in order to create a comfortable city/urban environment that stimulates creativity (Nohara, Okamura, & Kawahara, 2016). In turn, city leaders must explore trade-offs between the potential benefits and costs of demographic changes in recent decades, considering the interests of the different agents involved in the growth process (Nathan, 2012).

Creativity is a driver of cities' urban growth, leading necessarily to the paradigmatic change in strategies to be implemented in them (d'Ovidio & Cossu, 2017), as tools to face the declining or stagnant economic growth caused by concentrating on traditional economic factors and policies directly only to firms (Audretsch, 2003). This argument corroborates Florida (2005), who argues that creative human capital (the creative class) has the capacity to stimulate employment and wealth creation in cities, and that the policies implemented should be the reflection of places, i.e., the cities (Audretsch, 2003). Ratten (2017) also claims that current cities have the capacity to construct the predictors to solve their problems based on creativity, on the networks this stimulates. For this author, networks are intangible spaces of creativity, entrepreneurship and partnerships.

Despite the vast literature on creative cities, there is a lack of studies showing the measurement of cities' performance, more precisely in the dimension of creativity. Indeed, it is important to understand how the creative economy contributes to sustainable urban development (Cabrita, Cruz-Machado, & Cabrita, 2013); to study the contribution of industries, by typology, to entrepreneurship in cities in the current urban context (Audretsch, Belitski & Desai, 2015); to show the relevance of cities' contextual characteristics in the formation of creative industry networks (Virta & Lowe, 2017). Another gap identified concerns the need to carry out studies measuring cities' performance with a high number of variables and for large samples (Çetindamar & Günsel, 2012). In addition, it is essential to recognise the importance of the sub-dimensions included in the creativity dimension, such as culture, the creative industries that promote the creative economy and the creation of a favourable environment (e.g., urban regeneration, amenities) (Grodach, 2017).

Based on these gaps, it is argued here that creativity, as one of the dimensions of current's cities, is a pertinent and topical subject for research, and so the aims of this study are to: (1) identify the indicators/indices and sub-dimensions inherent to cities' creative performance; (2) determine the weight of each sub-dimension in the creativity dimension. Therefore, the study's main contribution lies in the construction of a Composite Index for the creativity dimension that can be generally applied. However, a composite indicator is an aggregate of all dimensions, objectives, individual indicators and variables used (OECD, 2008). Thus, in this study the composite index is used as an auxiliary means for calculating the weights of each dimension/sub-dimension.

This introduction is followed by the Literature Review, the Methodology and Discussion of the Results. Finally, the study's contributions to theory and practice are presented, together with suggestions for future research, the conclusions and limitations.

2. Literature review

2.1. Creativity in Cities

Current's cities include creativity as a key element of their growth, where all interested parties are important in generating a creative, innovative environment that will determine their future competitiveness (Stryjakiewicz, Męczyński, & Stachowiak, 2014). Therefore, the solution to cities' urban problems must include developing an attractive and vibrant city through urban creativity (Landry, 2000).

However, creativity is consolidated by crucial determinants/sub-dimensions, which are culture (e.g., Bosch et al., 2017; Durmaz, Platt, & Yigitcanlar, 2010; European Union, 2017) the creative economy (e.g., Joss, Cowley, & Tomozeiu, 2013; Kakiuchi, 2016; Lombardi et al., 2012; Panal & Yáñez, 2012; Skavronska, 2017) and a favourable environment (e.g., Caragliu, Del Bo, & Nijkamp, 2011; Dhingra & Chattopadhyay, 2016; Durmaz et al., 2010; Hartley, Potts, & MacDonald, 2012; United States Environment Protection Agency, 2016).

Culture has been associated with cities' economic growth and included in urban policies and urban dynamics (urban entrepreneurship) (d'Ovidio & Cossu, 2017; Oyekunle, 2017). Consequently, the new urban policies of creative cities stimulate sustainable urban regeneration, innovation and improved quality of life (Martone, Pennella, & Sepe, 2014). Moreover, a city's creative sector promotes entrepreneurship in the urban context and network formation (Stryjakiewicz *et al.*, 2014). In this connection, Schaller and Guinand (2018) explained that urban entrepreneurs are catalysts of new investment and allow the recuperation of abandoned buildings through regeneration. This emphasis on culture was discussed by Hall (1998), concluding that the construction of a truly creative city should incorporate culture and creativity networks.

In addition, current debate on urban regeneration (Hesse & Lange, 2012; Krueger & Buckingham, 2012; Martí-Costa & Miquel, 2012; Sabaté & Tironi, 2008) has emphasized the growing role of culture in regional/local development (Rahbarianyazd & Doratli, 2017), where this has become a trademark for cities (Okano & Samson, 2010), which highlights the weight of negative factors associated with creative cities, such as gentrification and social exclusion (Barnes *et al.*, 2006; Catungal, Leslie, & Hii, 2009; Gainza, 2017) caused by the elitism of the creative class, as argued by these authors. Nevertheless, Veal (2017) considered that urban governance that stimulates culture aiming to provide urban well-being promotes the minimization of negative factors, i.e., the social inequalities caused by elitism. This means that cities' attractiveness depends on a sustainable structure supported by a relevant regional/local network (Grodach, 2017; Liu & Silva, 2018), by their own resources and by understanding of cultural strategies as an urban instrument (Grodach, 2017). Realising the potential of own resources includes the provision of regenerated areas for cultural and creative activities (Charrieras, Darchen, & Sigler, 2018).

Regarding the **creative economy**, this includes economic activities that produce creative actions and generate intangible value, i.e., creative and cultural industries (Augusto Mateus & Associados, 2010). For these authors, these industries are divided into occupations linked to heritage, the arts, the media and functional creations, which give rise to employment and wealth (Silva & Araújo, 2010). Howkins (2001) also argued that the creative economy reflects exploitation of the economic value of creative activities by individuals who develop their imagination, i.e., the intellectual human capital that is the condition of the creative industries. Recently, Correa-Quezada et al. (2018) clarified that these industries have a significant influence on local/regional development.

Concentrating on the creative industries, whose main actors are new entrepreneurs in the area of technology, media and entertainment (Scott, 2000), is fundamental for better understanding of the spatial dimension of creative work, as the existence of effective connectivity (partnerships/networks) is relevant for creative workers (Brennan-Horley, 2010), namely social networks and open collaboration networks to spread knowledge (Przygodzki & Kina, 2015).

Similarly, Lazzeretti (2012) argued that creative industries are a force of innovation and economic development, which through sharing sustains cities' social development. New forms of city governance prioritize cultural and social resources to improve their competitive advantage and sustainability, based on innovation and creativity (Lederman, 2015). So culture and creativity are the path to development, urban entrepreneurship and are part of the political agenda of leaders (Bayliss, 2007), who aim to conjugate culture, creativity and urbanism in their cities (Yde, 2012).

A **favourable environment** is another essential factor for creativity, where Florida (2002) claims that creative people (the creative class) are attracted by a tolerant urban environment, open to new ideas and new people. For this author, cities with a high density of this class will have better economic performance, as they present relevant levels of innovation, entrepreneurship and creative business. This means that cities should be characterised by tolerance, talent and technology (3Ts) and by cultural diversity, for new business formation, job creation and economic growth (Florida, 2002, 2005). However, there must be interaction between culture and the market, economy and leisure, culture and creativity, as a crucial factor in this class's choice of location, for them to stimulate creative and cultural industries

(Esmaeilpoorarabi, Yigitcanlar, & Guaralda, 2018; He & Huang, 2018; He, Huang, & Xi, 2018; Mommaas, 2004). This environment is achieved by strategies that aim for economic growth based on partnerships/cooperation/networks (Landry & Bianchini, 1995; Landry, 2000) and by policies based on the creative class (Florida, 2002,2005) having as pillars the capacity to attract talented individuals (the creative class), urban amenities and the quality of life offered by cities.

With creativity being connected to a knowledge-based society, where the migratory flow of people has begun to be a problem in some cities, regional/local governments have turned to public-private partnerships (3Ps) to implement policies that improve people's satisfaction, productivity, people's active participation, the possibility of accessing a continuous educational supply, the cultural provision and the promotion of diversity, tolerance, talent and technology (the 3Ts of Florida), aiming to reverse the demographic decline seen in some places (Suciu & Florea, 2017). Therefore, creative cities seek to strengthen competitiveness, find ways to promote the interaction between culture, urban regeneration, economic development and social questions, besides allowing diversified lifestyles (Martone & Sepe, 2012). The same authors consider that the primary drivers of creativity, urban regeneration and innovation are the active participation of citizens and the formation of public-private partnerships. These partnerships allow the formation of networks and the retention of individuals with different capacities, and so are important for the economic vitality of a creative city (Friedrichs, 1995; Lin, 2018).

2.2. Indicators of Creative Performance

Cities' performance should be measured in economic, social and cultural terms, and in relation to creativity, based on qualitative and/or quantitative indicators (Donegan & Lowe, 2008; Long, 2016; Lorenzen & Andersen, 2011; Miškovičová et al., 2016; Thite, 2011; Yigitcanlar & Lönnqvist, 2013).

Cities' creative performance has been measured based on indices constructed for a specific geographical context (e.g., Andersson & Andersson, 2015; Caset & Derudder, 2017, Florida, 2002; Kourtit, Nijkamp, & Arribas, 2012; Miškovičová et al., 2016). However, existing studies generally focus on cities of a significant size in various countries supported by a number of minimalist indicators, with it being essential to construct a Composite Index for Creativity that reflects the weight of culture, the creative economy and cities' favourable environment with a larger body of indicators (Çetindamar & Günsel, 2012; Flores & Teixeira, 2017).

Given the massive development of indices to measure creativity and due to the complexity involved in the issue, Hartley et al. (2012) identified and revised 23 indices of creativity, applied at the regional and national level in cities/countries, aiming to elaborate a mix of indicators and their proxies. However, the indices analysed by these researchers do not cover all existing indices, which reflects the underlying difficulty in joining all indicators and proxies in a single index with the required scientific robustness, as stated by the same authors.

In these circumstances, it is seen to be extremely complex to explain all indices of creativity. The table below shows the sub-dimensions, general and specific indicators most commonly used in the theoretical and empirical literature on this topic.

Table 1 – Creativity Index

Subdimension	General indicator	Specific indication	Source
Culture	Places of culture and facilities	1) Interest and brands 2) Museums 3) Cinemas 4) Concerts and shows 5) Theatres 6) Restaurants and Accommodation 7) Heritage	Bosch et al. (2017); Durmaz et al. (2010); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Kakiuchi, 2016; Lombardi et al. (2012)
	Cultural participation and attractiveness	1) Tourist bednights 2) Museum visitors 3) Cinema attendance 4) Satisfaction with cultural amenities	
Creative economy	Creativity and employment	1) Employment in the arts, culture and entertainment 2) Employment in media and communication 3) Employment in ICT and high technology 4) Research and Development (R&D) 5) Knowledge transfer 6) Impact of creative industries on GNP 7) Total employment in creative industries 8) Territorial analysis of creative industries	Bosch et al. (2017); Caragliu et al. (2011); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Joss et al. (2013); Kakiuchi (2016); Lombardi et al. (2012); Panal and Yáñez (2012); Skavronska (2017)
	Intellectual property and innovation	1) Applications for ICT patents 2) Innovation in creative industries 3) Application of design in the community	
Favourable environment	Human capital and education	1) Higher studies in arts and humanities 2) Higher studies in ICT 3) Creative class (talent) 4) Average university rankings	Caragliu et al. (2011); Dhingra and Chattopadhyay (2016); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Skavronska (2017); United States Environment Protection Agency (2016)
	Openness, tolerance and trust	1) Foreigners with higher studies 2) Foreign population 3) Tolerance of foreigners 4) Foreigners' integration 5) People's trust 6) General tolerance	
	Local and international connections	1) Passenger flights	
		2) Road access	
		3) Direct trains to other cities	
	Governance	1) Quality and management	

Source: Own elaboration

Summarizing, it is urgent and pertinent to study the performance of creative cities, and so it is essential to compile these indices with economic (supply/demand), social and cultural indicators, so that urban policies can be improved (Borén & Young, 2013), to encourage cities' long-term sustainable growth (Comunian, 2011), meaning economic growth at the micro and macro level (Suciu, Suciu, & Schawlowski, 2013), and also because more studies are important in cities with platforms/networks (micro level) that act as facilitators of growth (macro level) (Tukiainen, Leminen, & Westerlund, 2015) and on partnerships between all parties involved (public, private and citizens) (Trip & Romein, 2014).

3. Methodology

3.1. Sample

Portugal is divided in 7 regions – North, Centre, Metropolitan area of Lisbon, Alentejo, Algarve, Azores and Madeira -, with the coastal regions having greater density of population. Consequently, this heterogeneous distribution of the population implies that policies associated with cities' creativity have different impacts and performances. The largest cities are Lisbon, Sintra, Vila Nova de Gaia, Porto, Cascais, Loures, Braga, Matosinhos, Amadora, Almada, Oeiras, Gondomar, Seixal, Guimarães and Odivelas. However, in this study the sample corresponds to the universe of all Portuguese cities and towns (N=308).

3.2. Selection of Dimensions and Variables

To fulfil the objectives defined and based on the literature review carried out, the indicators and respective proxies were categorised, the process being guided by their clarity, simplicity, reproduction, scientific nature, salience, credibility, legitimacy and comparability (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005). In addition, the construction of a composite index implies statistical proof of their relevance and significance, as well as the use of more than one indicator. This means that the indicators selected to determine the performance of cities' creative dimension provide multi-dimensional measurement of concepts that cannot be measured by a single indicator (Kľúčik & Haluška, 2008; OECD, 2008).

The final data obtained per variable reflect absolute values, but they were transformed into relative values (proxy/resident population per*1000 city inhabitants), to allow subsequent comparison between cities, irrespective of their size.

Table 2 shows the indicators and proxies used in this research, as well as the databases and their unit of measurement.

Table 2 – Creativity index for Portuguese cities

I) Culture						
General indicator: 1.1) Places of culture and facilities						
Specific indicator	**Variable**	**N**	**Proxies**	**Databases**	**Period of reference**	**Unit of measure**
A) Places of historical interest	LIC1	308	1) Places of historical, cultural and artistic interest, such as buildings, religious structures, monuments and statues, churches and cathedrals, bridges, towers and others	Tripadvisor	2018	Number
B) Museums and similar	MA1	308	1) Art galleries: buildings	Pordata	2016	Number
	MA2	287	2) Art galleries: exhibitions			
	MA3	308	3) Number of museums open to the public			
C) Cinema	CIN1	308	1) Capacity			
	CIN2	308	2) Places			
D) Concerts and Shows	CE1	304	1) Number of cultural locations	Pordata	2015	Number
	CE2	179	2) Capacity of cultural locations			
E) Theatres	TEA1	308	1) Theatres	Meloteca.com	2018	Number
F) Restaurants and accommodation	RAL1	308	1) Number of hotel establishments	Pordata	2016	Number
	RAL2	266	2) Number of rooms in hotel establishments			
	RAL3	308	3) Restaurants	Tripadvisor	2018	Number
General indicator: 1.2) Cultural participation and attractiveness						
A) Tourist bednights	DORT1	247	1) Total bednights in hotel establishments	Pordata	2015	Number
	DORT2	244	2) Proportion of foreign guests			%
	DORT3	268	3) Total income from hotel establishments		2016	M.€
B) Museum visitors	VISM1	264	1) Total visitors	Pordata	2016	Number
	VISM2	264	2) Total foreign visitors			
C) Cinema attendance	ATENC1	308	1) Nº of spectators	Pordata	2016	Number
	ATENC2	308	2) Ticket sales			M.€
D) concerts and shows	DCE1	147	1) Nº of spectators	Pordata	2016	Number
	DCE2	147	2) Ticket sales			M.€
E) Cultural supply	OCC1	308	1) Total cultural premises (local authority)	Annals by region - INE	2016	Number
F) Local authority/public expenditure	DM1	308	1) Expenditure on cultural activities and similar			

Table 2 – Creativity index for Portuguese cities (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
II) Creative Economy						
General indicator: 2.1) Creative Industries						
A) Creative jobs	EC1	308	1) Jobs in creative and cultural activities	INE	2016	Number
B) Impact of creative industries on GDP	ICPIB1	308	1) Turnover of cultural and creative industries	INE	2016	€
	ICPIB2	308	2) % of creative industries in total economic activity			%
	ICPIB3	308	3) Expenses with staff in cultural and creative industries			€
	ICPIB4	308	4) Production of cultural and creative industries			
	ICPIB5	308	5) Intermediate consumption of cultural and creative industries			
	ICPIB6	308	6) Gross added value, at market prices, of cultural and creative industries			
	ICPIB7	308	7) Gross fixed capital formation of cultural and creative industries			
C) Territorial analysis of creative industries	ATIC1	308	1) Total number of cultural and creative industries	INE	2016	Number
	ATIC2	308	2) Number of people employed in creative and cultural companies, divided by the total of people employed in all economic activities and multiplied by 100;	Own calculation		%
	ATIC3	308	3) Total number of industries by city over the total of all cities (concentration) multiplied by 100			
	ATIC4	308	4) Density per capita of cultural and creative industries (Nº of industries/resident population multiplied by 100)			
	ATIC5	308	5) Weight of cultural and creative industries in the total industries in the city (relevance) multiplied by 100			
General indicator: 2.2) Research & Development						
A) Firms	ID1	308	1) Firms with most expenditure on R&D activities	Dgeec.mec	2016	Number
	ID2	308	2) R&D expenditure of those firms			M.€
	ID3	308	3) Total resources allocated by firms to R&D areas			Number
B) Knowledge transfer	TC1	308	1) R&D units in higher education institutions	Dgeec.mec	2016	Number
	TC2	308	2) Total researchers in those units financed by FCT			
	TC3	308	3) Higher education establishments	Pordata	2017	
	TC4	308	4) Lecturers in higher education	Pordata	2015	Number
General indicator: 2.3) Intellectual property and innovation						
A) Patent applications	PP1	308	1) Applications for patents and similar	INPI	2017	Number
	PP2	308	2) Applications for patents from higher education institutions			
	PP3	308	3) Applications for patents from other entities			

Table 2 – Creativity index for Portuguese cities (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
			III) Favourable Environment			
General indicator: 3.1) Human capital and education						
A) Creative class (talent)	CC1	308	1) Number of higher education students enrolled in arts and humanities courses	Pordata	2016	Number
	CC2	308	2) Higher education graduates in arts and humanities			
	CC3	308	3) Number of higher education students enrolled in ICT courses			
	CC4	308	4) Higher education graduates in ICT	Annals by region - INE	2016	Number
	CC5	308	5) Higher education graduates	Pordata	2016	Number
	CC6	308	6) Number of students in higher education			
	CC7	308	7)) Number of higher education institutions			
	CC8	308	8) Employed population with average/high qualifications (secondary, post-secondary and higher)		2013	
B) HEIs' presence in rankings	PR1	308	1) HEIs in rankings	Webometrics	2018	Number
General indicator: 3.2) Openness and diversity						
A) Tolerance, social classes and young people	TOL1	308	1) Legally resident foreign population: total	Pordata	2016	Number
	TOL2	308	2) Socio-cultural heterogeneity (social classes) – employees' basic average monthly salary		2013	
	TOL3	308	3) Young population (resident population, estimated at 31 December: 0-25 years)		2016	%
	TOL4	308	4) Marriages solemnized between nationals and foreigners		2017	Number
General indicator: 3.3) Local and international connections						
A) International connections	LI1	308	1) Airports	INE	2017	Number
	LI2	308	2) Passenger arrivals by airport			
B) Local connections	LL1	308	1) Transport and storage companies	INE	2012	Number
General indicator: 3.4) Governance						
A) Endogenous factors	FE1	308	1) Concluded building redevelopment (urban regeneration)	Annals by region - INE	2016	Number
	FE2	308	2) Licensed building redevelopment (urban regeneration)			
	FE3	308	3) Annual population variation (global attractiveness for new residents)			%

Source: Own elaboration

3.3. Data analysis

Data analysis was in three main stages, with statistical treatment being carried out using IBM SPSS (version 25.0) software.

The first stage was to determine the validity of the observations (308 observations representing around five times the variables analysed: 65), considering the mean value (zero) for missing data (imputation of missing data) so as not to eliminate/lose important information. Normalization of data due to the multiple units of measurement and periods of reference (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Kubrusly, 2001; Marôco, 2014; Nardo et al., 2005; OECD, 2008; Pestana & Gageiro, 2014; Stevens, 1986) was also performed.

The second stage involved descriptive analysis (mean, standard deviation, variation coefficient and minimum and maximum values), but data normalization transformed the mean in zero and the standard deviation in one, and so it is not presented, according to Marôco (2014) and OECD (2008), in this study.

The third stage consisted of applying exploratory factor analysis (EFA) and principal component analysis (PCA), as the method to construct the Composite Index. This multivariate statistical technique allows the grouping of data that can have a similar interpretation in the sample, as well as determination of the main components that should be retained and robust data treatment (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Marôco, 2014; Pestana & Gageiro, 2014; Stevens, 1986). This method aims to determine the weights representing the importance of the variables measured by maximum variance (Kubrusly, 2001). It is therefore possible to *"summarise a set of individual indicators while preserving the maximum possible proportion of the total variation in the original data set."*, as well as "*largest factor loadings are assigned to the individual indicators that have the largest variation across countries, a desirable property for cross-country comparisons, as individual indicators that are similar across countries are of little interest and cannot possibly explain differences in performance*" (OECD, 2008: 26). However, in this study the units of analysis are cities rather than countries.

Finally, to check acceptability of this technique, we applied the Kaiser–Meyer–Olkin (KMO) (Kaiser, 1974) sample suitability measure and the Bartlett sphericity test. In order to verify the internal consistency of the (sub)dimensions used, it is usual to calculate the Cronbach alpha, but in this study, the Cronbach Coefficient Alpha was not considered because the "*correlations do not necessarily represent the real influence of the individual indicators on the phenomenon expressed by the composite indicator*" (OECD, 2008: 27).

4. Results

Tables 3, 4 and 5 show the results obtained in the stages described above. As observed, the KMO test (Kaiser, 1974) presents values of an average quality to apply EFA (Marôco, 2014) in the sub-dimensions of culture and favourable environment. However, for the sub-dimension of creative economy, linear dependence was found between some of the variables studied, with a Pearson correlation coefficient of 1 (Marôco, 2014). Therefore, from the values obtained from analysis of the correlation between the variables of this sub-dimension, the variables ATIC3, ATIC4, ICPIB4, ICPIB5, ICPIB6, TC2 and PP3 were withdrawn.

In addition, the communalities $\mathbf{h^2}$ extracted (Tables 3, 4, 5) are above the required minimum of 0,32 (Costello & Osborne, 2005; Tabachnick & Fidell, 1996), where in the culture sub-dimension these explain 16% of the variance, and 38% and 30%, respectively, of the variance in creative economy and favourable environment. The variable loadings are also always equal to or above the required minimum of 0,40 (Marôco, 2014). This was followed by calculation of the *"weights from the matrix of factor loadings after rotation, given that the square of factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor"* (Kubrusly, 2001; OECD, 2008: 90).

Finally, we determined the weights of the sub-dimensions of culture, creative economy and favourable environment in the Composite Index to measure cities' creative performance. More precisely, the factors' associations with the variables per sub-dimension were calculated. As observed in Tables 3, 4 and 5, the weights for each variable were obtained by the product between the normalized squared loadings and the value of the variance explained for each factor.

Table 3 - Culture

		Results of Exploratory Factor Analysis							Squared factor loading (scaled to unit sum)[5]						
Variable	**h²**	**Factor**							**Factor**						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LIC1	0,795					0,775							0,448		
MA1	0,722						0,828							0,591	
MA2	0,587						0,747							0,481	
MA3	0,579						0,600							0,310	
CIN1	0,908			0,893							0,290				
CIN2	0,849			0,904							0,297				
CE1	0,584							0,681							0,407
CE2	0,713					0,719							0,386		
TEA1	0,402		0,593							0,104					
RAL1	0,552	0,625							0,085						
RAL2	0,945	0,970							0,205						
RAL3	0,741	0,723							0,114						
DORT1	0,913	0,943							0,194						
DORT2	0,485	0,393							0,034						
DORT3	0,920	0,950							0,197						
VISM1	0,899				0,935							0,382			
VISM 2	0,882				0,921							0,370			
ATENC 1	0,891		0,859							0,218					
ATENC2	0,885		0,873							0,225					
DCE1	0,553							0,659							0,381
DCE2	0,567		0,612							0,111					
OCC1	0,664					0,785							0,460		
DM1	0,606						0,528							0,240	
Eigenvalue		4,59	3,38	2,75	2,29	1,34	1,16	1,14							
% Explained variance		17,21	11,53	9,87	9,39	9,32	9,01	6,03							
Total explained variance		72,35							0,276[6]	0,203	0,165	0,138	0,080	0,070	0,068

Table 3 – Culture (cont.)

Variable	Weights – coefficients of variables[7] Factor 1	2	3	4	5	6	7
LIC1					3,61		
MA1						4,12	
MA2						3,35	
MA3						2,16	
CIN1			4,79				
CIN2			4,91				
CE1							2,79
CE2					3,11		
TEA1		2,11					
RAL1	2,35						
RAL2	5,65						
RAL3	3,14						
DORT1	5,34						
DORT2	0,93						
DORT3	5,42						
VISM1				5,25			
VISM 2				5,10			
ATENC 1		4,43					
ATENC2		4,58					
DCE1							2,61
DCE2		2,25					
OCC1					3,70		
DM1						1,67	
	Hotels and restaurants (22,83)	**Theatres and similar (13,37)**	**Cinema (9,70)**	**Museum visitors (10,35)**	**Cultural supply (10,41)**	**Art and museums (11,31)**	**Cultural premises (5,39)**

Varimax rotation; N = 308; KMO = 0,711; Bartlett Sphericity Test = 2335,137; gl = 253; p < 0,000

Source: Adapted from outputs of SPSS

[5] Example of calculation for RAL1: o,625^2/4,59 = 0,085
[6] Example of calculation: 4,59/∑ 4,59+3,38+2,75+2,29+1,34+1,16+1,14 = 0,276
[7] Example of calculation for RAL1: (0,276*0,085) *100 = 2,346

Table 4 - Creative economy

Results of Exploratory Factor Analysis							Squared factor loading (scaled to unit sum)					Weights – coefficients of variables				
Variable	**h²**	**Factor**					**Factor**					**Factor**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
EC1	0,964		0,797					0,241					4,66			
ICPIB1	0,960		0,938					0,333					6,45			
ICPIB2	0,971				0,977					0,697					7,00	
ICPIB3	0,930		0,889					0,299					5,79			
ICPIB7	0,806		0,866					0,284					5,50			
ATIC1	0,705		0,710					0,191					3,70			
ATIC2	0,979				0,981					0,702					7,06	
ATIC5	0,956					0,958					0,987					6,73
ID1	0,639			0,791					0,297					4,59		
ID2	0,905			0,937					0,416					6,44		
ID3	0,774			0,792					0,297					4,60		
TC1	0,887	0,877					0,117					5,64				
TC3	0,615	0,721					0,079					3,81				
TC4	0,945	0,917					0,128					6,17				
PP1	0,809	0,867					0,114					5,51				
PP2	0,795	0,889					0,120					5,79				
Eigenvalue		6,59	2,64	2,11	1,37	0,93						**R&D in higher education institutions (26,92)**	**Creative industries' contribution to GDP (26,10)**	**R&D in firms (15,62)**	**Proportion of creative industries (14,05)**	**Weight of creative industries (6,73)**
%Explained variance		25,42	25,12	14,49	13,69	6,52										
Total explained variance		85,25					0,483	0,194	0,155	0,100	0,068					

Varimax Rotation; N = 308; KMO = 0,723; Bartlett Sphericity Test:= 6244,488; gl = 120; p < 0,000

Source: Adapted from outputs of SPSS

Table 5 - Favourable Environment

Results of Exploratory Factor Analysis							Squared factor loading (scaled to unit sum)					Weights - coefficients of variables				
Variable	**h²**	**Factor**					**Factor**					**Factor**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CC1	0,832	0,907					0,115					5,72				
CC2	0,821	0,901					0,113					5,65				
CC3	0,866	0,924					0,119					5,94				
CC4	0,802	0,890					0,110					5,60				
CC5	0,934	0,961					0,129					6,42				
CC6	0,947	0,967					0,130					6,50				
CC7	0,638	0,778					0,084					4,21				
CC8	0,562	0,529					0,039					1,95				
PR1	0,546	0,702					0,069					3,43				
TOL1	0,714				0,842					0,496					4,93	
TOL2	0,802		0,877					0,306					5,35			
TOL3	0,619		0,759					0,230					4,01			
TOL4	0,695				0,805					0,453					4,51	
LI1	0,560			0,690					0,222					3,31		
LI2	0,618					0,565					0,285					2,22
LL1	0,794					0,861					0,662					5,16
FE1	0,925			0,950					0,422					6,28		
FE2	0,859			0,910					0,387					5.76		
FE3	0,836		0,896					0,320					5,58			
Eigenvalue		7,18	2,51	2,14	1,43	1,12						**Higher education (45,32)**	**Population (14,94)**	**Redevelopment of buildings and airports (15,35**	**Foreigners (9,44)**	**Transport (7,38)**
% Explained variance		35,93	12,37	12,01	9,08	6,25										
Total explained variance		75,64					0,499	0,175	0,149	0,099	0,078					

Varimax Rotation; N = 308; KMO = 0,750; Bartlett Sphericity Test:= 6577,490; gl = 171; p < 0,000

Source: Adapted from outputs of SPSS

Finally, based on the analysis presented and for greater robustness of the results, EFA was applied to the creativity dimension, as well as determining the weight of each sub-dimension analysed in that dimension, with the results appearing in Table 6.

Table 6 – Exploratory Factor Analysis of the Creativity Dimension and Weights

Subdimensions	h^2	Factor - Creativity	Weights [8]
Culture	0,446	0,668	0,220
Creative Economy	0,772	0,878	0,380
Favourable Environment	0,810	0,900	0,399
Eigenvalue		2,03	
% Explained variance		67,59	
Total explained variance		67,59	

Varimax Rotation; N = 308; KMO = 0,607; Bartlett Sphericity Test = 299,642; gl = 3; p < 0,000; **h^2** >0,67; loadings>0.40

Source: Adapted from outputs of SPSS

5. Discussion of the results

According to the results obtained, Tables 3, 4 and 5 show 17 crucial factors that can have an impact on the creative performance of Portuguese cities. These factors present different weights for each sub-dimension analysed *per se*, but the total explained variance for each of them is considerably relevant (see Tables 3, 4, 5 above), which means that the factors obtained are explanatory and pertinent (Marôco, 2014) in measuring creative performance. It is also noted that the communalities obtained for the variables forming the factors are high, demonstrating that the factors retained are appropriate to describe the latent correlational structure between all the variables (Marôco, 2014).

The analysis of **culture** revealed that the variables implicit in cultural premises and facilities (provision of amenities) which stand out most are hotel capacity (RAL2) with a weight of 5,65 and restaurant provision (RAL3) with a weight of 3,140; cinema provision is also very positive (CIN1 = 4,79) compared to theatre provision (TEA1) with a coefficient of only 2,11, since the latter is found mainly in Lisbon and Porto. In addition, the variety of premises to hold concerts and shows (CE2) presents a weight of 3,11 contrasting with reasonable public attendance (DCE1 = 2,61). Finally, cities' cultural and historical identity only shows a coefficient of 3,70, reflecting an incipient effect of local cultural policies. These results show some urban dynamics in Portuguese cities to promote existing resources to improve their creative performance, corroborating d'Ovidio and Cossu (2017) and Oyekunle (2017), who concluded that when culture is taken to be a factor stimulating economic growth, these dynamics are generated. However, local cultural strategy should include vectors aiming for the creation of cultural spaces, such

[8] Example of calculation: Culture = (0,668^2/2,03) * 100 = 21,9875

as theatres, and promote the organisation of more local shows, thereby avoiding the elitism of some cities and the consequent gentrification (Veal, 2017).

As for cultural participation and cities' attractiveness, hotel income stands out (DORT3 = 5,42), despite a proportion of foreign guests under 1 (DORT2). Concerning museums and similar, significant total visitor numbers are found (VISM1, MA1, MA2 and MA3), with foreign visitors representing a weight of 5,10 (VISM2). The coefficients referring to attractiveness show that conservation of local heritage and its promotion, and forming various partnerships to do so, make cities more attractive for current and potential residents and visitors, since this strategic orientation enhances the city's brand image (Okano & Samson, 2010).

It is also noted that Portuguese cities' cultural heritage reaches 3,70 (OCC1), despite public expenditure on culture falling far short of the desirable level (DM1 = 1,67). This lack of investment in culture highlights the need to understand networks/partnerships with other public, private and civil institutions in large cities (e.g., Lisbon, Porto), as an instrument to enable improved performance of culture associated with creativity (Grodach, 2017).

Summarizing, the variables implicit in this sub-dimension are divided in 7 main factors/components as shown in Table 3, which corroborates the importance also attributed to them by various authors (e.g., Bosch et al., 2017; Durmaz et al., 2010; García Suárez & Pulido Fernández, 2015; Giffinger et al., 2007; Hartley et al., 2012; Kakiuchi, 2016; Lombardi et al., 2012). These authors concluded that it is necessary to continue to recreate the crucial role played by culture in cities' attractiveness and their economy, valuing their competences and resources in this area, as well as conserving their cultural heritage which increases effective synergies.

A city that wants to be recognised as creative should also include the creative and cultural sector – **Creative economy** – in its economic strategies. In Portugal, creative and cultural industries have been gaining importance, as contributors to micro and macro economic growth, as argued by Tukiainen et al. (2015). These industries have tended to concentrate in the large cities, but this homogeneity of concentration has recently undergone a change stimulated by local and regional policies, as a way to encourage the growth of isolated or small towns.

Analysing the empirical evidence, there is clear relevance of the weight coefficients of the variables measuring the creative economy. Specifically, creative and cultural industries contribute to increased employment in cities by 4,66 (EC1), with the benefits for these individuals being reflected in those firms' expenditure on salaries (ICPIB3 = 5,79); presenting a turnover (ICPIB1) of 6,45 and gross capital formation of 5,50. Their weight in total economic activity (ICPIB2) is around 7 and the proportion of total employment is 7,06 (ATIC2). No less importantly, this sector presents relevance by city of 6,73. Therefore, these industries generate employment and begin to have some impact on their regions' GDP, since they reflect the exploitation of economic and intangible value by creative individuals, whose imagination takes the form of creative industries (Augusto Mateus & Associados, 2010; Howkins, 2001). These industries provide cities with new jobs and greater wealth (Silva & Araújo, 2010).

Included in these industries is R&D activity, both in firms and higher education institutions (HEI). Here, it is found that HEIs have been creating R&D units (TC1 = 5,64), although these remain in cities with HEIs (TC3 = 3,81), and so in these the weight of teaching staff is 6,17 (TC4). Another important variable in this domain is patents (PP1, PP2), where HEIs stand out with a weight of 5,79. Currently, Portuguese firms recognise the importance of R&D, and so they attribute around 6,44 to that area (ID2) in a universe of around 100 firms (ID1 = 4,59) and allocate around 6 of human capital to this (ID3). In other words, both contribute to the spread and transfer of knowledge concerning technology and innovative ideas, with the actors being the new entrepreneurs attracted by cities' amenities (Scott, 2000).

Moreover, this type of creative industry forms various connections inside and outside the city, which stimulate creative individuals and facilitate the spread of knowledge (Brennan-Horley, 2010; Przygodzki & Kina, 2015). In total, the creative economy is influenced by 5 factors/components, highlighting the contribution of creative industries and the area of R&D - R&D in HEIs (26,92); creative industries' contribution to GDP (26,10); R&D in firms (15,62) – where cities should use their competences and resources so that talented individuals can develop their capacities, given their important role for innovation and increased economic growth in the places they carry out their activity (European Union, 2017; Lazzeretti, 2012; Lederman, 2015).

The third sub-dimension included in creativity is a **favourable environment**. A city can employ numerous tangible and intangible resources, but if it does not generate an appropriate climate for creativity, the synergies obtained will be considerably limited. Recognising the essence of this climate, Portuguese cities have introduced strategies and policies to improve the quality of life provided by openness, tolerance, capturing new talents and valuing existing ones, by encouraging residents' participation, knowledge and technology to increase their economic growth.

In this context, the results show 5 factors/components, with Higher Education having a total weight of 45,32. These factors allow the creation of that environment, highlighting the place of higher education with significant weight coefficients, which corroborates Lombardi et al. (2012). These authors emphasized the fundamental nature of this variable. The other factors show that the profile of residents (population, foreigners) in cities is important, as is cultural and historic buildings.

These results confirm the importance of HEIs, due to their capacity to attract talents with different training, their cultural dynamism and innovative capacity stimulating the city's economy (European Union, 2017). They also show the importance of openness and tolerance, as mentioned by Florida (2002). Analysing these results, it was found that the weights of the number of graduates distributed over the 308 Portuguese cities and towns (CC5 = 6,42) and students attending HEIs (CC6 = 6,50) are significant, highlighting the individuals with higher education in areas considered creative (CC1/CC2 = 5,72/5,65; CC3/CC4 = 5,94/5,60). However, these results do not cover the qualified employed qualified population (CC8 = 1,95).

The spatial distribution of HEIs was also found to represent their importance for cities (CC7 = 4,21). An aspect causing these results is the openness and tolerance that should co-exist in cities (TOL2/TOL3 = 5,35/4,01), which was reflected in a positive population variation (FE3 = 5,58), as well as the significance of foreign residents (TOL1/TOL4 = 4,93/4,51). These results lead to the conclusion that cities' openness to diversify their local community stimulates the creation of an appropriate climate for creative industries (e.g., related to the amenities provided by HEIs) to be able to develop and consequently attract new residents who will stimulate the local economy (Florida, 2002, 2005), as long as associated with the cultural supply as a market factor (Mommaas, 2004).

In addition, cities have been revitalized through the urban regeneration incentive (FE1/FE2 = 6,28/5,76), although differences remain between cities regarding mobility by air (LI1/LI2 = 3,31/2,22). On the other hand, mobility on land (LL1 = 5,16) presents a high value. In other words, it is noticeable that cities have adopted policies to promote urban regeneration by locating creative industries in rehabilitated buildings, and naturally promoting urban entrepreneurship as a bonus in cities' development (Hesse & Lange, 2012; Martí-Costa & Miquel, 2012; Sabaté & TIroni, 2008). Mobility policies require more territorial development strategies, which could involve more strategies conceived in networks/partnerships (Grodach, 2017; Landry, 2000; Trip & Romein, 2014), as a way to increase the flow of people between cities and contribute to raising local economies' performance.

After this analysis of the results for cities in Portugal, the weight of each sub-dimension in a city's **creative performance** was shown, where culture has a weight of 0,220, creative economy 0,380 and favourable environment 0,399 (cf., Table 6). Paraphrasing Scott (2006), these weights mean we have a paradigmatic and holistic economy, which concentrates on creativity as a requirement to improve cities' performance, besides traditional factors, as argued by Lawton et al. (2010). In this regard, the economic and political decision-makers in Portuguese cities have been implementing policies that combine culture and the creative economy based on creative and cultural industries (Lazzeretti, 2012) and stimulating a city environment that favours the growth of this economy, in terms of both people and firms, and in this way combating negative aspects occurring in recent years (Suciu & Florea, 2017).

Finally, the similar weights of the creative economy and the favourable environment means that creative and cultural industries' contribution to wealth and employment generation has a positive impact on the performance of Portuguese cities (Florida, 2005), revealing the great importance this sector has acquired for the country's decision-makers, where cities' endogenous and exogenous resources have been used to build unique, inimitable spaces (Audretsch, 2003). Here, networks are also beginning to play a dominant role as predictors of economic performance (Ratten, 2017).

6. Contributions and implications

Creativity is a complex and multi-dimensional concept, and so measuring its performance is a process that should be approached in an integrated and composite way, so that results obtained will be valid and scientifically robust. We have seen the development of a number of indicators, most of them presenting indicator weights with weak scientific robustness and applicable to large urban areas, by both public and private entities.

Concerning the global results, a Creativity Index for Portuguese cities was presented, which was seen to be apt for statistical analysis giving it the scientific robustness this type of research demands. Besides the sub-dimensions, the variables allowed the conclusion that creative performance can be measured in economic, social and cultural terms (e.g., Donegan & Lowe, 2008; Miškovičová et al, 2016), specifically at a micro and not only macro geographical level. To understand how creativity contributes to economic development (Cabrita et al., 2013), a representative sample and a significant number of indicators were used (Çetindamar & Günsel, 2012). Therefore, one of the main contributions of this study was the construction of a Composite Index for Creativity.

Based on the literature review carried out on the topic of research, and on the objectives proposed for this empirical study, 14 indices of creativity applied in diverse geographical contexts were compiled, allowing the identification of three sub-dimensions indissociable from creativity, these being: (1) culture; (2) creative economy; (3) favourable environment. Holistic grouping of the indicators and proxies, distributed over those indices, allowed their scientific measurement, leading to firm conclusions about the performance of creativity, this being another contribution of the study.

Another contribution lies in adapting these indicators to the situation of all Portuguese towns and cities, considering the availability, credibility and comparability of the data to be used. Such a study had never before been made simultaneously and inclusively for those towns and cities and with such a high number of indicators (17) and proxies (58), determining the weight coefficient for each proxy.

Yet another contribution was to give the results validity and scientific quality by using exploratory factor analysis, which allowed identification of the main indicators for each sub-dimension analysed. Therefore, the first research objective was achieved, which was to identify the most relevant sub-dimensions to measure cities' creativity.

Overall, those contributions meant the second aim could be fulfilled objectively and scientifically, as it was determined which sub-dimension had greatest weight in creativity's performance. This represents the construction of a relevant and up-to-date Composite Index to assess and monitor that performance continuously and consistently and to reach a comparable level between cities in any geographical context.

Regarding practical implications, the results obtained show that the weights of the proxies tested on Portuguese cities vary between 0,9 and 7, expressing their positive impacts on the respective sub-dimensions, and also that Portuguese cities have the necessary competences to change their traditional view of how to improve their performance, explicitly accepting the challenge to become creative. This challenge has been expressed by these cities, by creating the essential conditions to stimulate and develop creative and cultural industries, by improving and investing in intra and inter-collaboration networks, and encouraging closer connections between people, cultural establishments and institutions. Furthermore, this new vision local political decision-makers have for their cities involves them being micro-platforms with creative and participative leadership, besides concentrating increasingly on investment that allows benefiting synergetically from talented, creative people, who in turn are looking for dynamic cultural spaces, revitalized through the urban regeneration associated with urban entrepreneurship.

It should be noted that the culture sub-dimension, however, presents a coefficient lower than expected, given promotion of the understanding of this as a driver of economic growth in currents creative cities, and so more local strategies are still needed, allying places' development with their current and potential cultural and human resources, recuperating and benefiting from their historical heritage stimulated by urban entrepreneurship (Bayliss, 2007; Hall & Hubbard, 1996; Kipfer & Keil, 2002; Lederman, 2015; Peck & Tickell, 2014; Yde, 2012).

Moreover, the results obtained provide crucial information for political decision-makers to make a solid assessment of the outputs of policies implemented in cities. Indeed, this empirical study makes a relevant contribution to city authorities and political decision-makers, by constructing and testing an instrument and tool to manage the results of their creativity strategies, and one that can be applied in any territorial context.

Concerning theory, this research advanced scientific knowledge about the complexity of the topic studied, which has been subject to great debate in the academic and political spheres. Also, in theoretical terms, it demonstrated it is possible to build a composite index whose weights are determined based on scientific methods. Testing it allows its application in any territorial and geographical context, the final result being presentation of a scientific taxonomy for creativity.

7. Limitations and future research agenda

This study is not without limitations. The first concerns the subjectivity implicit in the selection of indicators and their proxies, which was imposed and limited by the availability of credible data. Therefore, the unavailability of data about the creativity dimension in Portugal gives rise to a future suggestion. This suggestion consists of proposing a challenge to make those data public and possibly reconsidering how existing data are structured.

Cities and their performance are not only determined by the creativity dimension as shown in this study, which represents another limitation. It is therefore suggested that future research should investigate how governance and ICT – the intelligence dimension – can also be considered sub-dimensions determining cities' economic growth, as well as other related ones such as urban sustainability. Indeed, currents cities should be understood holistically, and so construction of a Composite Index of Intelligence is recommended for all Portuguese towns and cities for generalized application in any geographical context.

Another limitation is the fact of the study being carried out only in Portugal. Therefore, it is also suggested this Composite Index of Creativity should be applied in other countries to enable a comparative study among countries. These future lines of research could be complemented with multiple case studies in diverse cities in Portugal and elsewhere.

8. Conclusions

In recent years, most Portuguese cities have suffered the effects of a falling population, a high rate of unemployment and especially a lack of motivation for their reconstruction in terms of attractiveness and innovative initiatives. Therefore, official Portuguese entities, in accordance with strategic options adopted by the European Union (Strategy 2020), have taken up the challenge to revitalize cities. This means that the emphasis and strategy includes attracting new investment, new talents, stressing cultural identity and urban regeneration, aiming to improve the quality of life provided irrespective of the city's geographical location – creativity -. Evidently, this required cities' tangible, intangible, endogenous and exogenous resources to be appropriately recognised and valued, as well as being assimilated as an integral part of this challenge. However, it is still necessary for Portuguese cities to become actively involved in internal and external collaboration processes (networks/partnerships).

This altered vision of currents cities' role in worldwide economic development has led to the need to assess and monitor their performance through other factors besides traditional economic ones such as GDP, employment and others. In the academic and political domains, new factors and dimensions, such as creativity, have emerged to respond to this new innovative vision. However, the multitude of indices developed to measure creativity's effect on cities' performance did not reflect the supply and demand sides in parallel. In this line of thought, a Composite Index for Creativity was presented here, including culture, creative economy and favourable environment as predictors of the positive performance of cities as urban platforms to raise a country's economic growth.

This index was applied to all Portuguese cities and towns, through a quantitative methodology, to determine the weight of culture, the creative economy and a favourable environment on the Composite Index of Creativity presented. This study also revealed the need to continue to define and implement strategies that stimulate culture as an essential determinant for Portuguese cities to be increasingly creative, while the creative economy and a favourable environment reflect a change in decision-makers' visionary paradigm.

It is also argued that cities should concentrate increasingly on networks/partnerships as open collaboration processes between all the actors involved, in order to absorb the synergies they provide to maximize their performance.

References

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1), 45-64.

Andersson, Å. E., & Andersson, D. E. (2015). Creative Cities and the New Global Hierarchy. *Applied Spatial Analysis and Policy*, *8*(3), 181–198.

Audretsch, D. B. (2003). Managing Knowledge Spillovers: the Role of Geographic Proximity. Advances in Strategic Management, 20, 23–48.

Audretsch, D. B., Belitski, M., & Desai, S. (2015). Entrepreneurship and economic development in cities. *Annals of Regional Science*, *55*(1), 33–60.

Augusto Mateus & Associados. (2010). O setor cultural e criativo em Portugal. *Lisboa: GPEARI-Ministério da Cultura*.

Barnes, K., Waitt, G., Gill, N., & Gibson, C. (2006). Community and Nostalgia in Urban Revitalisation: a critique of urban village and creative class strategies as remedies for social 'problems.' *Australian Geographer*, *37*(3), 335–354.

Bayliss, D. (2007). The Rise of the Creative City: Culture and Creativity in Copenhagen. *European Planning Studies*, *15*(7), 889–903.

Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.

Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.

Brennan-Horley, C. (2010). Multiple Work Sites and City-wide Networks: a topological approach to understanding creative work. *Australian Geographer*, *41*(1), 39–56.

Cabrita, M. D. R., Cruz-Machado, V., & Cabrita, C. (2013). Managing creative industries in the context of knowledge-based urban development. *International Journal of Knowledge-Based Development*, *4*(4), 318–337.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.

Caset, F., & Derudder, B. (2017). Measurement and interpretation of 'global cultural cities' in a world of cities. *Area*, *49*(2), 238–248.

Catungal, J. P., Leslie, D., & Hii, Y. (2009). Geographies of Displacement in the Creative City:

The Case of Liberty Village, Toronto. *Urban Studies*, *46*(5–6), 1095–1114.
Çetindamar, D., & Günsel, A. (2012). Measuring the Creativity of a City: A Proposal and an Application. *European Planning Studies*, *20*(8), 1301–1318.
Charrieras, D., Darchen, S., & Sigler, T. (2018). The shifting spaces of creativity in Hong Kong. *Cities*, 74, 134-141.
Comunian, R. (2011). Rethinking the Creative City: The Role of Complexity, Networks and Interactions in the Urban Creative Economy. *Urban Studies*, *48*(6), 1157–1179.
Correa-Quezada, R., Álvarez-García, J., del Río-Rama, M. D. L. C., & Maldonado-Erazo, C. P. (2018). Role of Creative Industries as a Regional Growth Factor. *Sustainability*, *10*(5), 1649.
Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.
d'Ovidio, M., & Cossu, A. (2017). Culture is reclaiming the creative city: The case of Macao in Milan, Italy. *City, Culture and Society*, *8*, 7–12.
Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563.
Donegan, M., & Lowe, N. (2008). Inequality in the Creative City: Is There Still a Place for "Old-Fashioned" Institutions? *Economic Development Quarterly*, *22*(1), 46–62.
Durmaz, B., Platt, S., & Yigitcanlar, T. (2010). Creative, culture tourism and place-making : Istanbul and London film industries. *International Journal of Culture, Tourism and Hospitality Research*, *4*(3), 198–213.
Esmaeilpoorarabi, N., Yigitcanlar, T., & Guaralda, M. (2018). Place quality in innovation clusters: An empirical analysis of global best practices from Singapore, Helsinki, New York, and Sydney. *Cities*, *74*, 156–168.
European Union. (2017). *The Cultural and Creative Cities Monitor*. European Union: Brussels, Belgium.
Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.
Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life)*. (Basic Books, Ed.). New York.
Florida, R. (2005). *Cities and the creative class*. Routledge.
Friedrichs, J. (1995). Cologne—a creative city. *European Planning Studies*, *3*(4), 441–463.
Gainza, X. (2017). Culture-led neighbourhood transformations beyond the revitalisation/gentrification dichotomy. *Urban Studies*, *54*(4), 953–970.
García Suárez, J. A., & Pulido Fernández, J. I. (2015). Creacity , una propuesta de índice para medir la creatividad turística . Aplicación en tres destinos urbano-culturales españoles. *Revista de Estudios Regionales*, (13), 69–108.
Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf*.
Grodach, C. (2017). Urban cultural policy and creative city making. *Cities*, *68*, 82–91.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Hall, P. (1998). The City as a Freeway. Los Angeles 1900-1980. *Cities in Civilization*, 803-841.
Hall, T., & Hubbard, P. (1996). The entrepreneurial city: new urban politics, new urban geographies? *Progress in Human Geography*, *20*(2), 153–171.
Hartley, J., Potts, J. D., MacDonald, T. (2012). CCI-CCI Creative City Index 2012. *Cultural Science Journal*, *5*(1), 1–38.
He, J., & Huang, X. (2018). Agglomeration, Differentiation and Creative Milieux: A Socioeconomic Analysis of Location Behaviour of Creative Enterprises in Shanghai. *Urban Policy and Research*, *36*(1), 79–96.
He, J., Huang, X., & Xi, G. (2018). Urban amenities for creativity: An analysis of location drivers for photography studios in Nanjing, China. *Cities*, *74*, 310–319.
Hesse, M., & Lange, B. (2012). Paradoxes of the Creative City. Contested Territories and

Creative Upgrading - the Case of Berlin, Germany. *Erde*, *143*(4), 351–371.
Howkins, J. (2001). *The Creative Economy: How people make from ideas.* (Allen Lane., Ed.).
Joss, S., Cowley, R., & Tomozeiu, D. (2013). Towards the "ubiquitous eco-city": An analysis of the internationalisation of eco-city policy and practice. *Urban Research and Practice*, *6*(1), 54–74.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.
Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.
Kipfer, S., & Keil, R. (2002). Toronto Inc? Planning the Competitive City in the New Toronto. *Antipode*, *34*(2), 227–264.
Kourtit, K., Nijkamp, P., & Arribas, D. (2012). Smart cities in perspective – a comparative European study by means of self-organizing maps. *Innovation: The European Journal of Social Science Research*, *25*(2), 229–246.
Kľúčik, M., & Haluška, J. (2008). Construction of Composite Leading Indicator for the Slovak Economy. *Stiin Ńe Economice*, *55*, 362–370.
Krueger, R., & Buckingham, S. (2012). Towards a "Consensual" Urban Politics? Creative Planning, Urban Sustainability and Regional Development. *International Journal of Urban and Regional Research*, *36*(3), 486–503.
Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.
Landry, C. (2000). *The creative city: A toolkit for urban innovators.* Earthscan.
Landry, C., & Bianchini, F. (1995). *The creative city* (Vol. 12). Demos.
Lawton, P., Murphy, E., & Redmond, D. (2010). Examining the role of "creative class" ideas in urban and economic policy formation: the case of Dublin, Ireland. *International Journal of Knowledge-Based Development*, *1*(4), 267-286.
Lazzeretti, L. (2012). *Creative industries and innovation in Europe: concepts, measures and comparative case studies.* Routledge.
Lederman, J. (2015). Urban fads and consensual fictions: Creative, sustainable, and competitive city policies in Buenos Aires. *City and Community*, *14*(1), 47–67.
Lin, C. Y. (2018). Emerging challenges of an urban creative economy: reflections on the governance of creative clusters in Taipei City. *European Planning Studies*, *26*(2), 421–437.
Liu, H., & Silva, E. (2018). Examining the dynamics of the interaction between the development of creative industries and urban spatial structure by agent-based modelling: A case study of Nanjing, China. *Urban Studies*, *55*(5), 1013–1032.
Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation*, *25*(2), 137–149.
Long, J. (2016). Constructing the narrative of the sustainability fix: Sustainability, social justice and representation in Austin, TX. *Urban Studies*, *53*(1), 149-172.
Lorenzen, M., & Andersen, K. V. (2011). Different creative cities: Exploring Danish data to adapt the creative class argument to small welfare economies. *Creative Industries Journal*, *4*(2), 123–136.
Marôco, J. (2014). Análise estatística com o SPSS Statistics.
Martí-Costa, M., & Miquel, M. P. i. (2012). The knowledge city against urban creativity? Artists' workshops and urban regeneration in Barcelona. *European Urban and Regional Studies*, *19*(1), 92–108.
Martone, A., Pennella, G., & Sepe, M. (2014). Improving quality of life through cultural regeneration and urban development: The Marseille Euroméditerranée renewal project. *Journal of Urban Regeneration and Renewal*, *7*(4), 351–362.
Martone, A., & Sepe, M. (2012). Creativity, urban regeneration and sustainability: The Bordeaux case study. *Journal of Urban Regeneration and Renewal*, *5*(2), 164–183.
Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.
Miškovičová, A., Vaňová, A., Vitálišová, K., & Borseková, K. (2016).Strategies of creative potential development in the cities. In *9th Annual Conference of the EuroMed Academy of Business*.(pp.1293-1312).
Mommaas, H. (2004). Cultural clusters and the post-industrial city: towards the remapping of urban cultural policy. *Urban Studies*, *41*(3), 507–532.
Murphy, E., & Redmond, D. (2009). The role of 'hard' and 'soft' factors for accommodating creative knowledge: insights from Dublin's 'creative class. '*Irish Geography*, *42*(1), 69–84.
Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators

building. *Analysis*, *EUR 21682* (December), 134.
Nathan, M. (2012). After Florida: Towards an economics of diversity. *European Urban and Regional Studies*, *22*(1), 3–19.
Nohara, T., Okamura, y. & Kawahara, S. (2016). Research for a comprehensive and active planning method in an industrial-residential mixed area - focused on ota creative town vision in Ota Ward, Tokyo. *Journal of the Malaysian Institute of Planners*, (Iv), 369–382.
OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.
Okano, H., & Samson, D. (2010). Cultural urban branding and creative cities: A theoretical framework for promoting creativity in the public spaces. *Cities*, *27*(SUPPL1), S10–S15.
Oyekunle, O. A. (2017). The contribution of creative industries to sustainable urban development in South Africa. *African Journal of Science, Technology, Innovation and Development*, *9*(5), 607–616.
Panal, G., & Yáñez, C. (2012). Industrias culturales en ciudades españolas . Un primer acercamiento . Cultural industries in Spanish cities . A first approach. *Revista de Estudios*, *94*, 71–103.
Peck, J. (2005). Struggling with the creative class. *International Journal of Urban and Regional Research*, *29*(4), 740–770.
Peck, J., & Tickell, A. (2002). Neoliberalizing space. *Antipode*, *34*(3), 380 404.
Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS*.
Ponzini, D., & Rossi, U. (2010). Becoming a creative city: The entrepreneurial mayor, network politics and the promise of an urban renaissance. *Urban Studies*, *47*(5), 1037–1057.
Przygodzki, Z., & Kina, E. (2015). Virtual Community for A Creative City. *Quaestiones Geographicae*, *34*(2), 65–73.
Rahbarianyazd, R., & Doratli, N. (2017). Assessing the contribution of cultural agglomeration in urban regeneration through developing cultural strategies. *European Planning Studies*, *25*(10), 1714–1733.
Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.
Sabaté, J., & Tironi, M. (2008). Rankings, creatividad y urbanismo. *EURE (Santiago)*, *34*(102), 5–23.
Schaller, S., & Guinand, S. (2018). Pop-up landscapes: a new trigger to push up land value? *Urban Geography*, *39*(1), 54–74.
Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.
Scott, A. J. (2006). Creative cities: Conceptual issues and policy questions. *Journal of Urban Affairs, 28*(1), 1–17.
Silva, F., & Araújo, H. (2010). *Indicador de desenvolvimento da economia da cultura*. Brasília: Ipea.
Skavronska, I. (2017). Creative industries in Ukraine: Analysis and prospects of the development. *Economics and Sociology*, *10*(2), 87–106.
Stevens, J. (1986). Chapter 11 - Exploratory and Confirmatory Factor Analysis. In L. E. Associates. (Ed.), *Applied multivariate statistics for the social sciences*. New Jersey. USA.
Stryjakiewicz, T., Męczyński, M., & Stachowiak, K. (2014). Role of Creative Industries in the Post-Socialist Urban Transformation. *Quaestiones Geographicae*, *33*(2), 19–35.
Suciu, C., Suciu, N., & Schawlowski, D. (2013). Creative Entrepreneurship and Urban Vitality as Key Determinants for a Smart, Sustainable and Inclusive Development. In *21st International-Business-Information-Management-Association Conference on Vision 2020: Innovation, Development Sustainability, and Economic Growth*. (pp. 1595–1611).
Suciu, M. C., & Florea, C. (2017). An empirical study on the migration among young skilled and creative people. *Amfiteatru Economic*, *19*(46), 727–741.
Tabachnick, B. G., & Fidell, L. S. (1996). *sing Multivariate Statistics*. (3rd ednHarper Collins. New York, Ed.).
Thite, M. (2011). Smart cities: Implications of urban planning for human resource development. *Human Resource Development International*, *14*(5), 623–631.
Trip, J. J., & Romein, A. (2014). Creative City Policy and the Gap with Theory. *European Planning Studies*, *22*(12), 2490–2509.
Tukiainen, T., Leminen, S., & Westerlund, M. (2015). Cities as Collaborative Innovation Platforms. *Technology Innovation Management Review*, *5*(10), 16–23.
United States Environment Protection Agency. (2016). *Framework for Creating a Smart Growth*

Economic Development Strategy : a Tool for Small Cities and Towns. Available online: https://www.epa.gov/smartgrowth/framework-creating-smart-growth-economic-development-strategy.
Veal, C. (2017). Dance and wellbeing in Vancouver's 'A Healthy City for All.' *Geoforum*, *81*, 11–21.
Virta, S., & Lowe, G. F. (2017). Integrating media clusters and value networks: Insights for management theory and research from a case study of Mediapolis in Finland. *Journal of Management and Organization*, *23*(1), 2–21.
Yde, N. C. (2012). What is a Creative City made up from. An approach to culture, leisure and creativity in the contemporary city. *Athenea Digital*, *12*(1), 169-190.
Yigitcanlar, T., & Lönnqvist, A. (2013). Benchmarking knowledge-based urban development performance : Results from the international comparison of Helsinki. *Cities*, *31*, 357–369.
Zimmerman, J. (2008). From brew town to cool town: Neoliberalism and the creative city development strategy in Milwaukee. *Cities*, *25*(4), 230–242.

CHAPTER 5

MEASURING CITIES' PERFORMANCE: PROPOSAL OF A COMPOSITE INDEX FOR THE INTELLIGENCE DIMENSION

ABSTRACT

This study aims to systematize indicators and indices that allow measurement of governance and information and communication technology (ICT) as sub-dimensions of cities' smart performance, and also present their individual weights in that performance. A systematization of 11 theoretical and empirical indices was elaborated, focused on these sub-dimensions as intrinsic pillars of cities' intelligence. The results allow construction of a Composite Index for Intelligence supported by multivariate statistical techniques confirming its scientific quality and robustness, forming the main contribution of this study. The results for the context of Portuguese cities also show the need to continue to equip cities with ICT and its articulation with open and participative governance, besides continuing to incentivise the formation of urban networks. Other implications for theory and practice are presented, together with suggestions for future research.

KEY-WORDS: Cities, Intelligence, Composite Index, Performance and Networks

1. Introduction

Cities' exponential urban development, as a consequence of the phenomenon of globalization associated with the declining economic growth of the majority of cities in the last decades, has given rise to a new urban paradigm. This paradigm has been reflected in the spread of new urban strategies to be implemented in cities as a way for them to overcome the negative effects of the economic and financial crisis of recent years. Among other urban strategies adopted by political decision-makers and authorities, cities' intelligence dimension has aroused the academic community's interest in studying this topic (e.g., Batty et al., 2012; Chourabi et al., 2012; Letaifa, 2015; Nam & Pardo, 2011). However, there is still no consensual definition of cities' intelligence, given the complexity involved in this concept (e.g., Alkandari, Alnashee, & Alshekhly, 2012; Caragliu, Del Bo, & Nijkamp, 2011; Giffinger et al., 2007; Lazaroiu & Roscia, 2012; Odendaal, 2003; Partridge, 2004; Paskaleva, 2009). This study adopted the definition that *"a smart city is [a city that] actively embraces new technologies [seeking] to be a more open* *society where technology makes it easier for people to have their say, gain access to services and to stay in touch with what is happening around them, simply and cheaply."* (Partridge, 2004; 4), as well as, *"a smart city is one that uses a smart system characterized by the interaction between infrastructure, capital, behaviours and cultures, achieved through their integration"* (Alkandari et al., 2012: 11).

The vast literature on this topic presents various factors influencing that intelligence, and so current urban policies concentrate increasingly on endowing cities with these, which means creating a more efficient socio-economic environment (Letaifa, 2015) associated with each city's intrinsic innovation and shown by its governance and how it applies technology (Nam & Pardo, 2011). This transformation of the city environment towards intelligence aims to improve its efficiency and effectiveness as a whole (Batty et al., 2012; Bouk et al., 2017; Hollands, 2008; Komninos, 2002), its equity and increased quality of life for its citizens (Batty et al., 2012; Bouk et al., 2017). In addition, current cities' economic vitality should recognize creative individuals regarding their aptitude to adapt to technological progress (Kakiuchi, 2016; Ratten, 2017), i.e., creativity is a condition *sine quo* in the smart axis of cities, since it allows intelligent innovation and undertaking (Ratten, 2017).

In these circumstances, cities' intelligence must show tangible benefits, but also intangible ones in the form of residents' life (Aurigi, 2005; Cohen, 2012) and its sustainability (Lee, Phaal, & Lee, 2013). What is more, the networks created by adopting intelligence in cities allow the spread of knowledge and creative ideas (Tranos & Gertner, 2012). This means that networks are used to create and reinforce cities' innovative capacity through interaction between all the actors involved and who have a common goal (Laitinen, Osborne, & Stenvall, 2016; Ling & Martins, 2017; Ratten, 2017), aiming to generate differentiating factors.

Despite the extensive literature on this topic, some gaps remain in need of greater study, particularly the need to incorporate urban networks in cities' intelligence dimension (Bifulco, Tregua, & Amitrano, 2017; Cohen, Almirall, & Chesbrough, 2016; Tranos & Gertner, 2012), and creative and entrepreneurial human capital's association with cities' intelligent axis (Richter, Kraus, & Syrjä, 2015). There is still a shortage of studies to fill the existing gap between theory and practice (Lee, Hancock, & Hu, 2014), and so Mora, Bolici, and Deakin (2017) argued that more studies are still necessary to show how current cities are built and what scientific tools can support all the actors involved in that construction.

Supported on the gaps identified and the need to study cities in a holistic and multi-dimensional way, considering the appropriate balance between creative, entrepreneurial individuals, innovation and intelligence, this study has two objectives: (1) to determine the sub-dimensions inherent to the intelligence dimension of cities and the respective indices/indicators to measure cities' smart performance; and (2) to present the weight of each sub-dimension of the intelligence dimension. The response to these objectives takes the form of a Scientific Index for this dimension for universal application, this being the study's main contribution. However, a composite indicator is an aggregate of all dimensions, objectives, individual indicators and variables used (OECD, 2008). Thus, in this study the composite index is used as an auxiliary means for calculating the weights of each dimension / sub-dimension.

The Introduction is followed by the Literature Review, Methodology and Discussion of the Results. Finally, the contributions of this empirical study are presented, together with the limitations, suggestions for future research and the conclusions with implications for theory and practice.

2. Literature review

2.1. Urban paradigm of intelligence

Today, cities aspire to be endowed with intelligence and, simultaneously, creativity to solve their everyday problems (Cohen, 2012), and so there is multi-dimensional integration of the smart and creative dimension in cities. Intelligence promotes a favourable environment for creative people (Ryser, 2014), who in turn induce that intelligence (Nam & Pardo, 2011), i.e., there is clear subjection between both. Moreover, this subjection stimulates the formation of networks (Fernandes & Gama, 2008).

The vast literature on intelligence in cities has focused fundamentally on the sub-dimensions of governance (e.g., Angelidou, 2017; Bosch et al., 2017; Garau, Balletto, & Mundula, 2017; García Suárez & Pulido Fernández, 2015; Giffinger et al., 2007; Madeira, Guimarães, & Mendes, 2016) and information and communication technology – ICT - (e.g., Caragliu et al., 2011; Ernst & Young, 2016; Lombardi et al., 2012; Networked Society City Index, 2016). These sub-dimensions have been widely assumed as crucial determinants of performance and intelligence (Batty et al., 2012; Chourabi et al., 2012).

Governance is understood as an integrating pillar of cities' intelligence (Batty et al., 2012), which requires innovative, participative and open models of governance to allow implementation of policies responding to that challenge (Bolívar & Meijer, 2016). This argument corroborates Giffinger et al. (2007), who argued that governance is at the core of cities' intelligence.

However, efficient governance requires articulation with ICT (Neirotti et al., 2014; Vilajosana et al., 2013). ICT improves the efficiency of cities' governance and functioning, which implies there are changes (Paskaleva, 2009) stimulated by long-term strategies for competitiveness and sustainability (European Comission, 2008) supported by networks, strategic planning, integration and appropriate exploitation of the benefits of technology (Curwell, Deakin, & Symes, 2005). Therefore, governments/local authorities should adopt e-governance allowing residents' greater public participation, the formation of urban public-private partnerships and transparency of processes (Odendaal, 2003; Paskaleva, 2009). Besides these aspects, the e-governance model is related to identity, privacy, security, communication policy regulations and economic development (Paskaleva-Shapira, 2007). These new dynamics in cities' governance imply greater attractiveness, liveliness and creativity and that urban strategies are guided by resilience, participation, mobility and collaboration (Networked Society City Index, 2016).

ICT's close relationship with cities' smart dimension is perceptible, and so Gouvea, Kapelianis, and Kassicieh (2017) clarified that the accessibility, adoption and spread of innovations and modern technology are driving forces of economic growth based on knowledge and strategic development. Consequently, ICT is transversal to the economic, social and environmental dimensions, therefore representing an intrinsic vector to direct places towards greater economic competitiveness (Gouvea et al., 2017; Mardikyan et al., 2015). In addition, ICT has the potential to improve the rates of spreading innovation and technology in economies and societies (Hanclova et al., 2014; United Nations Commission on Science and Technology for Development, 2016), since in recent decades knowledge has overtaken natural resources as the primary contributor to the economic system and to shaping nations' paths to development and economic growth (Gouvea et al., 2017).

Nevertheless, for the benefits and externalities provided by ICT to be visible, it is crucial to create an ecosystem to support it locally, between political decision-makers and the community, in the form of public-private partnerships. This will allow the promotion of entrepreneurship and new models of economic cooperation, harnessing resources and the use of innovative models of functioning (Gouvea et al., 2017). These partnerships stimulate open innovation networks – *living labs*, for example – (Meijer & Bolívar, 2016; Ratten, 2017; Snow, Håkonsson, & Obel, 2016) based on local, urban entrepreneurship and innovation (Nyström et al., 2014).

The networks provided by ICT and by smart governance are a crucial benefit, since implicit to these are the relationships between all cities' actors, providing urban externalities, scale economies and synergies (Capello, 2000) and stimulating economic growth (Meijers, Burger, & Hoogerbrugge, 2016), although they demand active participation, flexibility and open attitudes on the part of the actors involved (Capello, 2000). This means that spatiality began to be understood in terms of places, flows and network integration, which improves cities' economic performance (Pain et al., 2016), inter and intra-city transfer and share of knowledge (Dijkstra, Garcilazo, & Mccann, 2013) and easier access to information (David et al., 2013).

Summarizing, cities are a dynamic and complex socio-technical system, social places, where people live and work, where urban infrastructure acts as a collective facilitator that can be improved by implementing ICT (Finger & Razaghi, 2016). Therefore, their participative governance is crucial and should be based on technology to promote multiple networks and collaboration processes between all public and private actors (López-Quiles & Rodríguez Bolívar, 2018).

2.2. Measuring intelligence in cities

Cities' smart performance has been measured through various indices elaborated by the academic community (e.g., Caragliu et al., 2011; Lombardi et al., 2012) and by official bodies (e.g., Ernst & Young, 2016, Networked Society City Index, 2016). These indices have been applied in European cities of a relevant size, such as the studies by Angelidou (2017) in 50 European cities, Garau et al. (2017) in Italy, and García Suárez and Pulido Fernández (2015) in Spain.

However, these indices do not present a composite view of the impact of each sub-dimension on total smart performance in the form of an index that is not only applicable to a specific geographical context, meaning they are not transformed in a transversal and longitudinal scientific tool for cities/countries' decision-makers and authorities, and so construction of such an index is pertinent (Mora et al., 2017). In addition, these indices are more focused on ICT and its network infrastructure, as is the case of what is elaborated annually in Italy by Ernst and Young (2017) and are merely theoretical (Lee et al., 2014), such as that of Lombardi et al. (2012).

Measuring cities' intelligence also includes measuring entrepreneurial governance and the use of ICT as a way to improve the management of resources and services, prioritizing quality of life and sustainable economic development (Giffinger et al., 2007; Neirotti et al, 2014; Vilajosana et al., 2013). For Giffinger et al. (2007) and Nam and Pardo (2011), cities that take smart initiatives are able to become more competitive and sustainable and to solve their urban problems, through stimulating the use of ICT and appropriate governance (Caragliu et al., 2011). Consequently, the challenge for urban governments in the European Union is to implement and use ICT to develop their cities in a competitive and connected way (Paskaleva, 2009), which requires technological and institutional innovation, and policies that involve citizens so that prosperity and competitive advantages can be achieved (Torres, Pina, & Acerete, 2006; Van Den Berg & Van Winden, 2017). Equally importantly, it is underlined that smart city environments are spaces that allow open innovation, entrepreneurship and networks, particularly by the adoption of *living labs* and/or other types of incubator and ICT spaces (Schaffers et al., 2011), which can also be measured.

Summarizing, a variety of indices are found with their implicit dispersion, which raises the opportunity to make a theoretical and empirical compilation of them. Therefore, Table 2 (section 3.2.) presents the most commonly used indicators to measure the smart dimension of countries/cities, albeit without covering all existing indices, indicators and their variables.

3. Methodology

3.1. Population

Portugal is divided in 7 large regions (Nuts II), which in turn are sub-divided in 25 territorial units (Nuts III), as shown in Table 1.

Table 1 - Territorial characterisation of Portugal

Nuts II	Nuts III	Nuts II	Nuts III
1.North	Alto Minho Cávado Ave Metropolitan area of Porto Alto Tâmega Tâmega & Sousa Douro Terras de Trás-os-Montes	**3.** Metropolitan area of Lisbon	Metropolitan area of Lisbon
		4. Alentejo	Alentejo Litoral Baixo Alentejo Lezíria do Tejo Alto Alentejo Alentejo Central
2. Centre	West Region of Aveiro Region of Coimbra Region of Leiria Viseu Dão Lafões Beira Baixa Médio Tejo Beiras & Serra da Estrela	**6.** Autonomous region of the Azores	Azores
		7. Autonomous region of Madeira	Madeira

Source: INE

These territorial units are formed of 308 (N) towns/local authorities, which are the population analysed in this study.

3.2. Indicators and variables

To respond to the objectives defined and based on the literature review carried out, the most commonly used indicators and their respective variables were systematized for the Portuguese case, with this process following principles of clarity, simplicity, reproduction, scientificity, salience, credibility, legitimacy and comparability (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005). In addition, developing a composite index involves proving their relevance and meaning scientifically, as well as using more than one indicator. In this specific case, quantitative research was adopted, where the indicators chosen to determine cities' smart performance allow multi-dimensional measurement of concepts that cannot be measured by a single indicator (Kľúčik & Haluška, 2008; OECD, 2008).

Therefore, Table 2 shows the indicators most commonly used by researchers in the academic community and by private bodies to measure cities' intelligence, with the associated variables being adapted to the availability of data in Portugal with regard to the above-mentioned principles.

Table 2 – Intelligence index for Portuguese cities

Indicator	Variable	Sample	Proxies	Databases	Period of reference	Unit of measure
Sub-dimension: Governance						
Indicator I: Implementation – (Caragliu et al., 2011; Lombardi et al., 2012; United Nations, 2015)						
I) E-government	EGOV1	308	1) Use of electronic commerce	Annual reports by region - INE	2016	Number[9]
	EGOV2	308	2) Public consultation processes available on the website			
	EGOV3	308	3) Online completion and submission of forms			
Indicator 2: Strategy (Angelidou, 2017; Bosch et al., 2017; Madeira, Guimarães & Mendes, 2016)						
I) Finance	FIN1	308	1) Total debt	Annual reports by region - INE	2016	M.€
	FIN2	308	2) Municipal income per inhabitant			Euros
	FIN3	308	3) Municipal expenditure per inhabitant			
II) Networks	RED1	308	1) Members of national networks	http://redemunicipiossaudaveis.com/index.php/pt; Webpages of local authorities; http://www.rni.pt/visa; http://www.inteli.pt https://en.unesco.org/creativecities/home;www.openlivinglabs.eu;	2018	Number[9]
	RED2	308	2) Members of international networks			
Indicator: 3) Citizen participation (Angelidou, 2017; Bosch et al., 2017; Garau et al., 2017; García Suárez & Pulido Fernández, 2015; Giffinger et al., 2007; Lombardi et al., 2012)						
I) Elections	PEL1	308	1) Presidential – Voter turnout	Annual reports by region - INE	2016	Number
	PEL2	308	2) Central Government - Voter turnout		2015	
	PEL3	308	3) Local Authority - Voter turnout		2013	
	PEL4	307	4) European Parliament - Voter turnout		2014	
Indicator: 4) City vitality (Ernst & Young, 2016)						
I) Individual	VIND1	308	1) Renewal index of the population of working age	INE	2013	%
	VIND2	308	2) Population density per residence		2014	Km²
	VIND3	308	3) Newspapers and other periodic publications: circulation	Pordata	2016	Number
	VIND4	308	4) Resident population <15 years		2011	
	VIND5	308	5) Inactive population: total		2011	
II) Public	VPUB1	272	1) Area of urban parks and facilities	INE	2013	Ha
	VPUB2	272	2) Land use for tourism			

[9] 1 - Yes; 0 - No

Table 2 – Intelligence index for Portuguese cities (Cont.)

Indicator	Variable	Sample	Proxies	Databases	Period of reference	Unit of measure
Sub-dimension: Information and communication technology (ICT)						
Indicator: 1) Network infrastructure (Ernst & Young, 2016; Networked Society City Index; 2016)						
I) Telecommuni-cations	TEL1	308	1) Main public telephones	Pordata	2016	Number
	TEL2	308	2 Residential telephones per thousand inhabitants			%
II) Environment	AMB1	308	1) Quality of the water network for human consumption: safe water	Pordata	2016	%
	AMB2	308	2) Population served by waste water treatment networks (ETAR)		2009	
	AMB3	308	3) Electricity consumption for road lighting		2016	Kwh
	AMB4	308	4) Hierarchy index of urban waste management			%
Indicator: 2) Accessibility (Ernst & Young, 2016; Networked Society City Index; 2016)						
I) Mail and internet	ACES1	308	1) Post offices per local authority	Annual reports by region - INE	2016	Number
	ACES2	308	2) Access to broadband internet service at a fixed point			
Indicator: 3) Use of ICT (Caragliu et al., 2011; Giffinger et al., 2007; Lombardi et al., 2012; Madeira et al., 2016; Networked Society City Index, 2016)						
I) Public	PUB1	308	1) Average number of pupils per computer with internet connection in primary and secondary schools: total	Pordata	2016	%
II) Private	IND1	308	1) Companies providing ICT services	INE	2016	Number

Source: Own elaboration

3.3. Procedures and results obtained

Data analysis followed three main procedures, using IBM SPSS (version 25.0) software.

The first step was to determine the validity of the 308 observations representing around five times the number of variables analysed, considering the average value (zero) for missing data to avoid losing/eliminating important information. The normalization of data is justified by the multiple units of measure and periods of reference (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Kubrusly, 2001; Marôco, 2014; Nardo et al., 2005; OECD, 2008; Pestana & Gageiro, 2014; Stevens, 1986).

The second step involved descriptive analysis (mean, standard deviation, variation coefficient and minimum and maximum values). However, normalization transformed the mean in zero and the standard deviation in 1 and so it is not shown in this study, following Marôco (2014) and OECD (2008).

The third step was application of exploratory factor analysis (EFA) with the adoption of principle component analysis (PCA) as the method to construct the Composite Index. This multivariate statistical technique groups the data with similar significance in the sample, and defines the main components that should be retained, allowing robust data treatment (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Marôco, 2014; Pestana & Gageiro, 2014; Stevens, 1986). This method aims to determine the weights that transpose the importance of the variables measured by maximum variance (Kubrusly, 2001). In this scenario, it is possible to *"summarise a set of individual indicators while preserving the maximum possible proportion of the total variation in the original data set."*, and the *"largest factor loadings are assigned to the individual indicators that have the largest variation across countries, a desirable property for cross-country comparisons, as individual indicators that are similar across countries are of little interest and cannot possibly explain differences in performance"* (OECD, 2008: 26). Of course, in this study the units of analysis are towns rather than countries.

Finally, to check acceptability of this technique, we applied the Kaiser–Meyer–Olkin (KMO) (Kaiser, 1974) sample suitability measure and the Bartlett sphericity. In order to verify the internal consistency of the (sub)dimensions used it is usual to calculate the Cronbach's alpha. However, the Cronbach alpha was not considered in this study because the *"correlations do not necessarily represent the real influence of the individual indicators on the phenomenon expressed by the composite indicator"* (OECD, 2008: 27).

The results obtained from the procedures described above are shown in Tables 3 and 4, where the values of the KMO test (Kaiser, 1974) are seen to be of adequate quality to apply EFA (Marôco, 2014) to both sub-dimensions analysed.

Also the communalities (h^2) extracted (see Tables 3 and 4) are above the required minimum of 0,32 (Costello & Osborne, 2005; Tabachnick & Fidell, 1996), where in the governance sub-dimension these explain 29% of the variance and in ICT around 42%. Similarly, all the variables always present loadings above the required minimum of 0,40 (Marôco, 2014). The next step was to calculate the *"weights from the matrix of factor loadings after rotation, given that the square of factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor"* (Kubrusly, 2001; OECD, 2008: 90). Tables 3 and 4 show that the weights for each variable were obtained by the product between normalized loadings raised to the square and the value of the explained variance for each factor.

Finally, the weights of the governance and ICT sub-dimensions in the Composite Index were calculated to measure cities' smart performance (Table 5). Specifically, the factors' associations with the variables for each sub-dimension were found.

Table 3 - Governance

Variable	**h^2**	**I) Results of Exploratory Factor Analysis**								**II) *Squared factor loading (scaled to unit sum)***							
		Factor								**Factor**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
EGOV1	0,540				0,352								0,085				
EGOV2	0,805				0,887								0,543				
EGOV3	0.486							0,485								0,224	
FIN1	0,993			0,989								0,520					
FIN2	0,846				0,693								0,331				
FIN3	0,993			0,989								0,520					
RED1	0,666						0,709								0,445		
RED2	0,736						0,776								0,533		
PEL1	0,971	0,964								0,208							
PEL2	0,988	0,982								0,216							
PEL3	0,818	0,748								0,125							
PEL4	0,955	0,951								0,202							
VIND1	0,785		0,837								0,223						
VIND2	0,694				0,466								0,150				
VIND3	0,581					0,738								0,462			
VIND4	0,880		0,868								0,240						
VIND5	0,897		0,817								0,213						
VPUB1	0,852							0,913								0,794	
VPUB2	0,793								0,878								0,779
Eigenvalue		4,47	3,14	1,88	1,45	1,18	1,13	1,05	0,99								
% Explained Variance		23,53	16,51	9,92	7,64	6,18	5,94	5,52	5,19								
Total explained variance		80,42								0,292	0,205	0,123	0,095	0,077	0,074	0,069	0,065

Varimax rotation method; N = 308; KMO = 0,697; Bartlett Sphericity Test = 6471,587; gl = 171; p < 0,000

Source: Adapted from outputs of SPSS

Table 3 - Governance (Cont.)

	III) Weights - coefficients of variables							
Variable	**Factor**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
EGOV1				0,81				
EGOV2				5,15				
EGOV3							1,54	
FIN1			6,4					
FIN2				3,14				
FIN3			6,4					
RED1						3,29		
RED2						3,94		
PEL1	6,08							
PEL2	6,31							
PEL3	3,66							
PEL4	5,91							
VIND1		4,58						
VIND2				1,42				
VIND3					3,36			
VIND4		4,93						
VIND5		4,37						
VPUB1							5,45	
VPUB2				0,81				5,04
	21,96	13,88	12,8	10,52	3,36	7,23	6,99	5,04

Source: Adapted from outputs of SPSS

Table 4 – ICT

Results of Exploratory Factor Analysis and *Squared factor loading (scaled to unit sum)*									
Variable	h^2	Factor				Factor			
		1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
TEL1	0,945	0,961				0,225			
TEL2	0,940	0,966				0,228			
AMB1	0,935		0,923				0,361		
AMB2	0,806		0,877				0,326		
AMB3	0,798			0,863				0,683	
AMB4	0,970				0,953				1,032
ACES1	0,727			0,679				0,423	
ACES2	0,890	0,859				0,180			
PUB1	0,781		0,868				0,319		
IND1	0,648	0,598				0,087			
Eigenvalue		4,10	2,36	1,09	0,88				
% Explained Variance		40,98	23,65	10,94	8,850				
Total explained variance		84,41				0,486[10]	0,280	0,129	0,104

Weights – coefficients of variables[11]				
Variable	**Factor**			
	1	**2**	**3**	**4**
TEL1	10,96			
TEL2	11,07			
AMB1		10,11		
AMB2		9,12		
AMB3			8,83	
AMB4				10,77
ACES1			5,47	
ACES2	8.75			
PUB1		8,94		
IND1	4,24			
	35,02	28,17	14,3	10,77

Varimax rotation method; N = 308; KMO = 0,741; Bartlett Sphericity Test= 2378,938; gl = 45; p < 0,000

Source: Adapted from outputs of SPSS

Finally, EFA was applied to the intelligence dimension to strengthen the robustness of the results, calculating the impact of each sub-dimension on that dimension. The results obtained are shown in Table 5.

Table 5 – Exploratory Factor Analysis of the Intelligence Dimension and Weights

Sub-dimensions	**h^2**	**Factor - Intelligence 1**	**Weights[12]**
Governance	0,566	0,752	0,500
ICT	0,566	0,752	0,500
Eigenvalue		1,13	
% explained variance		56,55	
Total explained variance		56,55	

Varimax rotation method; N = 308; KMO = 0,500; Bartlett Sphericity Test = 5,290; gl = 1; p < 0,000; **h^2** > 0,5 l*oadings*>0.40

Source: Adapted from the outputs of SPSS

[10] Example of calculation for TEL1: 4,10/∑ 4,10+2,36+1,09+0,88 = 0,486
[11] Example of calculation for TEL1: (0,48636*0,225249) *100 = 1,0955
[12] Example of calculation for TIC: 0,752^2/1,13 = 0,504

4. Discussion of the results

According to the results obtained, 12 factors were essential to measure the smart performance of Portuguese cities restricted to the credible data available, being aware that many more pertinent variables should have been used in both sub-dimensions, if official bodies used cities as the unit of analysis. In any case, the variables used to obtain the factors showed that their weights are distinct when analysing each sub-dimension individually and that the total explained variance for them is extremely high (Governance = 80,42; TIC = 84,41). This means that those factors obtained from EFA are explanatory and pertinent (Marôco, 2014). Furthermore, the communalities achieved for all variables are very relevant, and so the factors retained from PCA are appropriate to describe the latent correlational structure between all the variables (Marôco, 2014).

Analysis of the **governance** sub-dimension revealed that its performance is influenced by 8 principal factors explained in the following paragraphs.

Factor 1– **Election turnout** reflects citizens' participation in the last elections held in Portugal, with a total weight of 21,96, which is rather insignificant compared to the universe of voters. This indicates that citizens have not yet absorbed the fact that it is crucial to participate actively in electing national and local leaders, for governance to be exercised with greater public participation and total transparency, as argued by Odendaal (2003).

Factor 2 – **Population vitality** is related to cities' demographic vitality (weight of 13,88), which includes the variable measuring renewal of the working population (VIND1 = 4,58). The value of this variable shows it is imperative to attract more people of working age to cities. This means that local governments have to find more incentives to attract talented individuals, who in turn attract more investment, as according to Ryser (2014), these individuals induce intelligence since they have the flexibility to adapt to technological progress (Kakiuchi, 2016; Ratten, 2017). Also associated with this factor is the circulation of newspapers in the city environment (VIND3 = 3,36) which represents, in turn, **factor 5,** where providing access to the internet and other communication technologies in public places influences this factor negatively, because as stated by Gouvea et al. (2017), technology in transversal to all dimensions of the city, in this case the community.

Regarding **factor 3 – Local public debt** (12,8) and **factor 4 – E-government vs. Density and Income** (19,52), an interconnection between them is perceptible, since they are intrinsically implicit in cities' form of governance, in relation to their financial situation and the adoption of e-government policies. In other words, Portuguese cities and towns have taken effective action to achieve financial balance (FIN1/FIN2 = 6,40) according to their residents' needs (VIND2 = 1,42), without neglecting the philosophy of e-government in their management and provision of online platforms. The reading of this situation agrees with the line of thought of

Batty et al. (2012), who clarified that smart governance should include open and participative models of governance that allow appropriate implementation of the policies implicit in these (Bolívar & Meijer, 2016). It is also shown that these models have to be accompanied by ICT strategies (European Comission, 2008; Paskaleva, 2009), such as e-government (Paskaleva-Shapira, 2007). In addition, **factor 7 – Municipal provision** indicates an association with **factors 3** and **4** referred to above, since city management also includes municipal provision of electronic platforms for services and public places and facilities (EGOV3 = 1,54; VPUB1 = 5,45). It is clear that public electronic platforms are still minimal, and so it is important to strengthen the provision of these services to improve their competitiveness (Torres et al., 2006; Van Den Berg & Van Winden, 2017), while the spatial provision is significant, improving citizens' quality of life (Neirotti et al., 2014; Vilajosana et al., 2013).

For various authors (e.g., Gouvea et al., 2017; Ratten, 2017; Snow et al., 2016), urban networks, in their various typologies, are crucial, intangible assets for cities' improved smart performance. **Factor 6 – Urban networks** (7,23) has a weight of 3,29 for cities belonging to national networks (RED1) and 3,94 for those belonging to international ones (RED2). As examples (cf. Table 2-database) we have Renner/*living lab,* the national incubator network and *Ennol*, among others. Although these weights highlight the actions local leaders have triggered in the network axis, as predictors of performance, it is still necessary to continue to encourage their formation in cities, whether networks of incubators or open innovation. Continuing in this line will allow their smart performance to be increasingly real, as a benefit of appropriate governance in harmony with ICT, with a synergy to attract new talents, investment in various areas of business and an appropriate environment, among others. This argument corroborates Fernandes and Gama (2008), who considered that a favourable environment promotes the formation of various types of networks (Odendaal, 2003), and can add to cities' performance (Meijers et al., 2016; Pain et al., 2016) and to other collective amenities (David et al., 2013; Dijkstra et al., 2013).

Finally, **factor 8 – Tourism** is especially connected to cities' concentration on tourism (VPUB2 = 5,04), showing that their leaders have prioritized regeneration of their cities for better performance, which reflects appropriate strategic planning (Curwell et al., 2005), valuing the associated entrepreneurship (Gouvea et al., 2017).

Concerning the sub-dimension of ICT, 4 factors were obtained, which as perceived from the empirical evidence obtained only include the basic variables and does not invalidate the scientificity of the variable weights presented. However, the specific variables of ICT were not measured regarding the infrastructure of telecommunications, energy, environment and mobility (e.g., Ernst & Young, 2016) due to the non-existence of credible data in the geographical domain of this study's unit of analysis (cities). In this context, the results obtained show that telecommunications and their access still fall short of expectations to create effectively smart environments in the 308 towns and cities in Portugal (**factor 1 -**

Communications and internet), since Nam and Pardo (2011) considered ICT crucial for this to be created. Network infrastructure **(factor 2 – network infrastructure)** only reflects what is inherent to the basic services provided (e.g., basic sanitation), i.e., ICT is transversal to the various dimensions of the city (Gouvea et al., 2017) for the services provided to come close to the level of quality required. The computer network supplied in state schools (VPUB1 = 8,937) is relevant for the creation of a smart environment in education supported by ICT and its networks. That environment was defended by Gouvea et al. (2017) and allows the creation of partnerships between the various actors (Capello, 2000). Finally, **factors 3 – Energy and mail** and **4 - Waste** show public management of energy used and waste. The weights of these factors (see Table 4) show local governments' concern about providing their residents with concrete quality of life, which ties in with the considerations presented by Finger and Razaghi (2016) when explaining that urban infrastructure is improved by ICT and by stimulating urban networks (López-Quiles & Rodríguez Bolívar, 2018).

In the overall analysis of the intelligence dimension, the two sub-dimensions analysed were found to present an equal weight of 0,50 (cf. Table 5), which expresses that governance is the core of cities' smart performance (Giffinger et al., 2007) and is based on implementing ICT (Neirotti et al., 2014) and on networks (Curwell et al., 2005). In the Portuguese case, there are various guidelines supported by the European Union, focused on the intelligent dimension and inherent performance of Portuguese towns and cities and which are operationalized by their local authorities, including strategic, open and participative governance and ICT. For example, Portuguese local authority governance should consider the leadership, involvement, participation, accountability and commitment of all urban agents, as well as recognising their collective ability to innovate, share and cooperate with all public and private actors and the community (networks) in the inter and intra-urban space, but cities' competitiveness includes the ICT which gives them knowledge-directed technology. In other words, Portugal increasingly has to adopt appropriate models of governance and increase the use of ICT (Caragliu et al., 2011) individually and collectively (Giffinger et al., 2007; Lombardi et al., 2012; Madeira et al., 2016; Networked Society City Index, 2016).

These arguments are based on the definitions of intelligence adopted in this study, since technology can interact with people and their quality of life (Partridge, 2004), and simultaneously with the hard and soft facilities promoted by governance (Alkandari et al., 2012). Here, networks are also crucial, as mentioned by López-Quiles and Rodríguez Bolívar (2018) and Schaffers et al. (2011).

5. Contributions of the study

Intelligence is a complex construct in cities, and so creating a smart environment in them implies cooperation and collective involvement by all city agents, both public and private. In addition, this dimension of cities has been understood as an essential axis of competitiveness influencing their performance. Indeed, this complexity and influence led to the emergence of countless specific indicators to measure cities' smart performance, particularly those of medium-high population density or for countries overall. However, many of those indices do not present a scientific weight for the sub-dimension of governance and ICT.

Therefore, a scientifically robust intelligence index (EFA and PCA) was presented. Specifically, a scientific tool was built – Composite Index of Intelligence – by presenting the weights for the sub-dimension of governance and ICT as an aid to political decision-makers (López-Quiles & Rodríguez Bolívar, 2018), which forms the first contribution of this study.

A second contribution concerns the review of 11 indices of intelligence in cities or countries, which allowed identification of two fundamental sub-dimensions: 1) governance; and 2) ICT. This review allowed indicators and respective variables to be grouped in a single theoretical index.

Adaptation of this theoretical index to the situation of 308 cities and towns in Portugal is a fundamental contribution, having followed the principles inherent to a good indicator. This adaptation, the respective empirical application and calculation of the weights for each variable is a pioneering study in Portugal, filling the gap between theory and practice (Lee et al., 2014), besides including networks as a viable and crucial indicator of cities' smart governance (Bifulco et al., 2017).

Those contributions respond to the study's first objective, since the answer to the second objective is given by the holistic analysis of the intelligence dimension, in which weight is scientifically attributed to each sub-dimension *per se*, which is the final contribution of this research.

6. Limitations and indications for future research

Like any study, this one is not without limitations. One concerns the inherent subjectivity in the choice of indicators and their variables, which was imposed and limited by the availability of credible data for the territory analysed. In these circumstances, there was a notable absence of data for Portuguese cities and towns regarding the intelligence dimension, despite this existing at the national level. This unavailability meant that regarding the ICT sub-dimension, there is a deficit of specific variables to measure cities' smart performance associated with the lack of information about municipal strategies, specifically non-financial data, and so the performance of this dimension could lack assessment. This leads to the strong recommendation for future study to detail those data at the town/city level. In addition, this limitation infers that multiple case studies (qualitative research) in cities can complete the missing data, allowing Portuguese towns' real intelligence to be measured, encouraging future studies.

Cities' performance has to include all their dimensions given the new vision of their role in global economic growth, and so it is not only determined by the intelligence dimension as demonstrated in this study, representing another limitation. It is therefore suggested that future studies should investigate the dimension of urban sustainability (economic, social and environmental) and its scientific and composite weight in cities' performance. Indeed, currents cities must be assimilated holistically, which suggests the construction of a Composite Index for that Sustainability for all Portuguese towns and cities for generalized application in any geographical context.

Another limitation is related to the study only being carried out in Portugal. Therefore, it is also suggested that this Composite Index of Intelligence should be applied in other countries to enable a comparative study to be made between them.

7. Conclusions and implications

By concentrating a great proportion of the population, firms and employment, cities currently have the function of stimulating economic development, creating differentiating competitive factors and continuously innovating. However, the migratory flow of people to cities has called into question, among other aspects, residents' quality of life and directed strategies towards intangible resources and not only to infrastructure and accessibility. The Portuguese case is no different, and it was pertinent to redirect territorial strategies towards knowledge and the technology associated with integrating and resilient governance. This strategic change is integrated in the European Union guidelines whose premises, among others, are balanced coordination between creativity and intelligence so that citizens can enjoy a quality of life that is at least satisfactory.

This new paradigm of cities has stimulated the scientific community to develop tools and instruments to measure their intelligence, particularly in theoretical terms. Nevertheless, when applied empirically, these indices fell short in scientific quality and strength. So to combat this tendency, a Composite Index for Intelligence was presented in this study, which equips decision-makers in Portuguese towns and cities with a tool to measure, assess and monitor their intelligence in relation to governance and the degree of ICT implementation.

Obviously, the construction of this tool has implications for theory and practice. Theoretically, it was proven that construction of a composite index is not unattainable, as it is possible to calculate weights scientifically (e.g., EFA and PCA), the testing of which allows its applicability in any geographical context, the final result being presentation of a scientific taxonomy for intelligence.

The practical implications arising from the empirical results obtained refer to the weights of the variables showing quite a wide interval of values in governance and those of ICT not reflecting the situation, due to official bodies not having data at the micro territorial level. This implies that political decision-makers will have difficulty in measuring the smart performance of Portuguese towns and cities, correcting remaining deficits and assessing the returns on technology provided by their governance. Another implication is related to urban networks, where the majority of Portuguese towns and cities belong to one, which determines prediction of these in cities' performance.

Summarizing, this dimension is still a fertile field of research in any geographical context, particularly its articulation with the formation of networks this allows.

References

Alkandari, A., Alnasheet, M., & Alshaikhli, I. F. T. (2012). Smart cities: a survey. *Journal of Advanced Computer Science and Technology Research,2*(2), 79-90.

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 4–28.

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1), 45-64.

Aurigi, A. (2005). *Making the digital city: the early shaping of urban internet space*. Routledge.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., & Bazzani, A. (2012). Smart cities of the future, *The European Physical Journal Special Topics*, *214*(1), 481-518.

Bifulco, F., Tregua, M., Amitrano, C. (2017). Co-governing smart cities through living labs. Top evidences from EU. *Transylvanian Review of Administrative Sciences*, 13(*50)*, 21–37.

Bolívar, M. P. R., & Meijer, A. J. (2016). Smart governance: Using a literature review and empirical analysis to build a research model. *Social Science Computer Review*, *34*(6), 673-692.

Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.

Bouk, S. H., Ahmed, S. H., Kim, D., & Song, H. (2017). Named-data-networking-based ITS for smart cities. *IEEE Communications Magazine*, *55*(1), 105-111.

Capello, R. (2000). The City Network Paradigm: Measuring Urban Network Externalities. *Urban Studies*, *37*(11), 1925–1945.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., ... & Scholl, H. J. (2012, January). Understanding smart cities: An integrative framework. In *System Science (HICSS), 2012 45th Hawaii International Conference on* (pp. 2289-2297). IEEE.

Cohen, B., Almirall, E., Chesbrough, H. (2016). The City as a Lab: open innovation meets the collaborative economy. *California Management Review*, *59*(1), 5-13.

Cohen, B. (2012). What exactly is a smart city. *Available online:* https://www.fastcompany.com/1680538/what-exactly-is-a-smart-city.

Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.

Curwell, S., Deakin, M., & Symes, M. (2005). Sustainable urban development: The framework, protocols and environmental assessment methods: Vol. 1. Available online:

http://researchrepository.napier.ac.uk/3837/.
David, Q., Peeters, D., Van Hamme, G., & Vandermotten, C. (2013). Is bigger better? Economic performances of European cities, 1960-2009. *Cities*, *35*, 237–254.
Dijkstra, L., Garcilazo, E., & Mccann, P. (2013). The Economic Performance of European Cities and City Regions : Myths and Realities. *European Planning Studies*,*21*(3), 334-354.
Ernst & Young. (2016). Rapporto Smart city index. Available online: www.ey.com/...smart...index-2016/.../2016-EY-smart-city-index.
European Comission. (2008). *A strategic European framework for international science and technology cooperation*. Available online: https://ec.europa.eu.
Fernandes, R., & Gama, R. (2008). A Criatividade Territorial Em Portugal: Dos Indicadores Aos Territórios Criativos. Available online: https://core.ac.uk/download/pdf/19133326.pdf.
Finger, M., & Razaghi, M. (2016). Conceptualizing "Smart Cities". *Informatik-Spektrum*. *40*(1), 6-13.
Garau, C., Balletto, G., & Mundula, L. (2017). A Critical Reflection on Smart Governance in Italy: Definition and Challenges for a Sustainable Urban Regeneration. In E. P. Bisello A., Vettorato D., Stephens R. (Ed.), *Smart and Sustainable Planning for Cities and Regions. SSPCR 2015. Green Energy and Technology* (p. 435).
García Suárez, J. A., & Pulido Fernández, J. I. (2015). Creacity , una propuesta de índice para medir la creatividad turística . Aplicación en tres destinos urbano-culturales españoles. *Revista de Estudios Regionales*, (13), 69–108.
Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf*.
Gouvea, R., Kapelianis, D., & Kassicieh, S. (2017). Assessing the nexus of sustainability and information & communications technology. *Technological Forecasting and Social Change*, *130*, 39-44.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Hanclova, J., Doucek, P., Fischer, J., & Vltavska, K. (2014). Does ICT capital affect economic growth in the EU-15 and EU-12 countries? *Journal of Business Economics and Management*, *16*(2), 387–406.
Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.
Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.
Kľúčik, M., & Haluška, J. (2008). Construction of Composite Leading Indicator for the Slovak Economy. *Stiin Ńe Economice*, *55*, 362–370.
Komninos, N. (2002). *Intelligent cities: innovation, knowledge systems, and digital spaces. Taylor & Francis*.
Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.
Laitinen, I., Osborne, M., & Stenvall, J. (2016). Complex regional innovation networks and HEI engagement – the case of Chicago. *International Journal of Knowlege-Based Development*, *7*(2), 184–201.
Lazaroiu, G. C., & Roscia, M. (2012). Definition methodology for the smart cities model. *Energy*, *47*(1), 326–332.
Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.
Lee, J. H., Phaal, R., & Lee, S. H. (2013). An integrated service-device-technology roadmap for smart city development. *Technological Forecasting and Social Change*, *80*(2), 286–306.
Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.
Ling, S., & Martins, J. T. (2015). Learning and innovation in network: online communicative practices of a local enterprise partnership sector group. *Regional Studies, Regional Science*, 2(1), 170–183.
Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city

performance. *Innovation*, *25*(2), 137–149.

López-Quiles, J., & Rodríguez Bolívar, M. (2018). Smart Technologies for Smart Governments : A Review of Technological Tools in Smart Cities. In *In Smart Technologies for Smart Governments . Springer, Cham.* (pp. 1–18).

Madeira, G., Guimarães, T., & Mendes, L. (2016). Assessing some models for city e-government implementation : a case study. *Electronic Government, An International Journal*, *12*(1), 86–105.

Mardikyan, S., Yıldız, E., Ordu, M., & Şimşek, B. (2015). Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA*, *2015*, 1–10.

Marôco, J. (2014). Análise estatística com o SPSS Statistics.

Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.

Meijer, A., & Bolivar, M. P. R. (2016). Governing the smart city : a review of the literature on smart urban governance governance. *International Review of Administrative Sciences*, *82*(2), 392-408.

Meijers, E. J., Burger, M. J., & Hoogerbrugge, M. M. (2016). Borrowing size in networks of cities: City size, network connectivity and metropolitan functions in Europe. *Papers in Regional Science*, *95*(1), 181-198.

Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research : A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3-27.

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Digital Government Research Conference on Digital Government Innovation in Challenging Times (pp.* 282-291).ACM.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis*, *EUR 21682* (December), 134.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). *Current trends in smart city initiatives: Some stylised facts. Cities* 38, 25-36.

Networked Society City Index (2016). *Cities play key role in sustainable development. Available online: https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.*

Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495.

Odendaal, N. (2003). Information and communication technology and local governance : understanding the difference between cities in developed and emerging economies. *Computers, Environment and Urban Systems*, *27*(6), 585-607.

OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.

Pain, K., Van Hamme, G., Vinciguerra, S., & David, Q. (2016). Global network, cities and economic performance: Observations from an analysis of cities in Europe and the USA. *Urban Studies*, *53*(6), 1137-1161.

Partridge, H. (2004). Developing a Human Perspective to the Digital Divide in the Smart City. *ALIA 2004 Biennial Conference Challenging Ideas*, 1–7. Available on: http://conferences.alia.org.au/alia2004/conference.papers.html.

Paskaleva-Shapira, K. A. (2007). E-city Europe: Status, propositions, and opportunities. In *Proceedings of the International Conference 'Intelligent Environments*, Ulm, Germany, 24–25 September.

Paskaleva, K. (2009). Enabling the smart city : the progress of city e-governance in Europe. *International Journal of Innovation and Regional Development*, *1*(4), 405–422.

Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS.*

Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.

Richter, C., Kraus, S., & Syrjä, P. (2015). The Smart City as an opportunity for entrepreneurship. *International Journal of Entrepreneurial Venturing*, *7*(3), 211–226.

Ryser, J. (2014). reviewed paper Planning Smart Cities ... Sustainable, Healthy, Liveable, Creative Cities ... Or Just Planning Cities? Judith Ryser. Plan Smart Cities, *8*, 447–456.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg.

Snow, C. C., Håkonsson, D. D., & Obel, B. (2016). A Smart City Is a Collaborative Community: Lessons from smart Aarhus. *California Management Review*, *59*(1), 92–108.
Stevens, J. (1986). Chapter 11 - Exploratory and Confirmatory Factor Analysis. In L. E. Associates. (Ed.), *Applied multivariate statistics for the social sciences*. New Jersey. USA.
Tabachnick, B. G., & Fidell, L. S. (1996). *sing Multivariate Statistics.* (3rd ednHarper Collins. New York, Ed.).
Torres, L., Pina, V., & Acerete, B. (2006). E-Governance Developments in EU Cities. Reshaping Government Relation To Citizens. *Governance*, *19*(2), 277–302.
Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.
United Nations. (2015). *Smart Sustainable Cities Indicators*. United Nations: New York, NY, USA.
United Nations Commission on Science and Technology for Development. (2016). *Economic and Social Council Report of the Partnership on Measuring Information and* (Vol. 4). Available online: http://www.tandfonline.com/doi/abs/10.3846/16111699.2012.754375.
Van Den Berg, L., & van Winden, W. (2017). *Information and communications technology as potential catalyst for sustainable urban development: Experiences in Eindhoven, Helsinki, Manchester, Marseilles and The Hague*. Routledge.
Vilajosana, I., Llosa, J., Martinez, B., Domingo-Prieto, M., Angles, A., & Vilajosana, X. (2013). Bootstrapping smart cities through a self-sustainable model based on big data flows. *IEEE Communications Magazine*, *51*(6), 128–134.

CHAPTER 6

CITIES AND MEASURING THEIR URBAN SUSTAINABILITY: COMPOSITE INDEX APPLIED IN PORTUGAL

ABSTRACT

Urban sustainability (economic, cultural, social and environmental) is one dimension that is inseparable from currents cities and its extent is a major concern for political decision-makers worldwide. Therefore, this study aims to (1) determine the intrinsic sub-dimensions of the cities' urban sustainability dimension and the respective indices/indicators to measure cities' sustainable performance; and (2) present the weight of each sub-dimension in the urban sustainability dimension. These objectives were reached by presenting a Composite Index through application of Exploratory Factor Analysis and Principal Component Analysis, retaining a total of 22 factors. These results are the principal contribution of this study. The evidence obtained for the 308 Portuguese towns/cities showed that more effective actions are needed for their sustainability to continue to improve substantially in the long term, for example, environmentally. Furthermore, the towns/cities analysed must change to the circular economy model as proposed by the European Union. Finally, implications for theory and practice, a future research agenda and final comments will be presented.

Key-words: Cities, Urban sustainability, Composite Index, Performance

1. Introduction

Nowadays, cities everywhere face major challenges, one of the main ones being their urban sustainability, which includes economic, social, environmental and also cultural issues that should be mitigated by the use of information and communication technology (ICT). This means that a city can be sustainable and creative simultaneously, as well as including intelligence as a means to apply its policies and strategies efficiently and effectively to be designated as such (Letaifa, 2015).

The promotion of cities as drivers and catalysts of economic growth has been the focus of the European Union's recent strategies, with demographic forecasts indicating that 75% of the population will live in cities by 2050 (Dizdaroglu & Yigitcanlar, 2014). This exponential urban growth raises relevant questions about economic (pillar 1), social (pillar 2) and environmental (pillar 3) sustainability, and so it must be understood that these are transversal to all areas and sectors of cities. This transversal character was approached by Yigitcanlar, Dur, and Dizdaroglu (2015), who claim that cities only maintain their prosperity if their environmental and social objectives are completely integrated with economic ones. However, it is crucial to add culture (pillar 4) to these objectives so that cities' values and cultural and historical identity are preserved (Oakley & Ward, 2018).

The multiple concepts involved in cities' urban sustainability results in its definition being somewhat controversial, multifaceted, complex and dispersed (Bibri, 2015; Bibri & Krogstie, 2017; McManus, 1996; Molnar, Morgan, & Bell, 2001). Consequently, urban sustainability includes the physical, social, economic (Camagni, Capello, & Nijkamp, 1998; Ratten, 2017; Tranos & Gertner, 2012) and cultural (Ratten, 2017) dimensions, understood as a whole, allowing cities to be innovative (Ballas, 2013) and showing a balance between environmental protection and integration, between economic development and urban regeneration and between social equity and justice (Bibri & Krogstie, 2017) and consequently being sustainable (Albino, Berardi, & Dangelico, 2015). This definition guides cities towards an urban ecosystem with broader economic, social, environmental and spatial systems (Haughton, 1999), to the importance of sustainability for quality of life (Agyeman, Bullard, & Evans, 2002) and to the importance of the right balance between all these systems (Phearson et al., 2016), without losing cultural identity and local values (Folke, 2006; Oakley & Ward, 2018), through good governance practices (Pozdniakova, 2017). In addition, it is important for cities to be seen as a collaborative network (Brorström et al., 2018) with various actors who compete and collaborate with each other (Camagni & Capello, 2004), and so collaboration partnerships (e.g., public-private partnerships) have been associated with cities' improved urban sustainability (Ferraris, Santoro, & Papa, 2018).

In this context, urban sustainability has been widely discussed in the academic world, since cities' prosperity is intrinsically linked to their sustainable urban development. Nevertheless, the vast literature on the subject still reveals some gaps that call for more research, particularly on how urban transformations are directed towards economic, social and environmental sustainability and how they are monitored and assessed (Nevens et al., 2013); the shortage of alternative models for the sustainability of creative cities (d'Ovidio & Cossu, 2017); the inclusion of performance indicators that ally creativity and culture with sustainability (Cabrita, Cruz-Machado, & Cabrita, 2013; Cohen, Almirall, & Chesbrough, 2017; Della Lucia, Trunfio, & Go, 2017); networks and their synergies for cities' sustainable performance (Echebarria et al., 2016; Ferraris et al., 2018; Walker & Hills, 2012); their holistic measurement (Cretu, 2012) with economic and non-economic indicators (Peda, Argento, & Grossi, 2013; Speklé & Verbeeten, 2014; Walker & Hills, 2012).

Based on the gaps identified and the fact that cities should be studied in a holistic, multidimensional way, considering the right balance between the pillars of urban sustainability, this study has two objectives: (1) to determine the intrinsic sub-dimensions of cities' urban sustainability dimension and the respective indices/indicators to measure cities' sustainable performance; and (2) present the weight of each sub-dimension in the urban sustainability dimension. These objectives are fulfilled by presenting a Composite Index for this dimension for transversal and generalized application, this being the study's major contribution. However, a composite indicator is an aggregate of all dimensions, objectives, individual indicators and variables used (OECD, 2008). Thus, in this study the composite index is used as an auxiliary means for calculating the weights of each dimension/sub-dimension.

The Introduction is followed by the Literature Review, the Methodology and Discussion of the Results. Finally, the contributions of this empirical study are presented, together with the limitations and suggestions for future research, as well as the conclusions with implications for theory and practice.

2. Literature review

2.1. Urban sustainability: economic, social, environmental

The extensive literature on urban sustainability reveals that this should be associated with the best governance practices, reflecting the endogenous competences of cities and their leaders to create and maintain the social conditions of stability, democracy, participation and justice, and provide and forecast the aspirations and needs of their inhabitants in an intelligent way, in the present and in the future (Pozdniakova, 2017); that culture contributes to sustainability by raising citizens' involvement and policies that originate additional investment (Oakley & Ward, 2018). These lines of thought are reflected in the vision and purpose of cities defined by the European Union and by UNESCO[13] (Duxbury, Hosagrahar, & Pascual, 2016), whereby cities should be attractive, diversified and open. Cities possessing urban sustainability emphasize the connection between economic vitality, quality of life, conservation of natural resources and social equity, with creativity playing an essential role by stimulating the regeneration of urban centres through encouraging cultural activities that attract people and investment in creative industries (Furtado & Alves, 2012). Bilbao is considered an example of how culture and creativity contributes towards sustainability (Silva & Tarouco, 2016).

In fact, cities are platforms of urban sustainability (Muñoz & Cohen, 2016), where public green spaces, cultural identity, planning, the environment, the economy, social aspects, health infrastructure, education and others are inseparable components of sustainable urban development aiming to enhance residents' quality of life (Fahy & Cinnéide, 2006; Fischer & Amekudzi, 2011). This sustainability is based on widely recognized pillars that are closely related. These are economic, social and environmental, among which there must be a balance

[13] *United Nations Educational, Scientific and Cultural Organization*

for effective sustainable development (Elkington, 1994). However, various authors have argued that the cultural pillar should be added to the previous three, as this gives cities greater vitality and dynamism (Cavalcanti, 1995; Hawkes, 2001; Skrede, 2016).

Consequently, the sustainable, inclusive growth defended by the European Union is a way to overcome the failings of the current economy to improve competitiveness, increase productivity and achieve a sustainable market economy (Bere, Precup, & Silvestru, 2015) and thereby provide an alternative to the relentless urban development that jeopardizes cities' sustainability (Pérez-Urrestarazu, Fernández-Cañero, & Franco-Salas, 2017). However, this growth is only effective if structural, process and cultural changes take place in the institutions making decisions and implementing them (Mendes, 2008), since cities should respond to their residents' needs (Keiner & Schmid, 2006).

It is also important to highlight that cities equipped with ICT have auxiliary means to achieve the desired sustainability (Bifulco et al., 2016; Funk, 2015; Wang, Chen, & Benitez-Amado, 2015; Wu & Raghupathi, 2015), namely in environmental (Gouvea, Kapelianis, & Kassicieh, 2017; Jain, 2011), social and economic (Jain, 2011) terms. Recently, Bibri and Krogstie (2017) concluded that the benefits of technology allied to sustainability include density (e.g., energy economy, greater accessibility to services) and compatibility (e.g., quality of life, social interaction), mixed use of the ground (e.g., security, reduced pollution), sustainable transport (e.g., reduced waste) and a green image (e.g., improved urban image, attractiveness).

The literature on urban sustainability addresses and identifies three pillars – economic, social and environmental sustainability – that will be reviewed in the following paragraphs. Note that given the dependence and correlation between those three pillars, their theoretical support will be elaborated accordingly. This argument was put forward by Neilagh and Ghafourian (2018), who proposed, for example, that social sustainability is closely related to economic and environmental sustainability, with the aim of improving the quality of life in the urban environment.

Generically, **economic sustainability** is related to generating prosperity in all society, i.e., the efficiency of economic activity, the generation of overall wealth, the creation of quality jobs – growth, productivity, competitiveness - (Pozdniakova, 2017). Cities' economic growth was traditionally only measured by GDP, employment and unemployment, for example, but urban transformations meant new factors must be added to those models (New Economic Foundation, 2015). Consequently, economic sustainability has also come to be related to the significant contribution of creativity (creative and cultural industries) (Hollands, 2008; Kirchberg & Kagan, 2013) and ICT (Hollands, 2008) and to the formation of multiple collaboration processes (Kirchberg & Kagan, 2013).

Naturally, the inclusion of new factors to measure sustainability shows that a city's prosperity is indicated by taking advantage of opportunities that create economic, social and environmental value, and so forms of cooperation have emerged in cities to encourage entrepreneurial and creative individuals (Cohen & Muñoz, 2015). This cooperation allows cities to be understood as critical nodes to apply the creative changes required in the 21st century (Ratten, 2017), and so local networks/partnerships are crucial for currents cities' competitive advantage (Banks et al., 2000) and for the exchange of symbolic knowledge (Asheim, Coenen, & Vang, 2007; Vinodrai, 2006). In this connection, it has become clear that networks are an important factor in promoting economic sustainability, and this is evident in the model of regional integration defined by the European Union, which includes structures and processes of formal and informal coordination and collaboration - *inter* and *intra* networks - and where exogenous and endogenous factors are crucial to stimulate them (Siegel, 2016). In addition, Sharma and Kearins (2011) suggested that through the collaboration process, the actors involved gain a better understanding of the economic, social and environmental issues affecting their regions' sustainability and can alter their position accordingly to gain greater legitimacy.

In this context, *living labs* emerge as an entrepreneurial partnership between firms, governments, citizens and institutions (Ratten, 2017), representing an open network of for-profit and non-profit businesses based on entrepreneurship and innovation to stimulate cities' economic growth (Nyström et al., 2014). A noted example of a *living lab* is the city of Amsterdam, whose actors are concentrated in sustainable energy, innovative solutions in the field of health, improved transport systems and also in encouraging citizens' participation, the city's image as a creative, completely open centre and in rehabilitating public buildings to accommodate entertainment companies for the community (Meijer & Bolívar, 2015; Ratten, 2017). This example corroborates the argument of Glaeser, Rosenthal, and Strange (2010) who state that *"entrepreneurs play a crucial role in making cities economically dynamic"*.

This dynamic role attributed to urban entrepreneurs supports the association of culture with cities' sustainability, where all the actors involved understand the importance of this in the environmental, social and economic context and their connection as a whole (Giampietro, Gamboa, & Lobo, 2011; Ratiu, 2013). This means it is fundamental to attract talented/creative and competent human capital to cities to promote sustainability in an intelligent way so that their growth is based on multiple, interconnected and dynamic activities (Florea, 2015), with creativity being the common thread (Çetindamar & Günsel, 2012) and supported by creative industries that generate long-term economic (e.g., wealth, employment) and non-economic (e.g. networks, urban regeneration) benefits (Bradford, 2004; Florida, 2002; Gertler, 2004; He & Gebhardt, 2014; Landry, 2000). Additionally, Cohendet and Zapata (2009) empirically concluded (Barcelona and Montreal) that the creative industries are the undisputed support of urban sustainability, since they generate wealth.

Regarding **social sustainability** in the urban context, Dempsey et al. (2011) explained this is multidimensional and wide-ranging, since it can include cohesion, social inclusion and exclusion, and also the people's right to have their needs satisfied, in the present and future, with fairness. This line of thought was examined by Pozdniakova (2017) who clarified that social sustainability covers justice and social inclusion, fair distribution of wealth, health and education, which was contained in Agenda 21 of the European Union as one of the strategic priorities to be implemented by the authorities (Pitarch-Garrido, 2018).

However, the implementation of social sustainability strategies originated greater involvement by the different actors in the decision-making process on assessment of socio-economic and cultural conditions in the territory (macro and micro) to determine the equity and social cohesion of urban areas, for example, cities (Andreotti, Mingione, & Polizzi, 2012), regarding the basic infrastructure accessible to residents (services and facilities) (Livert & Gainza, 2017; Vadrevu & Kanjilal, 2016). This means local governments and other entities are concerned with including social policy in their strategies to ensure fair access to all services provided and to income, due to the inequality and social segregation caused by cities' rapid urban development (Pitarch-Garrido, 2018).

Given the broad nature of social sustainability, various authors (e.g., Bramley et al., 2009; Burton, 2000; Chan & Lee, 2007; Hopwood, Mellor, & Brien, 2005; Meegan & Mitchell, 2001; Yiftachel & Hedgcock, 1993) identified the factors contributing to this situation in urban areas, highlighting education, social justice, inclusion and social cohesion, health, social networks, social interactions, access to employment, family stability, cultural traditions, suitable housing, environmental quality, quality amenities and others. Chan and Lee (2007) also found that the factors creating and improving social sustainability in urban areas are satisfaction of the requirements of well-being, preservation of resources and the environment, creation of a harmonious vibrant environment, amenities that facilitate everyday life, forms of development and the availability of open spaces.

For cities to achieve **environmental sustainability,** they must follow strategies and policies that maximize efficient use of energy and material resources, create a zero-waste system, support the production and consumption of renewable energy, reduce emissions, pollution and noise, reduce transport needs and emphasize spatial proximity (Bibri & Krogstie, 2017). Furthermore, the conservation and maintenance of local natural resources should be part of cities' value chain (Sepe, 2013).

With the emergence of a long-term sustainable environment associated with environmental concerns and promotion of social equity, security and economic stability simultaneously (Bibri & Krogstie, 2017), cities aspire to move towards a sustainable and efficient economy, which should use more human capital than natural resources, and in this way generate growth through the circular economy model (European Comission, 2015). The circular economy has gained prominence worldwide, given its importance for more sustainable future development (Ghisellini, Cialani, & Ulgiati, 2015; Jones & Comfort, 2017), and has been indicated as the most recent route to sustainability (Lilja, 2015; Staniškis, 2012), as it allows products' added value to be retained in the long term, the maximum value to be extracted from products and the elimination of waste (Smol, Kulczycka, & Avdiushchenko, 2017). Although the concept of the **circular economy** was initially directed towards natural resources, this has been approached in various scientific domains, highlighting studies about economic performance and others (Korhonen, Honkasalo, & Seppälä, 2018).

It is also emphasized that connectivity is crucial for the circular economy to allow benefiting from exogenous and endogenous synergies, the collaborative process among all parties (European Comission, 2015) and finally, network functioning (Jelinski et al., 1992) and partnership formation (Veleva & Bodkin, 2018), with individual and collective benefits (Álvarez & Ruiz-Puente, 2017). The connection required by the circular economy was also underlined by Prendeville, Cherim and Bocken (2018) when stating that many cities have begun to form *living labs* to develop their knowledge about the use of resources and to achieve the various stakeholders' commitment, as an experimental approach to implementing the circular economy, with Amsterdam being an example.

Once again, the pillars of global sustainability are correlated in this circular economy model, where **environmental sustainability** includes the reduction of raw material and energy inputs, with raw inputs being predominantly renewable; **economic sustainability** relates to reducing the amount of raw material and inherent costs, enhancing the value of resources as these are used more than once, minimizing the use of expensive resources, reducing the costs inherent to environmental legislation, taxes and environmental insurance, image and a potential green market; **social sustainability** is promoted by providing new job opportunities created through reusing resources and the community's increased sense of responsibility towards the city (Korhonen et al., 2018).

However, the conditions contemporary cities currently face require reflection about, and connection to the potential correlation between creativity and sustainability, which should be achieved through city planning, whatever their dynamics and/or demographic stability (Forte, 2011). This author also argues that technology and innovation can be of great help in making cities simultaneously creative and sustainable, but this must be supported by efficient governance that anticipates and foresees the community's aspirations in an intelligent way, in the present and future (Pozdniakova, 2017).

It should also be underlined that to prosper, a city must be guided by sustainability, connectivity, creativity/innovation and social cohesion, where sustainability reflects an appropriate density, compact growth, energy efficiency and public spaces, since connectivity relates to efficient mobility, pedestrianized areas, communications and international connections; innovation includes technology, talent and creative activities; and finally, social cohesion means the existence of democratic values, health, security, community spirit and diversity (Berrone, Gelabert, & Fosfuri, 2009).

2.2. Indicators to measure cities'urban sustainability

Cities possessing urban sustainability have the premises of improving the well-being of residents and society as a whole, which implies integrated urban planning and management, in order to take advantage of its benefits in the present and future (Suzuki et al., 2010). Moreover, Flores and Teixeira (2017) argue that these cities should promote social cohesion, economic productivity, the harmonization of natural resources and historic and cultural identity. Therefore, the monitoring and assessment of cities' sustainable performance is fundamental to understand why one city is sustainable and another is not, and so the use of appropriate tools has been widely discussed (Albrechts, 2013; Angelidou, 2014).

In this context, numerous indices have been developed in the academic sphere to measure the sustainable performance of regions, countries and cities (e.g., Adnan, Hamzah, & Alias, 2016; Irungbam, 2016) and of private entities (e.g., Bloom Consulting, 2017; Bosch et al., 2017; European Comission, 2014).

Despite the diversity of existing indices/indicators, effective assessment of the performance of urban sustainability involves indices that integrate the interactions between citizens and society (Ahvenniemi et al., 2017; Berardi, 2013; Komeily & Srinivasan, 2015; Turcu, 2013), quality of life (Alqahtany, Rezgui, & Li, 2013) and culture (Ameen, Mourshed, & Li, 2015). In other words, multiple indices have been required to measure performance, and so it is crucial to develop measuring indices with a diversity of factors (Lu et al., 2018), leading to the recognition of composite indices as increasingly useful tools to assess performance at the various territorial levels (Staníčková & Melecký, 2018).

Measurement of cities' sustainable performance should include indicators related to economic, social and environmental matters (Mori & Christodoulou, 2012). In this connection, Dhingra and Chattopadhyay (2016) suggested these are related to density, accessibility, public spaces and urbanism; Trivellato (2016) used indicators related to demographic changes, education and competences, employability, health, security, well-being, cultural identity and social equity; Lombardi et al. (2012) focused on the environment, for example, emissions, recycling and others. More recent studies have dealt with indicators implicit in the circular economy (Ligorio, 2017; Smol et al., 2017).

Summarizing, there is seen to be a great number and variety of indicators. But this heterogeneity of indices, some theoretical and others empirical, reveals the need to develop a multidimensional index of quality and scientific robustness that includes a mix of indicators and their proxies – a Composite Index – that captures phenomena and integrates a great amount of information that is not visible and understandable through only one indicator (Nardo et al., 2005; Staníčková & Melecký, 2018).

3. Methodology

3.1. Characterisation of the population

The population of this study is all towns and cities in Portugal (N = 308), their demography being presented in Figure 1.

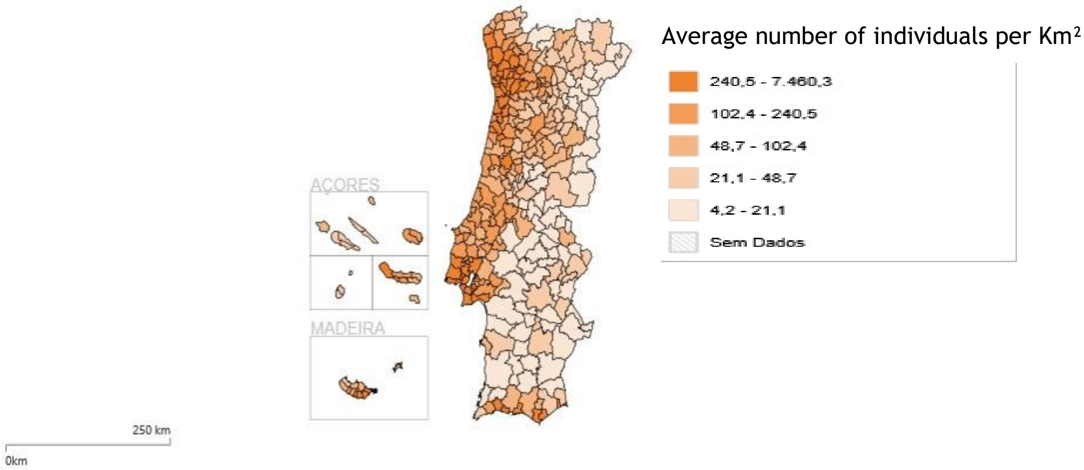

Figure 1 – Population density in Portuguese local authorities (Pordata, 2018)

Figure 1 shows clearly that coastal towns and cities have greater population density, and so there is an imbalance in the population's distribution and the facilities provided.

3.2. Listing of measurement indicators and the data collection

Responding to the objectives defined and supported by the literature review presented, an exhaustive survey was made of the indicators and proxies applicable to the population analysed, according to the availability of data for Portuguese towns and cities. This process was governed by principles of clarity, simplicity, reproduction, scientificity, salience, credibility, legitimacy and comparability of data (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005), since the quality of a composite index depends on the quality of the data used (Saisana & Tarantola, 2002; Staníčková & Melecký, 2018), as well as the choice of research method given the heterogeneity of measurement units and reference periods of the proxies (Saisana & Tarantola, 2002). For these authors, the weighting and aggregation methods used have a crucial effect on the final result obtained, and so the methods defined by the OECD (2008) are appropriate for measuring the performance of cities' urban sustainability.

According to the above-mentioned requirements, Table 1 presents the indicators used, their proxies and other relevant information.

Table 1 – Indicators to measure urban sustainability in Portugal (N = 308)

Acronym	Description	Additional information about the data collected[14]
Sub-dimension: Economic sustainability		
General indicator: Competitiveness and economic activity		
Specific indicator: Economic growth (Bloom Consulting, 2017; Bosch et al., 2017; Giffinger et al., 2007; Lombardi et al., 2012; Trivellato, 2016; United States Environment Protection Agency, 2016)		
CREC1	* Purchasing power per capita	Pordata: 2015; %
CREC2	* Exports	Pordata; 2016; euros
CREC3	* Imports	Pordata; 2016; euros
CREC4	* Town's employment rate	Pordata; 2011; %
CREC5	* Total unemployment rate	Pordata; 2011; %
Specific indicator: Business (Bloom Consulting, 2017; Bosch et al., 2017; Giffinger et al., 2007; United States Environment Protection Agency, 2016)		
NEG1	* Firms formed in the period of reference	Pordata; 2017; number
NEG2	* Firms dissolved	Pordata; 2017; number
NEG3	* Banks and Savings Institutions	Pordata; 2017; number
NEG4	* Non-financial firms	Pordata; 2016; number
NEG5	* Firms	Pordata; 2016; number
NEG6	* Employees in non-financial firms - total and by economic activity	Pordata; 2016; number
NEG7	* Turnover of non-financial firms: total and by economic activity	Pordata; 2016; M.€
NEG8	* Gross added value of non-financial firms: total and by sector of economic activity	Pordata; 2016; M.€
NEG9	* Non-financial firms with under 10 employees as a % of all non-financial firms: by sector of economic activity	Pordata; 2016; %
NEG10	* Youth unemployment rate - Unemployed registered with job centres and in vocational training (annual average): total and by age-group	Pordata; 2017; %
Specific indicator: Entrepreneurship (Angelidou, 2017; Giffinger et al., 2007; Trivellato, 2016)		
EMP1	* % of new firms in activity after 2 years	INE; 2015; %
EMP2	* % of employment with higher competences _ Employees: total and by level of education	Pordata; 2013; %
EMP3	* % of self-employment (self-employed, but employers)	Pordata; 2011; %
EMP4	* % of self-employment (self-employed, not employers)	Pordata; 2011; %
EMP5	* Density of established firms' part	INE; 2016; Km²
EMP6	* FABlabs , living labs	www.fablabsportugal.pt/; 2018; number[15]
Sub-dimension: Social sustainability		
General indicator: Population and citizenship		
Specific indicator: Demographic changes cultural/historic identity (Networked Society City Index 2016.; Trivellato, 2016; Bloom Consulting, 2017)		
AD1	* Percentage of population over 65	Pordata; 2011; number
AD2	* Percentage of population under 15	Pordata; 2011; number
AD3	* Migratory growth – contribution of migratory balance to the population variance	Pordata; 2013; %
AD4	* Index of dependent elderly	Pordata; 2016; %
AD5	* Index of dependent young people	Pordata; 2016; %
AD6	* Child mortality rate (<1 ano)	Pordata; 2017; %
AD7	* Gross birth rate	Pordata; 2016; %
ICH1	* Urban rehabilitation societies	INE;2012; Number
ICH2	* Critical areas of urban conversion and recovery	
ICH3	* Urban rehabilitation areas	

[14] Databases, period of reference and unit of measurement
[15] 1 – Yes; 0 - No

Table 1 – Indicators to measure urban sustainability in Portugal (N = 308)

Acronym	Description	Additional information about the data collected
Specific indicator: Infrastructure and competences (Batten, 2016; Bloom Consulting, 2017; Giffinger et al., 2007; Lombardi et al., 2012; Networked Society City Index 2016; Trivellato, 2016; United States Environment Protection Agency, 2016)		
ICOM1	* Establishments of pre-school, primary and secondary education	Pordata; 2016; number
ICOM2	* Pupils enrolled in pre-school, primary and secondary education	Pordata; 2016; number
ICOM3	* Total literacy rate – Resident population of 15 years and over according to the Census: total	Pordata; 2011; number
ICOM4	* Pupils enrolled in pre-school, primary and secondary education as a % of the resident population	Pordata; 2016; %
ICOM5	* Rate of completion of levels of education – Pupils in regular basic education completing the year: total	Pordata; 2016; number
General indicator: Inclusion and cohesion		
Specific indicator: Poverty and inequality (Bosch et al., 2017; Giffinger et al., 2007; Trivellato, 2016)		
PD1	* Recipients of social benefits – Recipients of Guaranteed Minimum Income and Social Insertion Income from Social Security in total active beneficiaries (%)	Pordata; 2017; %
PD2	* Residents at risk of poverty – Beneficiaries of unemployment subsidy from Social Security: total	Pordata; 2017; number
PD3	* Equity and citizenship projects	redemunicipiossaudaveis .com; 2018; number
General indicator: Social infrastructure		
Specific indicator: Health (Giffinger et al., 2007; Lombardi et al., 2012; Trivellato, 2016)		
DSA1	* Number of hospital beds – Hospital accommodation	Pordata; 2016; number
DSA2	* Health centres: appointments per inhabitant	Pordata; 2012; %
DSA3	* Inhabitants per health centre	Pordata; 2011; %
DSA4	* General and specialized hospitals	Pordata; 2016; number
DSA5	* Promotion of physical and mental well-being	redemunicipiossaudaveis .com; 2018; number
Specific indicator: Security (Bloom Consulting, 2017; Bosch et al., 2017; Giffinger et al., 2007; Networked Society City Index, 2016; Trivellato, 2016)		
DSE1	* Number of crimes: total	Pordata; 2016; number
DSE2	* PSP and GNR (police) stations	www.psp.pt/Pages/apsp /ondeEstamos.aspx?menu=2&submenu=1&qDistrito.http://www.gnr.pt/imagens/Organigrama_GNR .pdf 2018; number [2]
Sub-dimension: Environmental sustainability		
General indicator: Basic infrastructure		
Specific indicator: Energy, Water and Gas (Batten, 2016; Bosch et al., 2017; Lombardi et al., 2012)		
EGA1	* Annual energy consumption per capita – Electricity consumption per inhabitant: total	Pordata; 2016; KWH /Inhabitant
EGA2	* Natural gas consumption per capita - Natural gas consumption per inhabitant	Pordata; 2016; Nm3/inhabitant
EGA3	* Annual water consumption per capita – Water distributed/consumed per inhabitant	Pordata; 2015; m^3/ inhab
Specific indicator: Emission and production of pollutants (Batten, 2016; Bloom Consulting, 2017; Bosch et al., 2017; Lombardi et al., 2012; Networked Society City Index (2016))		
EPAT1	* Undifferentiated urban waste collected (Urban waste: total and by type of collection)	Pordata; 2016; tons
EPAT2	* Differentiated urban waste collected (Urban waste: total and by type of collection)	Pordata; 2016; tons
General indicator: Circular economy		
Specific indicator: Recycling and reuse (Batten, 2016; Bosch et al., 2017; Ligorio, 2017; Lombardi et al., 2012; Smol et al., 2017)		
RR1	* Income from waste management	INE; 2016; M.€
RR2	* Expenditure on waste management	INE; 2016; M.€
RR3	* Urban waste sent to energy recovery	Pordata; 2016; tons

Table 1 – Indicators to measure urban sustainability in Portugal (N = 308)

Acronym	Description	Additional information about the data collected
RR4	* Urban waste sent to organic recovery	Pordata; 2016; tons
RR5	* Urban waste sent to recycling	Pordata; 2016; tons
RR6	* Urban waste sent to landfill	Pordata; 2016; tons
General indicator: Environmental protection in urban areas		
Specific indicator: Territory (Artmann et al., 2017; Batten, 2016; Dhingra & Chattopadhyay, 2016; Lombardi et al., 2012; United States Environment Protection Agency, 2016)		
TER1	* Income from biodiversity and landscape protection	INE; 2016; M.€
TER2	* Expenditure on biodiversity and landscape protection	INE; 2016; M.€
TER3	* actions of environmental improvement and territorial development	redemunicipiossaudaveis.com; 2018; number
TER4	* Expenditure on air and climate protection, Protection and recuperation of soil, underground and surface water, protection against noise and vibrations, protection against radiation, R&D and other activities of environmental protection.	INE; 2016; M.€
TER5	* Income from air and climate protection, protection and recuperation of soil, underground and surface water, protection against noise and vibrations, protection against radiation, R&D and other activities to protect the environment.	INE; 2016; M.€

Source: Own elaboration

3.3. Research procedures and techniques

The data gathered to analyse urban sustainable performance in Portuguese towns and cities were treated statistically using IBM SPSS (version 25.0) software, involving three distinct procedures, as mentioned by Danielis, Rotaris, and Monte, (2018).

The first procedure was to determine the validity of the 308 observations representing around five times the number of variables analysed, to ensure no relevant information was lost. The data were also normalized, because any data aggregation must be preceded by normalization, as the indicators show different units of measure, periods of reference and missing data (El Gibari, Gómez, & Ruiz, 2018). In this study, it was decided to normalize data by *Z*-scores (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Kubrusly, 2001; Marôco, 2014; Nardo et al., 2005; OECD, 2008; Pestana & Gageiro, 2014; Stevens, 1986).

The second procedure concerns descriptive statistics of the population analysed, whose *Z*-scores converted the variables to a common scale, with the average of zero and standard deviation of one, and so this is not presented in this study (Danielis et al., 2018; El Gibari et al., 2018; Marôco, 2014; OECD, 2008). In addition, this means that the degree of dispersion was reduced to around zero for the mean and around one for the standard deviation (Castro-Higueras & de Aguilera-Moyano, 2018).

The third procedure concerns weighting, where El Gibari et al. (2018) explain that in constructing a composite index, the weights attributed to each indicator have an important effect on the total index and the results obtained. In this study, all the weights were obtained directly by applying Exploratory Factor Analysis (EFA) and the inherent Principal Components

Analysis (PCA). EFA and PCA are a multivariate statistical technique that allows cities be taken as a unit of analysis (Al Sharmin, 2011), the grouping of data that present similar significance in the sample and the restriction of principal components to retain, so that data treatment is robust (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Marôco, 2014; Pestana & Gageiro, 2014; Stevens, 1986).

Finally, to check acceptability of this technique, we applied the Kaiser–Meyer–Olkin (KMO) (Kaiser, 1974) sample suitability measure and the Bartlett sphericity. In order to verify the internal consistency of the (sub)dimensions used it is usual to calculate the Cronbach alpha, but in this study the Cronbach alpha was not considered because the *"correlations do not necessarily represent the real influence of the individual indicators on the phenomenon expressed by the composite indicator"* (OECD, 2008: 27).

4. Presentation and analysis of the results obtained

This section presents the results obtained by carrying out the procedures described in Section 3.3., in Tables 2, 3 and 4, showing that the values of the KMO (Kaiser, 1974) test are of average, good and reasonable quality to be applied to EFA (Marôco, 2014) in the sub-dimensions of economic, social and environmental sustainability, respectively.

Similarly, the communalities ($\mathbf{h}^2$) extracted (see Tables 2, 3 and 4) are above the required minimum of 0,32 (Costello & Osborne, 2005; Tabachnick & Fidell, 1996), and in the sub-dimension of economic sustainability these explain 29% of the variance, in social sustainability they explain 25% of the variance and in environmental sustainability around 34%. In addition, total variables always present loadings above the required minimum of 0,40 (Marôco, 2014). We also calculated the *"weights from the matrix of factor loadings after rotation, given that the square of factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor"* (Kubrusly, 2001; OECD, 2008: 90). Furthermore, Tables 2, 3 and 4 reveals that the weights for each variable were obtained from the product between the squared normalized loadings and the value of the explained variance for each factor.

Finally, we calculated the weights of the sub-dimensions of economic, social and environmental sustainability in the Composite Index to measure the performance of cities' urban sustainability (Table 5). Specifically, the factors' associations with the variables for each sub-dimension were determined.

Table 2 – Economic sustainability

Variable	h²	Results of Exploratory Factor Analysis – Factor 1	2	3	4	5	6	7	*Squared factor loading (scaled to unit sum)* – Factor 1	2	3	4	5	6	7
CREC1	0,811		0,665							0,151					
CREC2	0,541	0,399							0,025						
CREC3	0,728	0,813							0,104						
CREC4	0,740		0,411							0,058					
CREC5	0,702				0,454							0,135			
NEG1	0,803		0,858							0,252					
NEG2	0,664		0,776							0,206					
NEG3	0,716					0,697							0,395		
NEG4	0,788			0,758							0,296				
NEG5	0,791		0,745							0,190					
NEG6	0,916	0,759							0,090						
NEG7	0,841	0,870							0,119						
NEG8	0,829	0,836							0,110						
NEG9	0,815			0,443							0,101				
NEG10	0,679				0,738							0,356			
EMP1	0,781						0,780							0,569	
EMP2	0,751				0,651							0,277			
EMP3	0,812			0,704							0,255				
EMP4	0,866			0,838							0,362				
EMP5	0,680					0,767							0,478		
EMP6	0,803							0,883							0,780
Eigenvalue		6,37	2,92	1,94	1,53	1,23	1,07	1,00							
% Explained variance		30,35	13,88	9,26	7,31	5,84	5,08	4,75							
Total explained variance		76,46							0,397	0,182	0,121	0,095	0,077	0,067	0,062

Varimax Rotation Method; N = 308; KMO = 0,779; Bartlett SphericityTest = 4305,614; gl = 210; p < 0,000

Table 2 – Economic sustainability (Cont.)

Weights - coefficients of variables							
Variables	**Factor**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
CREC1		2,75					
CREC2	0,99						
CREC3	4,12						
CREC4		1,05					
CREC5				1,28			
NEG1		4,58					
NEG2		3,75					
NEG3					3,02		
NEG4			3,58				
NEG5		3,46					
NEG6	3,59						
NEG7	4,71						
NEG8	4,35						
NEG9			1,22				
NEG10				3,39			
EMP1						3,79	
EMP2				2,64			
EMP3			3,09				
EMP4			4,37				
EMP5					3,66		
EMP6							4,85
Total	17,76	15,59	12,26	7,31	6,68	3,79	4,85

Source: Adapted from the outputs of SPSS

Table 3 – Social sustainability

Variable	h^2	Results of Exploratory Factor Analysis – Factor 1	2	3	4	5	6	7	8	*Squared factor loading (scaled to unit sum)* – Factor 1	2	3	4	5	6	7	8
AD1	0,934	0,954								0,114							
AD2	0,891	0,929								0,109							
AD3	0,540	0,642								0,052							
AD4	0,902	0,944								0,112							
AD5	0,744	0,757								0,072							
AD6	0,500								0,678								0,430
AD7	0,763	0,613								0,047							
ICH1	0,828					0,903								0,582			
ICH2	0,656								0,796								0,592
ICH3	0,834					0,887								0,562			
ICOM1	0,893			0,932								0,400					
ICOM2	0,860	0,777								0,076							
ICOM3	0,800	0,767								0,074							
ICOM4	0,860	0,777								0,076							
ICOM5	0,799	0,846								0,090							
PD1	0,703							0,802								0,579	
PD2	0,564						0,576								0,263		
PD3	0,888				0,938								0,483				
DSA1	0,777		0,855								0,318						
DSA2	0,492	0,506								0,032							
DSA3	0,518							0,550								0,273	
DSA4	0,762		0,865								0,325						
DSA5	0,899				0,885								0,430				
DSE1	0,784						0,847								0,569		
DSE2	0,883			0,886								0,362					
Eigenvalue		7,95	2,30	2,17	1,82	1,40	1,26	1,11	1,07								
% Explained variance		31,82	9,21	8,67	7,30	5,58	5,03	4,42	4,26								
Total explained variance		76,29								0,417	0,121	0,114	0,095	0,073	0,066	0,058	0,056

Varimax Rotation Method); N = 308; KMO = 0,802; Bartlett SphericityTest:= 9623,441; gl = 300; p < 0,000

Table 3 – Social sustainability (cont.)

Variable	Weights - coefficients of variables							
	Factor							
	1	2	3	4	5	6	7	8
AD1	4,77							
AD2	4,52							
AD3	2,16							
AD4	4,67							
AD5	3,00							
AD6								2,41
AD7	1,97							
ICH1					4,27			0,00
ICH2								3,32
ICH3					4,12			
ICOM1			4,55					
ICOM2	3,16							
ICOM3	3,08							
ICOM4	3,16							
ICOM5	3,75							
PD1							3,37	
PD2						1,74		
PD3				4,61				
DSA1		3,83						
DSA2	1,34							
DSA3							1,59	
DSA4		3,92						
DSA5				4,10				
DSE1						3,76		
DSE2			4,11					
Total	35,58	7,75	8,66	8,71	8,39	5,50	4,96	5,73

Source: Adapted from the outputs of SPSS

Table 4 – Environmental sustainability

Variable	h^2	Results of Exploratory Factor Analysis – Factor 1	2	3	4	5	6	7	*Squared factor loading (scaled to unit sum)* – Factor 1	2	3	4	5	6	7
EGA1	0,888		0,925							0,468					
EGA2	0,898		0,945							0,488					
EGA3	0,763	0,792							0,160						
EPAT1	0,740	0,802							0,165						
EPAT2	0,778	0,845							0,183						
RR1	0,619	0,665							0,113						
RR2	0,696	0,652							0,109						
RR3	0,838			0,877							0,466				
RR4	0,956						0,965							0,870	
RR5	0,613	0,682							0,119						
RR6	0,913	0,638							0,104						
TER1	0,716				0,842							0,521			
TER2	0,675				0,803							0,474			
TER3	0,581							0,730							0,555
TER4	0,668					0,776							0,478		
TER5	0,700					0,809							0,519		
Eigenvalue		3,91	1,83	1,65	1,36	1,26	1,07	0,96							
% Explained variance		24,46	11,42	10,30	8,51	7,87	6,68	6,03							
Total explained variance		75,27							0,325[16]	0,152	0,137	0,113	0,105	0,089	0,080

Varimax Rotation Method); N = 308; KMO = 0,588; Bartlett Sphericity Test = 1792,370; gl = 120; p < 0,000

[16] Example of calculation: 3,91/Σ 3,91+1,83+1,65+1,36+1,26+1,07+0,96 = 0,325

Table 4 – Environmental sustainability (cont.)

Weights – coefficients of variables[17]							
Variables	**Factor**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
EGA1		7,11					
EGA2		7,42					
EGA3	5,21						
EPAT1	5,34						
EPAT2	5,93						
RR1	3,67						
RR2	3,53						
RR3			6,39				
RR4						7,73	
RR5	3,86						
RR6	3,38						
TER1				5,89			
TER2				5,36			
TER3							4,43
TER4					5,00		
TER5					5,44		
Total	30,92	14,53	6,39	11,25	10,44	7,73	4,43

Source: Adapted from the outputs of SPSS

[17] Example of calculation: (0,3247508*0,160) *100 = 5,21

Similarly, to the results obtained for the three sub-dimensions analysed, 22 significant factors were compiled to measure the sustainable performance of Portuguese towns and cities limited to the credible data available, despite still finding a shortage of data about sustainability in Portugal when this is the unit of analysis. Nevertheless, the variables used to obtain the factors are seen to present a total explained variance of above 75%, meaning that the factors obtained through EFA are explanatory and relevant (Marôco, 2014). In addition, the communalities achieved for total variables are very relevant, and so the factors retained through PCA are appropriate to report the latent correlational structure between all variables (Marôco, 2014).

So economic sustainability is determined by 7 factors, which will be discriminated and explored in the following paragraphs.

Factor 1 – **Economic activity** includes variables that portray the economic vibrancy of cities themselves and its contribution to the country's wealth, with a weight of around 18, highlighting the turnover of non-financial firms with a weight of 4,71 (NEG7). However, there is still a relevant imbalance between exports (CREC3 = 4,12) and imports (CREC2 = 0,99), understood as a synonym of Portuguese cities' recurrent dependence on the outside. Moreover, factor 1 has to be addressed simultaneously with **factor 2** – **Growth and employment** (weight of 15,59), which reflects the impact of businesses already formed (NEG5= 3,46) and those created in the period of analysis (NEG1 = 4,58) on cities' employment levels (CREC4 = 1,05), which in turn influences residents' purchasing power (CREC1 = 2,75). Also **factor 3** – **Entrepreneurship** (weight of 12,26) is directly related to factors 1 and 2, highlighting small and micro firms with a weighting above 1 (NEG9 = 1,22), and the creation of new business (self-employment) is of great significance (EMP3 = 3,09; EMP4 = 4,37). Interpretation of these results shows that local governments have concentrated on strategies to reinforce and improve their economic growth and raise their competitive advantage in connection with their sustainability, aiming to eliminate the negative effects of their demographic decline, among other aspects, creating the necessary conditions to attract talented human capital and new investment. This means that through its towns and cities, Portugal has implemented the policies defined by the European Union, whereby they take on the role of drivers and catalysts of improved economic sustainability at the macro level (Dizdaroglu & Yigitcanlar, 2014). This includes overcoming the negative effects of depopulation in some places, businesses moving to more attractive urban environments and other problems (Bere et al., 2015). Added to this evidence is the relevance of self-employment in all Portuguese towns and cities, revealing that talented, entrepreneurial and creative individuals exist and concentrate on creative businesses that contribute to generating wealth, employment and improved economic sustainability (Pozdniakova, 2017).

However, **factor 4** – **Unemployment** is still seen to be a scourge affecting the Portuguese population, and mainly young people (NEG10 = 3,39) in comparison to total unemployment (CREC5 = 1,28). It is also found that firms in Portuguese towns and cities only employ 2,69 people with higher competences (EMP2). In other words, more actions are still urgent at the local level for Portuguese towns to provide an urban environment that stimulates creativity even more, to attract more firms and individuals with higher education, for example, technology and culture-based companies, and become economically sustainable in the long term. This argument agrees with various lines of thought, in which creativity (Çetindamar & Günsel, 2012), culture (Giampietro et al., 2011; Ratiu, 2013) and technology (Hollands, 2008) are the new routes to economic sustainability, as demonstrated empirically by Cohendet and Zapata (2009).

Factor 5 – **Density of banks and firms** concerns their spread in Portuguese towns and cities, finding they have a similar weighting (NEG3 = 3,02; EMP = 3,66), since proximity to banking activities is an important amenity for companies. It is therefore underlined that facilities related to access to services are essential for firms to establish themselves in a certain place, as density is important for economic sustainability, as stated by Bibri and Krogstie (2017).

Finally, but no less importantly, **factor 6** – **New firms** and **factor 7** – **Public-private partnerships** show high weightings (EMP1 = 3,79; EMP6 = 4,85) and are mutually correlated. In other words, Portuguese towns banking on open collaboration processes is seen to be effective, specifically *Living Labs* (EMP6) networks, since these facilitate the establishment of firms with different activities and provide tangible and intangible means for them to remain in operation and progress economically. Local strategies directed to this type of partnership have been widely recommended by various authors (e.g., Asheim et al., 2007; Banks et al., 2000; Brorström et al., 2018; Camagni & Capello, 2004; Cohen & Munoz, 2015; Ferraris et al., 2018; Ratten, 2017; Vinodrai, 2006) as being crucial for economic sustainability, since all the actors are involved in matters that affect cities' sustainability and their improved economic performance (Nyström et al., 2014; Sharma & Kearins, 2011). Furthermore, these partnerships stimulate entrepreneurship in the urban context which is so essential for cities' economic dynamism, as argued by Glaeser et al. (2010).

To summarize, making Portuguese towns and cities economically sustainable has begun to be a priority for local political decision-makers, and this has been based above all on creativity, culture and partnerships, which implied process and institutional changes in the way to solve problems affecting economic sustainability in the urban context (Keiner & Schmid, 2006; Mendes, 2008). This stance by local governments corroborates the argument that economic growth should be sustained on multiple, inter-connected and dynamic activities (Cohendet & Zapata, 2009; Florea, 2015).

As for the social sustainability of Portuguese towns and cities, this is measured by 8 factors. **Factor 1** – **Demography and education** concerns the variables related to demographic changes in Portuguese towns and residents' level of education. Cities' demography presents a deficit of young people compared to the elderly (AD1 = 4,77 vs. AD2 = 4,52), which means that Portugal has a mostly aging population and the birth rate is particularly low (AD7 = 1,97). Education is balanced, as the literacy rate is 3,08 (ICOM3). In the light of these results, policies followed by political decision-makers to increase the birth rate in Portugal have fallen short of requirements, although the focus on education shows that equitable education for all citizens is visible in the towns and cities. This means that local governments have stimulated social cohesion and social inclusion as a way to reduce social inequalities and satisfy the basic needs of all residents (Dempsey et al., 2011), for example by providing everyone with access to education (Pitarch-Garrido, 2018; Pozdniakova, 2017).

Factor 2–**Health infrastructure** and **factor 3** – **Other basic infrastructure** include hospitals, schools and security, which are accessible to all citizens, with weightings between 3,83 and 4,55. These weightings are very positive, showing local authorities' concern about all residents having equitable access to basic, essential services to improve social sustainability in their towns, with this being necessary for well-being, as argued by Chan and Lee (2007), Livert and Gainza (2017), Pitarch-Garrido (2018) and Vadrevu and Kanjilal (2016).

Factor 4 – **Social projects for quality of life**, **factor 6** – **Poverty and criminality** and **factor** 7 – **Other social benefits** involve the promotion of strategies to stimulate social justice, reduce the risk of poverty and make up for the unemployment still found in some Portuguese towns, particularly small, inland ones. The final result of effective provision of social benefits, for example PD3 and DSA5, was shown by several authors (e.g., Bramley et al., 2009; Hopwood et al., 2005; Meegan & Mitchell, 2001) as contributing to social sustainability.

Factors 5 and **8** – **Urban renewal** shows the relationship between social sustainability and urban regeneration. That is, at the local level, public actions have been promoted to revitalize town centres in order to preserve their cultural identity and historic values (e.g., ICH2 = 3,32) with the inclusion of social projects to encourage the involvement of all residents, equitable distribution of wealth and social relations and networks, as described by several authors (Andreotti et al., 2012; Yiftachel & Hedgcock, 1993). Cohendet and Zapata (2009) also concluded that culture goes beyond the arts and generates wealth, specifically promoting social innovation and social inclusion (Bradford, 2004).

Finally, environmental sustainability is affected by 7 factors, which are interlinked to some extent, as described in the following paragraphs.

Factors 1, 2, 3 and **6** – **Management of waste and basic consumption** show that waste is an environmental concern in Portuguese towns and cities, with it being reused for energy and organically, as a positive consequence of selective waste disposal (EPAT2 = 5,93), i.e., there is empirical evidence that the circular economy in Portugal is in its early stages. Although the reuse of waste is still characterised by weaknesses affecting efficient and effective implementation of the circular economy model in Portuguese towns, this is noted as part of local governments' environmental sustainability strategies, as stated in the guidelines of the

European Comission (2015), that waste management should maximize added value through its reuse and minimize the use of natural resources (Ghisellini et al., 2016; Smol et al., 2017).

Factors 4, 5 and **7** – **Preservation and protection of the environment** include the financial results of managing natural resources and noise and environmental pollution (TER1, TER2, TER3, TER 4, TER5) with very high weightings, where the actions taken to achieve this reach 4,43 (TER3). This is essential because towns should include natural resources in their value chain (Sepe, 2013), these being preserved by embedding the principles of the circular economy, to become increasingly more sustainable (Ghisellini et al., 2016; Jones & Comfort, 2017; Lilja, 2015; Staniškis, 2012).

In addition, the weightings of **factors 1** to **7** associated with environmental sustainability are an indication that appropriate management of waste, natural resources and inherent circularity in the population analysed leads to network functioning, irrespective of the typology (e.g. *living lab*) so that all the synergies provided are benefited from effectively with economic and non-economic returns (Álvarez & Ruiz-Puente, 2017; European Comission, 2015; Jelinski et al., 1992; Veleva & Bodkin, 2018), originating in their correlation with social and economic sustainability (Berrone et al., 2009; Korhonen et al., 2018; Neilagh & Ghafourian, 2018; Yigitcanlar et al., 2015).

Finally, EFA applied to the urban sustainability dimension allowed reinforcing the robustness of the results obtained from individual analysis of the sub-dimensions, as the weighted impact of each sub-dimension on the urban sustainability dimension was calculated. The results obtained are shown in Table 5.

Table 5 - Exploratory Factor Analysis of the Urban Sustainability Dimension and Weightings

Sub-dimensions	**h²**	**Factor – Urban Sustainability**	**Weightings[18]**
		1	
Economic sustainability	0,621	0,788	0,386
Social sustainability	0,393	0,627	0,245
Environmental sustainability	0,593	0,770	0,369
Eigenvalue		1,61	
% explained variance		53,60	
Total explained variance		53,60	

Varimax Rotation Method; N = 308; KMO = 0,598; Bartlett SphericityTest = 83,775; gl = 3; p < 0,000; **h^2** >or close to 0,4 loadings>0.40

Source: Adapted from the outputs of SPSS

The results in Table 5 show that the KMO test reveals a reasonable quality of data and that the communalities extracted are above 0,39, explaining 16% of the variance and justifying that the weightings obtained are situated between 0,2 and 0,39. In addition, these weightings show that Portuguese towns' urban sustainability still requires the adoption of more effective measures, mainly in relation to social sustainability. Another conclusion indicated by these weightings is

[18] Example of calculation for economic sustainability: 0,788^2/1,61 = 0,386

that their proximity reveals they are inter-related and that the actions implemented in economic terms have social and environmental impacts, as argued by Korhonen et al. (2018). Moreover, the use of intangible resources, such as human and creative capital, shown by the birth of new self-employed businesses and focusing on *living labs,* is a catalyst leading to urban sustainability (Forte, 2011; Pozdniakova, 2017).

Discussion of the above results finds theoretical support in the concept of sustainability adopted in this study, where the sub-dimensions analysed imply the balance between them and cannot be dissociated from culture, historic values and urban regeneration (Albino et al., 2015; Camagni et al., 1998; Folke, 2006; Phearson et al., 2016; Ratten, 2017; Tranos & Gertner, 2012), which in turn are influenced by good governance practices (Pozdniakova, 2017) and by the participation of all actors in solving matters of urban sustainability in their towns and cities (Oakley & Ward, 2018) for improved quality of life (Agyeman et al., 2002).

5. Contributions and implications

Today, for a city to be competitive, this implies possessing the essential competences to respond pro-actively to the challenges and changes required to face the demands of urban sustainability, which cannot be postponed. This is because cities are seen as places concentrating people, businesses and social and cultural activities as tangible and intangible assets that must be managed in a circular way (e.g., European Comission, 2015) and in a network (e.g., Brorström et al., 2018; Ferraris et al., 2018) to achieve the desired sustainability. However, four-fold urban sustainability – economic, social, environmental and cultural pillars - (Dizdaroglu & Yigitcanlar, 2014; Oakley & Ward, 2018) involves great complexity, and performance must be measured jointly rather than by each pillar individually (e.g., Collins, Mahon, & Murtagh, 2018) and by using financial and non-financial indicators (e.g., Speklé & Verbeeten, 2014) associated with creativity/culture, as corroborated by Duxbury et al. (2016), Furtado and Alves (2012) and Silva and Tarouco (2016).

The importance of measuring urban sustainability jointly and holistically originated the development of countless quantitative and qualitative indices, but with scientific robustness that fell short of what is necessary, and mostly without a joint approach of all the pillars of sustainability. Therefore, one of the contributions of this study lies in presenting a Composite Index to measure credible urban sustainability that can be applied generally in any geographical context, as a methodological tool whose robustness was confirmed by EFA and PCA, indicated as appropriate multivariate statistical techniques for this typology of indices and calculation of scientific weightings (e.g., El Gibari et al., 2018; Nardo et al., 2005). Another contribution lies in the systematic review of various indices, aiming to compile the most commonly used indicators to measure cities' urban sustainability with the necessary theoretical support. These two contributions form the implications for theory, as there was confirmation of the existence of theoretical frameworks and individual studies about economic, social, environmental and cultural urban sustainability that can be transformed in a single index for generalized application, irrespective of the adaptation to each territorial situation *per se*, in which the final weighting of each sub-dimension has scientific value. Therefore, one of the objectives defined in this study was attained, by identifying the sub-dimensions and essential indicators grouped in a single index, for a city to be sustainable.

As for the contributions and implications for practice, the Composite Index was applied at the micro territorial level in Portugal – 308 towns and cities – , which forms the fundamental contribution of this study. This means that the empirical evidence obtained in Portugal shows that the Composite Index allows the grouping of cities' complex and multidimensional situations regarding data about urban sustainability, and in this way concluding about their performance holistically as well as overcoming the dispersion of data. This practical contribution responds to the other objective proposed in this study, since the weightings for each sub-dimension identified were presented. The implications for practice are perceptible in determining those weightings for Portuguese towns and cities, something that had not been done before in the country, added to filling the gaps identified in the literature such as establishing the bridge between sustainability and creativity/culture (Cabrita et al., 2013; Cohen et al., 2017; Della Lucia et al., 2017), the importance of cities belonging to open network platforms, such as *living labs* (Echebarria et al., 2016; Ferraris et al., 2018; Walker & Hills, 2012) and the urgent need to find out urban areas' sustainable performance (Nevens et al., 2013).

6. Limitations and future research agenda

Like any study, this one is not without limitations. One concerns the subjectivity present in selecting the indices/indicators used, given the poor availability of data in terms of towns/cities and the fact of their choice having to consider the characteristics of a good indicator. This scenario suggests that the competent authorities should be pressed to conceive new compact databases with information about the variables determining micro and macro sustainability in Portugal, so that subsequent studies can increase the number of indicators used and go on to replicating application of the Composite Index developed and concluding about its evolution.

Another limitation concerns the question of having studied only the dimension of towns' sustainability, as towns are collective and individual places covering multifaceted, diversified, tolerant, open and intelligent aspects. In other words, the performance of towns and cities in Portugal and in any geographical context is realistic only if all their dimensions – Creativity, Intelligence and Urban Sustainability – are studied through quantitative techniques simultaneously. It is therefore suggested that an empirical study should be made to show the weightings of each of those dimensions in the financial and non-financial performance of towns, countries and regions worldwide.

The lack of detailed data about the use of ICT in achieving sustainability is another limitation in need of future research.

The last limitation is related to the Composite Index only being applied in Portugal, and so its application in other countries is suggested, followed by a comparative study.

7. Final comments

In currents towns and cities, concerns about economic, cultural, social and environmental issues have come to be a priority in their governance, and there is an urgent need for four-fold indices of urban sustainability so that political decision-makers have a tool to measure and assess their policies on sustainability. However, these indices must take into consideration all the sub-dimensions of sustainability mentioned, be flexible enough to include new indicators (e.g., circular economy) and adaptable to the context in which they are applied. Composite Indices have an increasingly preponderant role in assessing and measuring cities' sustainable performance so that corrective measures can be taken to achieve the sustainability desired for the world.

Similarly to other towns and cities in Europe and worldwide, Portuguese ones face the same aims and problems of urban sustainability, and these were shaken in recent years by the effects of the economic and financial crisis regarding equitable distribution of wealth and social justice, as well as by the environmental effects of climatic and other changes on citizens' quality of life. Consequently, policy orientation in Portugal, nationally and implemented locally, has begun to reflect the will and decision to make towns and cities sustainable, without neglecting their cultural traditions and simultaneously highlighting creativity, to make them attractive to human, social and financial capital, as defined by the European Union (sustainable, inclusive and intelligent growth).

This change in political strategies in Portugal and Europe has aroused the interest of the academic community and other institutions in presenting their positive results in towns and countries, and so countless indices have been developed theoretically. But their practical application has been in densely populated urban areas, for example, capital cities rather than for all towns and cities in the same countries. In addition, the majority attribute weightings to the sub-dimensions and indicators without using scientific methods. Given this panorama, the originality of this study lies in presenting a scientific and robust collection of indicators and their proxies to measure cities' urban sustainability, whatever their population density – Composite Index -, as a tool to help in cities' governance, where collective and individual participation, the use of intelligence (ICT) and banking on partnerships and networks are all fundamental.

Summarizing, this research topic is of continuing relevance, as shown in the future agenda, and so it is crucial that towns and cities begin to be used more as units of analysis in empirical terms in order to contribute to enhancing scientific knowledge about urban sustainability. Towns and cities are the means whereby the world can reach the desired and necessary sustainable balance between all its pillars, which are inseparable in the present and future.

References

Adnan, Y. M., Hamzah, H., & Alias, A. (2016). An initiatives-based framework for assessing smart city. *Planning Malaysia Journal*, *14*(5), 13-22.

Agyeman, J., Bullard, R. D., & Evans, B. (2002). Exploring the nexus: Bringing together sustainability, environmental justice and equity. *Space and polity*, *6*(1), 77-90.

Ahvenniemi, H., Huovila, A., Pinto-seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities ? *Cities*, *60*, 234–245.

Al Sharmin, A. (2011). *A Composite Index to Assess the Regional Development: A Districts-Level analysis*. VDM Publishing.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 1–19.

Albrechts, L. (2013). Trends and policies in Strategic Spatial Planning and Regional Governance in Europe. *Territorial Cohesion in Europe: For the 70th Anniversary of the Transdanubian Research Institute*, 168-177. Available online: http://www.rkk.hu/rkk/conference/2013/dti70/presentations/Albrechts.pdf.

AlQahtany, A., Rezgui, Y., & Li, H. (2013). A proposed model for sustainable urban planning development for environmentally friendly communities. *Architectural Engineering and Design Management*, *9*(3), 176-194.

Álvarez, R., & Ruiz-Puente, C. (2017). Development of the Tool SymbioSyS to Support the Transition Towards a Circular Economy Based on Industrial Symbiosis Strategies. *Waste and Biomass Valorization*, *8*(5), 1521–1530.

Ameen, R. F. M., Mourshed, M., & Li, H. (2015). A critical review of environmental assessment tools for sustainable urban design. *Environmental Impact Assessment Review*, *55*, 110–125.

Andreotti, A., Mingione, E., & Polizzi, E. (2012). Local Welfare Systems: A Challenge for Social Cohesion. *Urban Studies*, *49*(9), 1925–1940.

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities*, *41*, S3–S11.

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 4–28.

Artmann, M., Kohler, M., Meinel, G., Gan, J., & Loja, I. (2017). How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecological Indicators*, (June), 1-13.

Asheim, B., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670.

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1), 45-64.

Ballas, D. (2013). What makes a happy city'? *Cities*, *32*, S39-S50.

Banks, M., Lovatt, A., O'Connor, J., & Raffo, C. (2000). Risk and Trust in the Cultural Industries. *Geoforum* , *31*(4), 453–464.

Batten, J. (2016). Sustainable Cities Index 2016. *Arcadis Global*, 10. Available online: https://www.arcadis.com/media/0/6/6/%7B06687980-3179-47AD-89FD-F6AFA76EBB73%7DSustainable Cities Index 2016 Global Web.pdf.

Berardi, U. (2013). Sustainability assessment of urban communities through rating systems. *Environment, Development and Sustainability.*, *15*(6), 1573–1591.

Bere, R. C., Precup, I. B., & Silvestru, C. I. (2015). On growth poles from EU Countries in the framework of Europe 2020. *Procedia economics and finance*, *23*, 920-925.
Berrone, P., Gelabert, L., & Fosfuri, A. (2009). The Impact of Symbolic and Substantive Actions on Environmental Legitimacy. *Working Paper*, *3*, 1–30.
Bibri, S. E. (2015). The Shaping of Ambient Intelligence and the Internet of Things. (Vol. 10). Amsterdam: Atlantis Pres.
Bibri, S. E., & Krogstie, J. (2017). On the social shaping dimensions of smart sustainable cities: A study in science, technology, and society. *Sustainable Cities and Society*, *29*, 219–246.
Bifulco, F., Tregua, M., Amitrano, C. C., & D'Auria, A. (2016). ICT and sustainability in smart cities management. *International Journal of Public Sector Management*, *29*(2), 132–147.
Bloom Consulting. (2017). Portugal ConsultingCity Brand Ranking 2016 - Municípios Portugueses. *Bloom Consulting Countries Regions and Cities*, 1–56. Available online: http://www.bloom-consulting.com.
Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.
Bradford, N. (2004). Creative Cities: Structured Policy Dialogue Backgrounder. Ottawa: Canadian Policy Research Networks.
Bramley, G., Dempdey, N., Power, S., Brown, C., & Watkins, D. (2009). Social sustainability and urban form: Evidence from five British cities. *Environment and Planning A*, *41*(9), 2125–2142.
Brorström, S., Argento, D., Grossi, G., Thomasson, A., & Almqvist, R. (2018). Translating sustainable and smart city strategies into performance measurement systems. *Public Money & Management*, *38*(3), 193–202.
Burton, E. (2000). The Compact City: Just or Just Compact? A Preliminary Analysis. *Urban Studies*, *37*(11), 1969–2006.
Cabrita, M. D. R., Cruz-Machado, V., & Cabrita, C. (2013). Managing creative industries in the context of knowledge-based urban development. *International Journal of Knowledge-Based Development*, *4*(4), 318–337.
Camagni, R., & Capello, R. (2004). The City Network Paradigm : Theory and Empirical Evidence. In *Urban Dynamics and Growth: Advances in Urban Economics* (pp. 495-529). Emerald Group Publishing Limited.
Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: An economy-environment technology nexus. *Ecological Economics*, *24*(1), 103–118.
Castro-Higueras, A., & de Aguilera-Moyano, M. (2018). Assessing creativity: an index proposal. *Creative Industries Journal*, *11*(1), 102–118.
Cavalcanti, C. (1995). *Sustentabilidade da economia: paradigmas alternativos de realização econômica. Desenvolvimento e natureza: estudos para uma sociedade sustentável.* São Paulo: Cortez.
Çetindamar, D., & Günsel, A. (2012). Measuring the Creativity of a City: A Proposal and an Application. *European Planning Studies*, *20*(8), 1301–1318.
Chan, E., & Lee, G. K. L. (2007). Critical factors for improving social sustainability of urban renewal projects. *Social Indicators Research*, *85*(2), 243–256.
Cohen, B., Almirall, E., Chesbrough, H. (2016). The City as a Lab: open innovation meets the collaborative economy. *California Management Review*, *59*(1), 5–13.
Cohen, B., & Muñoz, P. (2015). Toward a Theory of Purpose-Driven Urban Entrepreneurship. *Organization & Environment*, *28*(3), 264-285.
Cohendet, P., & Zapata, S. (2009). Innovation and Creativity : Is there economic significance to the creative city ? *Management International*, *13*, 23–26.
Collins, P., Mahon, M., & Murtagh, A. (2018). Creative industries and the creative economy of the West of Ireland: evidence of sustainable change? *Creative Industries Journal*, *11*(1), 70–86.
Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.
Cretu, L. G. (2012). Smart Cities Design using Event-driven Paradigm and Semantic Web. *Informatica Economica*, *16*(4), 57–67.
d'Ovidio, M., & Cossu, A. (2017). Culture is reclaiming the creative city: The case of Macao in Milan, Italy. *City, Culture and Society*, *8*, 7–12.
Danielis, R., Rotaris, L., & Monte, A. (2018). Composite indicators of sustainable urban mobility:

Estimating the rankings frequency distribution combining multiple methodologies. *International Journal of Sustainable Transportation*, *12*(5), 380–395.

Della Lucia, M., Trunfio, M., & Go, F. M. (2017). Heritage and Urban Regeneration: Towards Creative Tourism. In *Tourism in the City* (pp. 179-191). Springer, Cham.

Dempsey, N., Bramley, G., Power, S., & Brown, C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable development*, *19*(5), 289-300.

Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563.

Dizdaroglu, D., & Yigitcanlar, T. (2014). A parcel-scale assessment tool to measure sustainability through urban ecosystem components: The MUSIX model. *Ecological Indicators*, *41*, 115–130.

Duxbury, N., Hosagrahar, J., & Pascual, J. (2016). Why must culture be at the heart of sustainable urban development? *Agenda 21 for Culture*.

Echebarria, C., Barrutia, J. M., Aguado, I., Apaolaza, V., & Hartmann, P. (2016). Capturing the benefits that emerge from regional sustainability networks: The Castile-La Mancha network of sustainable cities and towns. *Papers in Regional Science*, *95*, S27–S49.

El Gibari, S., Gómez, T., & Ruiz, F. (2018). Building composite indicators using multicriteria methods: a review. *Journal of Business Economics*, 1–24.

Elkington, J. (1994). Towards the sustainable corporation: win–win–win business strategies for sustainable development. *California Management Review*, *36*(2), 90–100.

European Comission. (2014). *Modernisation of Higher Education in Europe: Access, Retention and Employability 2014*. *American Salon* (Vol. 137).

European Comission. (2015). An EU action plan for the circular economy, *614*, 21. Available online: https://ec.europa.eu/growth/industry/sustainability/circular-economy_en.

Fahy, F., & Cinnéide, M. Ó. (2006). Community-based quality of life indicators for urban areas as derived in Galway City, Ireland. *WIT Transactions on Ecology and the Environment*, *93*, 691-702.

Ferraris, A., Santoro, G., & Papa, A. (2018). The cities of the future: Hybrid alliances for open innovation projects. *Futures*, 1-23.

Fischer, J. M., & Amekudzi, A. (2011). Quality of life, sustainable civil infrastructure, and sustainable development: strategically expanding choice. *Journal of urban planning and development*, *137*(1), 39-48.

Florea, C. A. (2015). Creative and Innovative Cities–A New Perspective for Sustainable Development. *Network Intelligence Studies*, (5), 49-54.

Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.

Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life)*. (Basic Books, Ed.). New York.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267.

Forte, F. (2011). City Design, Creativity, Sustainability. In Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives*. (pp. 289–321).

Funk, J. L. (2015). IT and sustainability: New strategies for reducing carbon emissions and resource usage in transportation. *Telecommunications Policy*, *39*(10), 861–874.

Furtado, G., & Alves, S. (2012). Cidades criativas em Portugal e o papel da arquitetura : Mais uma estratégia a concertar. *Revista Crítica de Ciências Sociais*, (99), 125-140.

Gertler, M. S. (2004). *Creative cities: What are they for, how do they work, and how do we build them?* (pp. 1-13). Ottawa: Canadian Policy Research Networks.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy : the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11-32.

Giampietro, M., Gamboa, G., & Lobo, A. (2011). The Urban Metabolic Pattern: Dynamics and Sustainability. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable City and Creativity: Promoting Creative Urban Initiatives* (pp. 323–338).

Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart*

cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf.
Glaeser, E. L., Rosenthal, S. S., & Strange, W. C. (2010). Urban economics and entrepreneurship. *Journal of Urban Economics*, *67*(1), 1–14.
Gouvea, R., Kapelianis, D., & Kassicieh, S. (2017). Assessing the nexus of sustainability and information & communications technology. *Technological Forecasting and Social Change*, *130*, 39-44.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Haughton, G. (1999). Environmental justice and the sustainable city. *Journal of Planning Education and Research*, *18*(3), 233–243.
Hawkes, J. (2001). The Fourth Pillar of Sustainability: Culture's essential role in public planning. *Common Ground*.
He, J. L., & Gebhardt, H. (2014). Space of creative industries: a case study of spatial characteristics of creative clusters in Shanghai. *European planning studies*, *22*(11), 2351-2368.
Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320.
Hopwood, B., Mellor, M., & O'Brien, G. (2005). Sustainable development: mapping different approaches. *Sustainable development*, *13*(1), 38-52.
Irungbam, R. S. (2016). The Model of Smart Cities in Theory and in Practice. *Journal for Studies in Management and Planning*, *2*(4), 156-187.
Jain, H. (2011). Green ICT Organizational Implementations and Workplace Relationships. In *Handbook of Research on Green ICT: Technology, Business and Social Perspectives* (pp. 146-168). IGI Global.
Jelinski, L. W., Graedel, T. E., Laudise, R. a, McCall, D. W., & Patel, C. K. (1992). Industrial ecology: concepts and approaches. *Proceedings of the National Academy of Sciences*, *89*(3), 793–797.
Jones, P., & Comfort, D. (2017). Towards the circular economy : A commentary on corporate approaches and challenges. *Journal of Public Affairs*, *17*(4), e1680.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.
Keiner, M., & Schmid, W. A. (2006) On the way to Gigapolises : can global urban development become sustainable ? *WIT Transactions on Ecology and the Environment*, *93*, 169-178.
Kirchberg, V., & Kagan, S. (2013). The roles of artists in the emergence of creative sustainable cities: Theoretical clues and empirical illustrations. *City, Culture and Society*, *4*(3), 137–152.
Komeily, A., & Srinivasan, R. S. (2015). A need for balanced approach to neighborhood sustainability assessments: A critical review and analysis. *Sustainable Cities and Society*, *18*, 32-43.
Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy : The Concept and its Limitations. *Ecological Economics*, *143*, 37–46.
Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.
Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.
Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.
Ligorio, V. (2017). New economic development pattern: from a linear to a circular economy, a challenge for eu's economy. *Міжнародний Науковий Журнал Інтернаука International Scientific Journal of International Science*, *1*(2), 20–23.
Lilja, R. K. (2015). Policy instruments for promoting material efficiency: case of Finland. *Clean Technologies and Environmental Policy*, 17(7), 2029-2040.
Livert, F., & Gainza, X. (2017). Distributive politics and spatial equity: the allocation of public investment in Chile. *Regional Studies*, *52*(3), 403–415.
Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation*, *25*(2), 137–149.
Lu, W. M., Kweh, Q. L., Hung, S. W., Chou, H. C., & Yang, K. C. (2018). Exploring the cultural and creative promotion performance in Taiwan: A network-based ranking approach. *Infor*, *56*(1), 115–135.

Marôco, J. (2014). *Análise estatística com o SPSS Statistics.*

McManus, P. (1996). Contested terrains: Politics, stories and discourses of sustainability. *Environmental Politics*, *5*(1), 48–73.

Meegan, R., & Mitchell, A. (2001). “It’s not community round here, it’s neighbourhood”: Neighbourhood change and cohesion in urban regeneration policies. *Urban Studies*, *38*(12), 2167–2194.

Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.

Meijer, A., & Bolivar, M. P. R. (2016). Governing the smart city : a review of the literature on smart urban governance governance. *International Review of Administrative Sciences*, *82*(2), 392-408.

Mendes, W. (2008). Implementing social and environmental policies in cities: The case of food policy in Vancouver, Canada. International Journal of Urban and Regional Research, 32(4), 942-967.

Molnar, D , Morgan, A., & Bell, D. (2001) *Defining Sustainability, Sustainable Development and Sustainable Communities: A working paper for the Sustainable Toronto Project*. Available online: https://www.google.com.tw/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwilje3xnLDeAhUKdt4KHTs0DEcQ FjAAegQICBAC&url=http%3A%2F%2Fsites.utoronto.ca%2Fenvstudy%2Fsustainabletoronto%2Fresource s%2FSustainableTorontoDefinitionsPaper-FinalDraft.doc&usg=AOvVaw3FreTQcwerwSBvQ5-MbUc.

Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review*, *32*(1), 94–106.

Muñoz, P., & Cohen, B. (2016). The making of the urban entrepreneur. *California Management Review*, *59*(1), 71-91.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis*, *EUR 21682* (December), 134.

Neilagh, Z. M., & Ghafourian, M. (2018). Evaluation of Social Sustainability in Residential Neighborhoods. *European Journal of Sustainable Development*, *7*(1), 209–217.

Networked Society City Index (2016). *Cities play key role in sustainable development. Available onlibe: https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.*

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: Co-creating transformative action for sustainable cities. *Journal of Cleaner Production*, *50*, 111–122.

New Economics Foundation (NEF). (2015). *Five headline indicators of national success - A clearer picture of how the UK is performing. London, UK.*

Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495.

Oakley, K., & Ward, J. (2018). The art of the good life: culture and sustainable prosperity. *Cultural Trends*, *27*(1), 4–17.

OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.

Peda, P., Argento, D., & Grossi, G. (2013). Governance and Performance of a Mixed Public-Private Enterprise: An Assessment of a Company in the Estonian Water Sector. *Public Organization Review*, *13*(2), 185–196.

Pérez-Urrestarazu, L., Fernández-Cañero, R., & Franco-Salas, A. (2017). Vertical Greening Systems and Sustainable Cities. Vertical. *Journal of Urban Technology*, *22*(4), 65-85.

Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS.*

Phearson, T. M., Pickett, S. T. A., Grimm, N. B., Niemelä, J., Alberti, M., Elmqvist, T., … Qureshi, S. (2016). Advancing Urban Ecology toward a Science of Cities. *BioScience*, *66*(3), 198–212.

Pitarch-Garrido, M. D. (2018). Social Sustainability in Metropolitan Areas: Accessibility and Equity in the Case of the Metropolitan Area of Valencia (Spain). *Sustainability*, *10*(2), 371.

Pozdniakova, A. (2017). Smart sustainable cities: the concept. *Acta Innovations*, *22*, 5–19.

Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular Cities: Mapping Six Cities in

Transition. *Environmental Innovation and Societal Transitions*, *26*, 171–194.
Ratiu, D. E. (2013). Creative cities and/or sustainable cities: Discourses and practices. *City, Culture and Society*, *4*(3), 125–135.
Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.
Saisana, M. and Tarantola, S., (2002). "State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development", European Commission, Joint Research Centre, Ispra, Italy, EUR 20408 EN.
Sepe, M. (2013). Urban history and cultural resources in urban regeneration: a case of creative waterfront renewal. *Planning Perspectives*, *28*(4), 595–613.
Sharma, A., & Kearins, K. (2011). Interorganizational collaboration for regional sustainability: What happens when organizational representatives come together? *Journal of Applied Behavioral Science*, *47*(2), 168–203.
Siegel, K. (2016). Can Regional Cooperation Promote Sustainable Development? In J. Grugel & D. Hammett (Eds.), *The Palgrave Handbook of International Development* (pp. 713–730).
Silva, T. &, & Tarouco, F. (2016). A concepção de cidades criativas sustentáveis. *MIX Sustentável*, *2*(2), 67–72.
Skrede, J. (2016). What may culture contribute to urban sustainability? Critical reflections on the uses of culture in urban development in Oslo and beyond. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *9*(4), 408-425.
Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy*, *19*(3), 669–678.
Speklé, R. F., & Verbeeten, F. H. M. (2014). The use of performance measurement systems in the public sector: Effects on performance. *Management Accounting Research*, *25*(2), 131–146.
Staníčková, M., & Melecký, L. (2018). Understanding of resilience in the context of regional development using composite index approach: the case of European Union NUTS-2 regions. *Regional Studies, Regional Science*, *5*(1), 231–254.
Staniškis, J. K. (2012). Sustainable consumption and production: How to make it possible. *Clean Technologies and Environmental Policy*, *14*(6), 1015–1022.
Stevens, J. (1986). Chapter 11 - Exploratory and Confirmatory Factor Analysis. In L. E. Associates. (Ed.), *Applied multivariate statistics for the social sciences*. New Jersey. USA.
Suzuki, H., Dastur, A., Moffatt, S., Yabuki, N., & Maruyama, H. (2010). *Eco2 Cities Ecological Cities as Economic Cities*. *The world bank*: Washington, WA, USA.
Tabachnick, B. G., & Fidell, L. S. (1996). *sing Multivariate Statistics*. (3rd ednHarper Collins. New York, Ed.).
Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.
Trivellato, B. (2016). How can ' smart ' also be socially sustainable ? Insights from the case of Milan. *European Urban and Regional Studies*, 24(4), 337-351.
Turcu, C. (2013). Re-thinking Sustainability Indicators: local perspectives of urban sustainability. *Journal of Environmental Planning and Management*, *56*(5), 695–719.
United States Environment Protection Agency. (2016). *Framework for Creating a Smart Growth Economic Development Strategy : a Tool for Small Cities and Towns*. Available online: https://www.epa.gov/smartgrowth/framework-creating-smart-growth-economic-development-strategy.
Vadrevu, L., & Kanjilal, B. (2016). Measuring spatial equity and access to maternal health services using enhanced two step floating catchment area method (E2SFCA) - A case study of the Indian Sundarbans. *International Journal for Equity in Health*, *15*(1), 1–12.
Veleva, V., & Bodkin, G. (2018). Corporate-entrepreneur collaborations to advance a circular economy. *Journal of Cleaner Production*, *188*, 20–37.
Vinodrai, T. (2006). Reproducing Toronto's Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. *Economic Geography*, *82*(3), 237–263.
Walker, R. M., & Hills, P. (2012). Partnership Characteristics, Network Behavior, and Publicness: Evidence on the Performance of Sustainable Development Projects. *International Public Management Journal*, *15*(4), 479–499.
Wang, Y., Chen, Y., & Benitez-Amado, J. (2015). How information technology influences environmental performance: Empirical evidence from China. *International Journal of Information Management*, *35*(2), 160–170.
Wu, S. J., & Raghupathi, W. (2015). The Strategic Association between Information and

Communication Technologies and Sustainability: A Country-Level Study. *Journal of Global Information Management*, *23*(3), 92–115.

Yiftachel, O., & Hedgcock, D. (1993). Urban social sustainability. *Cities*, *10*(2), 139–157.

Yigitcanlar, T., Dur, F., & Dizdaroglu, D. (2015). Towards prosperous sustainable cities: A multiscalar urban sustainability assessment approach. *Habitat International*, *45*(P1), 36–46.

CHAPTER 7

COMPOSITE INDEX TO MEASURE THE PERFORMANCE OF CURRENTS CREATIVE CITIES: A HOLISTIC PERSPECTIVE

ABSTRACT

The urgency to make currents cities competitive has made political decision-makers focus on strategies oriented towards creativity, intelligence and urban sustainability. This scenario has led to the need to measure, assess and monitor the effects of those strategies on cities' performance. Therefore, this study aims to present the scientific and robust weighting of the creativity, intelligence and urban sustainability dimensions in cities' holistic, integrated and overall performance. Implicit in this objective is the previous construction of Composite Indices for each of those dimensions. In this context, Exploratory Factor Analysis was found to be appropriate to respond to this aim, with empirical evidence being obtained in Portugal. The results show a weighting of 38%, 23,4% and 38,6% for creativity, intelligence and urban sustainability respectively. The contributions and implications for theory and practice, followed by indications for future research and the conclusions are also presented.

KEY-WORDS: Creativity, Intelligence, Urban Sustainability, Composite Index, Performance, Cities

1. Introduction

Cities are increasingly seen as the main driver of regional and global economic development, irrespective of their population density or geographical context. However, some duality has persisted in the emphasis of local governments and central political decision-makers regarding the strategies adopted and the inherent investment. Given this scenario, the European Union (EU), aiming for European Cities characterised by competitiveness and territorial and social cohesion, defined strategies to be implemented at the micro level – cities – by member countries so that inclusive, intelligent and sustainable growth can become a reality (Eurostat, 2015).

In this context, interest has been aroused in the academic community regarding cities and the route they have chosen to grow in all their dimensions. Currents cities are multi-dimensional and pluralist, places conciliating the historical past with the future, culture with economic factors, talents, technology and business with sustainability and with creativity (Ratten, 2017), so that wealth creation can be demonstrated and supported by tri-partite pillars – creativity, intelligence and urban sustainability – to allow long-term growth and sustained performance. Obviously, this path is an enormous challenge for political decision-makers and local governments, as these objectives imply multiple transformations (Bouton et al., 2013), going beyond the traditional models of economic growth and including both tangible and intangible factors (Romero-Padilla, Navarro-Jurado, & Malvárez-García, 2016). This means that the strategies implemented and to be implemented in cities should be directed to strategic governance of spaces and places (Audretsch, 2003; Malecki, 2007), towards people and not simply organisational structures (Audretsch, 2003).

This paradigmatic change in the role of currents cities in economic growth has given rise to a vast amount of literature (e.g., Cabrita, Cruz-Machado, & Cabrita, 2013; Florida, 2002, 2005; Girard, Baycan, & Nijkamp, 2011; Landry, 2000; Letaifa, 2015; Mcgranahan & Wojan, 2007; Ortegel, 2017; Rahbarianyazd & Doratli, 2017; Ratiu, 2013; Scott, 2006; Tranos & Gertner, 2012) on this topic, directed towards creative, intelligent and sustainable cities, to the connection between culture, urban regeneration, collaboration processes and partnerships, and economic and non-economic factors of the multi-dimensional performance of cities today. This heterogeneity of theoretical and empirical studies has stimulated the development of indices to measure cities' performance regarding their creativity (e.g., European Union, 2017; Florida, 2002, 2005; Mellander & Stolarick, 2008; Giffinger et al., 2007; Kakiuchi, 2016), intelligence (e.g., Angelidou, 2017; Ernst & Young, 2016; Picard, Grönlund, & Toivonen, 2003) and sustainability (e.g., European Commission, 2014; Irungbam, 2016; Trivellato, 2016).

However, these indices have not yet filled existing gaps in the literature on measurement of cities' performance as a whole, noting a shortage of studies including the dimensions of creativity, intelligence and sustainability in a single index with the required scientificity. In addition, the most studied topics have been global cities, incredible cities, city networks and city paradigms in social, ecological and cultural terms (Nijkamp & Kourtit, 2013). In this area, there is a steady production of empirical studies addressing cities' performance (Malecki, 2007) through indices showing a compilation of indicators in the various dimensions characterising cities (Borén & Young, 2013; Flores & Teixeira, 2017), with a great number of variables and for large samples (Çetindamar & Günsel, 2012). Another gap identified concerns the relevance of including performance indicators that ally creativity and culture to sustainability (Cabrita et al., 2013; Cohen, Almirall, & Chesbrough, 2016; Della Lucia, Trunfio, & Go, 2017); networks and their synergies for cities' sustainable (Echebarria et al., 2016; Ferraris, Santoro, & Papa, 2018; Walker & Hills, 2012) and intelligent (Bifulco et al., 2017; Cohen et al., 2016; Tranos & Gertner, 2012) performance. Another fundamental gap identified in the extensive literature concerns filling the existing gap between theory and practice (Lee, Hancock, & Hu, 2014), leading to Mora, Bolici, and Deakin (2017) calling for more studies designing holistic models of how current cities are built and about the scientific instruments that can help all the actors involved in that construction (Huovila et al., 2016; Priano & Guerra, 2014).

Aiming to fill these gaps, this study aims to present scientific and robust weighting of the creativity, intelligence and urban sustainability dimensions in cities' holistic, integrated and global performance. This objective implies the previous construction of Composite Indices for each of those dimensions. Howeve, a composite indicator is an aggregate of all dimensions, objectives, individual indicators and variables used (OECD, 2008). Thus, in this study the composite index is used as an auxiliary means for calculating the weights of each dimension/sub-dimension.

Among the various contributions of this empirical study, the main one lies in presenting a Composite Index for the holistic performance of currents creative cities with the respective scientific weightings.

2. Literature review

2.1. Dimensions of currents creative cities

The new role attributed to currents cities concerning economic growth has caused a certain ambiguity around the concept itself and the dimensions included, which means studies on cities should be holistic and integrated. The literature on this topic highlights creativity (e.g., Florida, 2002, 2005; Grant & Kronstal, 2010; Hospers & Pen, 2008; Kakiuchi, 2016; Kong, 2014; Landry, 2000; Pratt, 2008; Ratten, 2017; Scott, 2000), intelligence (e.g., Bouk et al., 2017; Dodgson & Gann, 2011; Letaifa, 2015; Mardikyan et al., 2015; Nam & Pardo, 2011; Ratten, 2017) and urban sustainability (e.g., Camagni, Capello, & Nijkamp, 1998; Cavalcanti, 1995; Elkington, 2004; Pozdniakova, 2017; Wheeler & Beatley, 2014) as inseparable dimensions of cities at the present time. These dimensions point us towards simultaneously creative, intelligent and sustainable cities, and these are defined as possessing a creative, diversified, open and tolerant climate, creative talents and relevant cultural dynamics (Florida, 2005; Grant & Kronstal, 2010; Romein & Trip, 2009), provided by participative governance, the adoption of technology, and recognition of the social, human, physical, cultural and natural capital in which social and environmental questions are included (Bibri & Krogstie, 2017; Ratten, 2017). This means that current cities' overall performance must be addressed in a tri-partite and holistically integrated way.

This holistic approach to currents cities aims to show that they must be provided with creative/favourable environments to stimulate the attraction and interaction of talented people and the fulfilment of cultural synergies, in articulation with the co-creation of economic value and with a catalysing effect in promoting urban regeneration and thereby achieving urban sustainability (Furtado & Alves, 2012). However, the advantages of intelligence must be indexed to those driving forces, to make cities even more attractive and entrepreneurial (Caragliu, Del Bo, & Nijkamp, 2011). Furthermore, creativity in cities arises from the catalysing benefit of culture through restoration and regeneration of cultural heritage as a driver of the economy by encouraging synergies, networks and partnerships between all stakeholders in order to obtain economic return in the present and future (Girard, 2011); intelligence is shown by the support of value exchange cycles, the circular economy process and participative and creative governance (Girard, 2011) organised around technological resources (Neirotti et al., 2014); and urban sustainability from recognizing the importance of their tangible and intangible amenities, as predictors of their quality of life and performance (Neirotti et al., 2014).

In conclusion, Figure 1 shows the conceptual model of a current city, approached holistically and characterised by multiple dimensions and sub-dimensions.

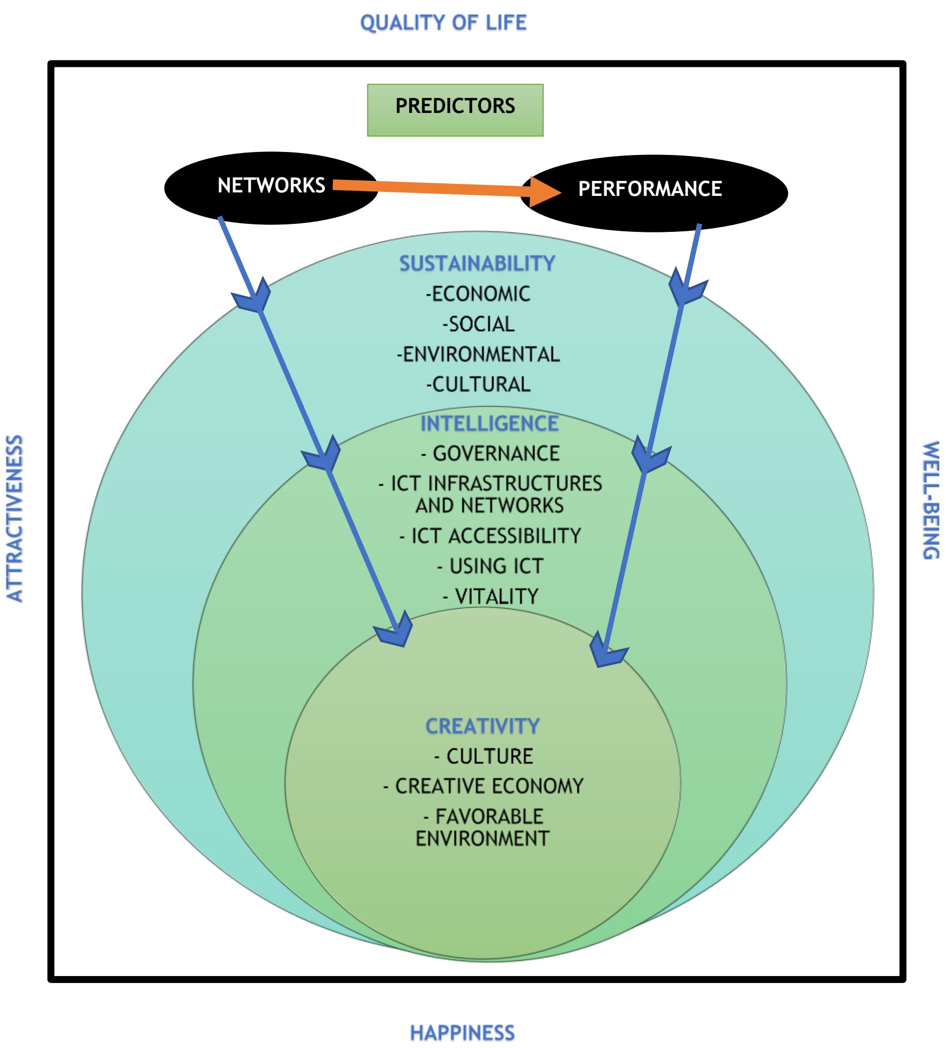

Figure 1 – Multi-dimensional design model for currents cities

This model is complemented in the following section by indicators and proxies to measure the overall, integrated performance of currents cities.

2.2. Measuring the creative, intelligence and urban sustainability of currents creative cities

Cities' global performance should be measured through a multi-dimensional and holistic approach (Girard et al. 2011; Networked Society City Index, 2016), due to cities' crucial role in global economic development, as places of connectivity (networks), creativity and innovation associated with social and economic progress, culture, diversity and the environment (European Commission, 2011). In other words, cities' performance includes dimensions inherent to their tangible and intangible resources, as argued by Anthopoulos (2017), and is the reflection of the strategies implemented with a view to giving cities creativity, intelligence and urban sustainability (Davoudi & Sturzaker, 2017).

In this context, there is still a dispersion of indices and indicators to measure performance, due to the complexity of managing a city holistically (Albino, Berardi & Dangelico, 2015), despite all of them aiming to improve citizens' quality of life (Shapiro, 2006). In other words, this performance is measured by a battery of indicators, which are understood as a methodological instrument, since analysis of the indicators used allows political decision-makers to identify cities' opportunities/threats so that their global performance can improve continuously and sustainably (United Nations, 2015), irrespective of their size. Corroborating this argument, Borsekova et al. (2018) concluded that a city's size does not determine the implementation of strategies emphasizing creativity, intelligence and sustainability, since people are important in their integrated approach (Giffinger et al., 2007; Hollands, 2008; Nam & Pardo, 2011).

Recognizing that not all existing indices, indicators and proxies to measure cities' global performance have been explored, Table 1 compiles those most used by the academic community and other public and private entities.

Table 1 – Index of creativity, intelligence and urban sustainability

Sub-dimension	General indicator	Source
Culture	Places of culture and facilities	Bosch et al. (2017); Durmaz, Platt, and Yigitcanlar (2010); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley, Potts and MacDonald, (2012); Kakiuchi, 2016; Lombardi et al. (2012)
	Cultural participation and attractiveness	
Creative economy	Creativity and employment	Bosch et al. (2017); Caragliu et al. (2011); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Joss, Cowley, and Tomozeiu (2013); Landry (2013); Kakiuchi (2016); Lombardi et al. (2012); Panal and Yáñez (2012); Skavronska (2017)
	Intellectual property and innovation	

Table 1 – Index of creativity, intelligence and urban sustainability (cont.)

Sub-dimension	General indicator	Source
Favourable environment	Human capital and education	Caragliu et al. (2011); Dhingra and Chattopadhyay (2016); European Union (2017); García Suárez & Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Landry (2013); Skavronska (2017); United States Environment Protection Agency (2016)
	Openness, tolerance and trust	
	Local and international connections	
	Governance	
Governance	Implementation	Landry (2013); United Nations (2015)
	Strategy	Angelidou (2017); Bosch et al. (2017); Landry (2013); Madeira, Guimarães and Mendes (2016)
	Democratic	Angelidou (2017); Bloom Consulting (2017); Garau, Balletto, and Mundula (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Lombardi et al. (2012)
ICT infrastructure and networks	Telecommunications	Ernst and Young (2016); Networked society city index (2016)
	Transport	Ernst and Young (2016)
	Energy	
	Environment	
	Sensors	
ICT accessibility	Tariffs	Networked society city index (2016)
	Mobility	Ernst and Young (2016)
Use of ICT	of technology	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
	Individual	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
	Public	Bloom Consulting (2017); Caragliu et al. (2011); Giffinger et al. (2007); Lombardi et al. (2012); Madeira et al. (2016); Ernst and Young (2016); Networked society city index (2016)
Vitality	Individual and public	Ernst and Young (2016)
Economic	Competitiveness	Adnan, Hamzah and Alias (2016;) Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Caragliu et al. (2011); Devol, Ratnatunga, and Bedroussian (2016); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
	Economic activity	Angelidou (2017); Bloom Consulting (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)
Social	Population	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Trivellato (2016); United States Environment Protection Agency (2016)
	Education	Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012)); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
	Inclusion and cohesion	Bosch et al. (2017); Giffinger et al. (2007); Trivellato (2016)
	Social infrastructure	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)
Environmental	Basic infrastructure	Batten (2016); Bosch et al. (2017); Lombardi et al. (2012); Networked society city index (2016)
	Emission and production of atmospheric pollution	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Joss et al. (2013); Lombardi et al. (2012); Networked society city index (2016)
	Circular economy	Ligorio (2017); Smol, Kulczycka, and Avdiushchenko (2017)
	Urbanism	Artmann et al. (2017); Batten (2016); Bloom Consulting (2017); Dhingra and Chattopadhyay (2016); Lombardi et al. (2012); Networked society city index (2016); United States Environment Protection Agency (2016)

Source: Own elaboration

3. Methodology

3.1. Observed population

The population observed is represented by the 308 towns and cities in Portugal, where those situated on the coast have a greater population density. The metropolitan areas of Lisbon and Porto have the greatest concentration of population. Table 2 presents the population distribution by region (NUTS II).

Table 2 – Population distribution in Portugal for 2017

NUTS II	Number of towns/cities	Population (Number)
North	86	3.580.390
Centre	100	2.237.640
Lisbon Metropolitan Area	18	2.827.514
Alentejo	58	715.019
Algarve	16	440.543
Autonomous Region of the Azores	19	244.573
Autonomous Region of Madeira	11	254.622
Total	308	10.300.300

Source: Pordata

3.2. Data collection, indicators and proxies

Collecting data about the population analysed (N = 308) was a lengthy process through the need to compile data, due to the non-existence of a single database with numerical information about the dimensions of creativity, intelligence and urban sustainability. Added to the dispersion of data was the insufficiency of data when the unit of analysis is the town/city.

In these circumstances, selection of the indicators and respective proxies was governed above all by data availability, which did not prevent the selection considering the characteristics necessary for a good indicator, i.e., their clarity, simplicity, reproduction, scientificity, salience, credibility, legitimacy and comparability (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005). The indicators listed must have these characteristics, as the quality of a composite index depends on this (Saisana & Tarantola, 2002; Staníčková & Melecký, 2018), as well as the research method chosen. Appropriate definition of the research method, namely multivariate statistical techniques, aims to overcome the dissimilarity of units of measure and periods of reference of the data by employing more than one indicator (Kľúčik & Haluška, 2008; OECD, 2008). These authors also explain that the use of multiple indicators endow the results obtained with scientificity, relevance and meaning, as required by this typology of indices.

It was therefore indicated that measuring the global performance of the 308 Portuguese towns and cities should involve the aggregation and weighting methods defined by the OECD (2008), i.e., Exploratory Factor Analysis (EFA).

Given the high number of sub-dimensions (8) of indicators used (24 general and 47 specific indicators) and of proxies corresponding to 157 variables to measure creative, intelligent and sustainable performance, detailed information about these is found in Appendix 1(summary of data collection).

3.3. Stages of data analysis

Statistical treatment of the data to assess the global performance of 308 Portuguese towns and cities was performed using software IBM SPSS (version 25.0) software and covered three distinct stages for the dimensions studied: creativity, intelligence and urban sustainability, as revealed by various authors (e.g., Danielis, Rotaris, & Monte, 2018; Marôco, 2014; Pestana & Gageiro, 2014). However, as the intention is to determine the scientific weighting of each of those dimensions in cities' total performance, i.e., a Composite Index, data analysis includes two more stages (e.g., Kubrusly, 2001; OECD, 2008). The following paragraphs detail the methodological procedures associated with the set of five stages.

The first step is to determine the validity of the 308 observations, and so the observations analysed represent around five times the variables studied, which ensures no relevant information is lost. However, the heterogeneity of the units of measurement, periods of reference and possible omission of data requires data normalization, as any aggregation of data has to be preceded by normalization (El Gibari, Gómez, & Ruiz, 2018; Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Kubrusly, 2001; Marôco, 2014; Nardo et al., 2005; OECD, 2008; Pestana & Gageiro, 2014; Stevens, 1986). In this study, Z-scores were chosen for data normalization (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Kubrusly, 2001; Marôco, 2014; Nardo et al., 2005; OECD, 2008; Pestana & Gageiro, 2014; Stevens, 1986).

It is noted that Z-scores converted the variables to a common scale with the mean of zero and standard deviation of one (Danielis et al., 2018; El Gibari et al., 2018; Marôco, 2014; OECD, 2008). This means that the degree of dispersion was reduced to around zero for the mean and one for the standard deviation (Castro-Higueras & de Aguilera-Moyano, 2018). This analysis refers to the second stage, of descriptive analysis (mean, standard deviation, variation coefficient and minimum and maximum values), although the transformations arising from the above normalization mean they are not presented in this study (Marôco, 2014; OECD, 2008).

The third stage concerns the calculation of weightings, considering that in building a composite index, the weights to attribute to each indicator have great significance for the total index and the results obtained (El Gibari et al., 2018). Supported by this crucial requirement, all the weightings presented in this study were obtained directly by applying EFA and the intrinsic Principal Component Analysis (PCA) to present a robust Composite Index of quality. This scientific robustness and quality is obtained through the multivariate statistical techniques mentioned above, since they allow towns/cities to be taken as the unit of analysis (Al Sharmin, 2011), the grouping of data presenting similar significance in the sample and the restriction of principal components to retain (Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; Marôco, 2014; Pestana & Gageiro, 2014; Stevens, 1986). This technique also allows the weightings obtained to represent the importance of the variables (157) measured by maximum variance (Kubrusly, 2001). The benefits of using EFA and PCA were stated by the OECD (2008), concluding that these can *"summarise a set of individual indicators while preserving the maximum possible proportion of the total variation in the original data set.",* and that the *"largest factor loadings are assigned to the individual indicators that have the largest variation across countries, a desirable property for cross-country comparisons, as individual indicators that are similar across countries are of little interest and cannot possibly explain differences in performance"* (OECD, 2008: 26). It is noted that in this study the unit of analysis is towns rather than countries.

Finally in the third stage, to check acceptability of this technique, we applied the Kaiser–Meyer–Olkin (KMO) (Kaiser, 1974) sample suitability measure and the Bartlett sphericity test. To verify the internal consistency of the eight (sub)dimensions, it is usual to calculate the Cronbach's alpha, but this was not considered here as the "correlations do not necessarily represent the real influence of the individual indicators on the phenomenon expressed by the composite indicator" (OECD, 2008: 27).

After carrying out the first three stages for each dimension *per se* (creativity, intelligence and urban sustainability), we are ready for the next stages (4 and 5), since the weightings obtained for the 154 variables distributed over the dimensions analysed are the starting point for these.

The fourth stage consists of calculating the value observed for each town for the 8 sub-dimensions (culture, creative economy, favourable environment, governance, information and communication technology (ICT), economic, social and environmental sustainability) and then for the three dimensions (creativity, intelligence and urban sustainability) determined by the sum of the product between the value of each normalized variable by the weighting coefficient obtained for each of them in the previous stages (1, 2 and 3). For the values observed by town, by sub-dimension and dimension, descriptive analysis was performed. The data obtained at this stage are the variables to be analysed in the next stage, the calculation process being according to that described by the OECD (2008).

Finally, the fifth stage concerns application of EFA to the dimensions of creativity, intelligence and urban sustainability to obtain the total weight of each in the Composite Index of Portuguese towns/cities' total performance, with the first three stages being repeated.

4. Results obtained

Following the procedures described in Section 3.3. regarding the third stage led to obtaining a great volume of statistical information all presented in Appendices 2 (creativity dimension), 3 (intelligence dimension) and 4 (urban sustainability dimension). It is important to mention that the values obtained in the KMO test (Appendices 2, 3 and 4) for the sub-dimensions referring to each dimension (Kaiser, 1974) show that data quality varies between reasonable, average and good, which means that EFA can be applied to them (Marôco, 2014). However, in the creative economy sub-dimension of the creativity dimension, there was found to be linear dependence between some of the variables studied, whose Pearson correlation coefficient is 1 (Marôco, 2014). Given the values obtained from the analysis of correlation between the variables of this sub-dimension, the variables of ATIC3, ATIC4, ICPIB4, ICPIB5, ICPIB6, TC2 and PP3 were withdrawn, in order to assess data quality through the KMO test.

In addition, the communalities extracted (h^2) respect the required minimum of 0,32 (Costello & Osborne, 2005; Tabachnick & Fidell, 1996) in all the sub-dimensions (8) analysed. Similarly, the 154 variables analysed present loadings above the required minimum of 0,40, and so the explained variances have significant values (Marôco, 2014) (see Appendices 2, 3 and 4).

Finally, EFA and PCA retained a total of 51 factors for the dimensions of creativity (17), intelligence (12) and urban sustainability (22). Based on the values obtained for each factor, the next step was to calculate the *"weights from the matrix of factor loadings after rotation, given that the square of factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor"* (Kubrusly, 2001; OECD, 2008: 90)(see Appendices 2, 3 and 4).

Based on these results, the conditions are right to calculate the weightings associated with each variable, obtained from the product between the normalized loadings raised to the square and the value of the explained variance (Appendices 2, 3 and 4) for each factor, as shown in Tables 3, 4 and 5.

Table 3–Creativity dimension

Weights - coefficients of variables[19]							
Variables	Factor						
	1	2	3	4	5	6	7
Sub-dimension culture							
LIC1					3,61		
MA1						4,12	
MA2						3,35	
MA3						2,16	
CIN1			4,79				
CIN2			4,91				
CE1							2,79
CE2					3,11		
TEA1		2,112					
RAL1	2,35						
RAL2	5,65						
RAL3	3,14						
DORT1	5,34						
DORT2	0,93						
DORT3	5,42						
VISM1				5,25			
VISM 2				5,10			
ATENC 1		4,43					
ATENC2		4,58					
DCE1							2,61
DCE2		2,25					
OCC1					3,70		
DM1						1,67	
	Hotels and restaurants	**Theatres and similar**	**Cinema**	**Museum visitors**	**Cultural supply**	**Art and museums**	**Cultural premises**

Variables	Factor				
	1	2	3	4	5
Sub-dimension Creative Economy					
EC1		4,66			
ICPIB1		6,45			
ICPIB2				7,00	
ICPIB3		5,79			
ICPIB7		5,50			
ATIC1		3,70			
ATIC2				7,06	
ATIC5					6,73
ID1			4,59		
ID2			6,44		
ID3			4,60		
TC1	5,64				
TC3	3,81				
TC4	6,17				
PP1	5,51				
PP2	5,79				
	R&D in higher education institutions	**Creative industries' contribution to GDP**	**R&D in firms**	**Proportion of creative industries**	**Weight of creative industries**

[19] Example of calculation for RAL1: (0,276*0,085) *100 = 2,346 (values taken from Appendix 2, Table A)

Table 3–Creativity dimension (cont.)

Variables	Factor				
	1	**2**	**3**	**4**	**5**
Sub-dimension Favourable Environment					
CC1	5,72				
CC2	5,65				
CC3	5,94				
CC4	5,60				
CC5	6,40				
CC6	6,50				
CC7	4,21				
CC8	1,95				
PR1	3,43				
TOL1				4,93	
TOL2		5,35			
TOL3		4,01			
TOL4				4,51	
LI1			3,31		
LI2					2,22
LL1					5,16
FE1			6,28		
FE2			5,76		
FE3		5,58			
	Higher education	**Population**	**Redevelop-ment of buildings and airports**	**Foreigners**	**Transport**

Table 4 - Intelligence dimension

Weights – coefficients of variables								
Variables	**Factor**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Sub-dimension governance								
EGOV1				0,81				
EGOV2				5,15				
EGOV3							1,54	
FIN1			6,4					
FIN2				3,14				
FIN3			6,4					
RED1						3,29		
RED2						3,94		
PEL1	6,08							
PEL2	6,31							
PEL3	3,66							
PEL4	5,91							
VIND1		4,58						
VIND2				1,42				
VIND3					3,36			
VIND4		4,93						
VIND5		4,37						
VPUB1							5,45	
VPUB2								5,04
	Election turnout	**Population vitality**	**Local public debt**	**E-govern-ment vs. Density and Income**	**Access**	**Municipal provi-sion**	**Urban net-works**	**Tourism**

Table 4 - Intelligence dimension (cont.)

Sub-dimensão ICT				
Variables	**Factor**			
	1	**2**	**3**	**4**
TEL1	10,96			
TEL2	11,07			
AMB1		10,11		
AMB2		9,12		
AMB3			8,83	
AMB4				10,77
ACES1			5,47	
ACES2	8.75			
PUB1		8,94		
IND1	4,24			
	Communi-cations and internet	**Network infrastruc-ture**	**Energy and mail**	**Waste**

Table 5 – Urban Sustainability Dimension

Weights – coefficients of variables							
Variables	**Factor**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Sub-dimension Economic sustainability							
CREC1		2,75					
CREC2	0,99						
CREC3	4,12						
CREC4		1,05					
CREC5				1,28			
NEG1		4,58					
NEG2		3,75					
NEG3					3,02		
NEG4			3,58				
NEG5		3,46					
NEG6	3,59						
NEG7	4,71						
NEG8	4,35						
NEG9			1,22				
NEG10				3,39			
EMP1						3,79	
EMP2				2,64			
EMP3			3,09				
EMP4			4,37				
EMP5					3,66		
EMP6							4,85
Total	17,76	15,59	12,26	7,31	6,68	3,79	4,85
	Economic activity	**Growth and employment**	**Entrepre-neurship**	**Unemploy-Ment**	**Density of banks and firms**	**New firms**	**Public-private partnerships**

Table 5 – Urban Sustainability Dimension (cont.)

Variables	1	2	3	4	5	6	7	8
Sub-dimension Social Sustainability								
AD1	4,77							
AD2	4,52							
AD3	2,16							
AD4	4,67							
AD5	3,00							
AD6								2,41
AD7	1,97							
ICH1					4,27			0,00
ICH2								3,32
ICH3					4,12			
ICOM1			4,55		0,00			
ICOM2	3,16							
ICOM3	3,08							
ICOM4	3,16							
ICOM5	3,75							
PD1							3,37	
PD2						1,74		
PD3				4,61				
DSA1		3,83						
DSA2	1,34							
DSA3							1,59	
DSA4		3,92						
DSA5				4,10				
DSE1						3,76		
DSE2			4,11					
Total	35,58	7,75	8,66	8,71	8,39	5,50	4,96	5,73
	Demography and education	**Health**	**Other**	**Social projects**	**Poverty and criminality**	**Urban renewal(a)**	**Other benefits**	**(a)**

Weights – coefficients of variables

Variables	Factor 1	2	3	4	5	6	7
Sub-dimension Environmental Sustainability							
EGA1		7,11					
EGA2		7,42					
EGA3	5,21						
EPAT1	5,34						
EPAT2	5,93						
RR1	3,67						
RR2	3,53						
RR3			6,39				
RR4						7,73	
RR5	3,86						
RR6	3,38						
TER1				5,89			
TER2				5,36			
TER3							4,43
TER4					5,00		
TER5					5,44		
	Management of waste and basic consump-tion(a)			**Preservation and protection of the environ-ment(b)**		**(a)**	**(b)**

Source: Adapted from the outputs of SPSS

The weightings shown in Tables 3, 4 and 5 allowed calculation of the value observed by town, which was obtained by summing the product of each normalized variable (*Zscores*) obtained with IBM SPSS software by the weighting (fourth stage, Tables 3, 4 and 5). These calculations were made for all the dimensions (3) and sub-dimensions (8) analysed. For example, the numerical value of the creativity dimension for a town was obtained as follows:

$$\sum (Zscore\ \ i \times weighting\ i) + \cdots (Zscore\ i \times weighting\ i)$$
$$= value\ observed\ for\ a\ town\ in\ the\ culture\ sub$$
$$-\ dimension\ (1{,}61926)\ \ Formula\ 1$$

(i = LIC1 to DM1, where i = 23 variables; *Zscores* obtained through SPSS)

However, to calculate the final weighting of each of the 3 dimensions analysed, it was necessary to determine the weight of each sub-dimension analysed in the respective dimension, and so EFA was applied, the detailed results being shown in Appendix 5.

It was then necessary to calculate the numerical value per town in each dimension, resulting from the sum of the product between the value observed per town for each sub-dimension in the dimension. As an example for the creativity dimension, we have the following formula:

$$Culture(1{,}619 \times 0{,}220) + Creative\ Economy(4{,}987 \times 0{,}380)$$
$$+\ Favourable\ Environment(3{,}171 \times 0{,}396) = Creativity(3{,}5158)\ Formula\ 2$$

Finally, the values obtained from formula 2 for the 308 Portuguese towns and cities represent the numerical data to enter in SPSS for the creativity (variable 1), intelligence (variable 2) and urban sustainability (variable 3) dimensions to apply EFA (Table 7), aiming to obtain the composite weighting of each dimension in the total performance of Portuguese towns (fifth stage), following descriptive analysis (Table 6).

Table 6 - Descriptive statistics of the population

Dimensions	N	Mean	Standard Deviation	Minimum	Maximum
Creativity	308	0,000	0,383	-0,3077	3,5158
Intelligence	308	0,000	0,261	-0,6105	0,9299
Urban Sustainability	308	0,000	0,230	-0,4519	1,5015

Source: Adapted from the outputs of SPSS

Table 7 - Exploratory Factor Analysis for the dimensions of creativity, intelligence and urban sustainability

Dimensions	h^2	Factor Total Performance	Weights[20]
Creativity	0,692	0,832	0,380
Intelligence	0,426	0,652	0,234
Urban Sustainability	0,702	0,838	0,386
Eigenvalue		1,82	
% explained variance		60,65	
Total explained variance		60,65	

Varimax Rotation; N = 308; KMO = 0,613; Bartlett Sphericity Test =162,366; gl = 3; p < 0,000;

Source: Adapted from the outputs of SPSS

[20] Example of calculation for creativity: 0,832^2/1,821628 = 0,380

The results in Table 5 show that the KMO test confirms reasonable quality of data and that the communalities (**h**^{2}) extracted are above the required 0,40 (Marôco, 2014).

5. Discussion of the results

The results obtained in Section 4 led to obtaining the scientific weighting of each dimension forming the Composite Index for towns' total performance. So in the Portuguese context, the intelligence dimension has the least significant weighting, (0,234), followed by the creativity dimension (0,380) and the urban sustainability dimension (0,386).

Global reading of these results indicates that political decision-makers and local governments have made relevant efforts to reflect the importance of these three dimensions in their strategies and guidelines, particularly at the town level. These efforts represent a constant challenge given the transformations this implies in the various urban spaces, infrastructure, institutions and implementation and monitoring processes. It is noted that this transformative scenario was mentioned by Bouton et al. (2013), due to economic growth also being stimulated by intangible and tangible amenities (Romero-Padilla et al., 2016). Furthermore, this paradigmatic alteration in the model of economic growth in urban areas led to people and spaces involved in the urban environment being revealed as crucial for cities' urban growth, with positive effects on their total performance (Audretsch, 2003; Malecki, 2007). In addition, for Portuguese towns it was confirmed there has been a concentration on endogenous cultural factors associated with the revitalization of places, aiming to develop cultural activities and also provide premises for new businesses linked to culture and creativity. This involvement has been mentioned by several authors (e.g., Cabrita et al., 2013; Florida, 2002, 2005; Ortegel, 2017).

The following paragraphs analyse the dimensions of creativity, intelligence and urban sustainability individually, as the weightings obtained for each require this.

The creativity dimension has a weighting of 0,380 in the total performance of Portuguese towns, in which culture has an impact of 0,22, the creative economy 0,38 and the favourable environment 0,399. This means that local governments in the 308 towns and cities analysed have directed their policies towards providing regenerated or even new cultural spaces, pluralist, tolerant and open urban environments, which in turn are attractive amenities for the so-called creative class and implicit cultural and creative industries. This type of city provision was mentioned by Florida (2005), Grant and Kronstal (2010) and Romein and Trip (2009), who highlighted the importance of cities generating a favourable environment and a creative economy associated with the dynamics produced by culture, and people's creativity as a lever to direct cities to creativity, intelligence and urban sustainability. Moreover, the factors obtained through EFA and the respective weightings of the variables included in them clearly show the positive impacts of creativity on performance in the 308 Portuguese towns and cities, for example, in the significance of the weightings of creative and cultural industries in the sub-dimension of the creative economy (Table 3), which means this is already happening in Portugal and generating economic value. The wealth produced by these industries was shown by Furtado and Alves (2011). These authors also argued that the economic results of cultural and creative industries allow them to contribute to cities' urban sustainability.

Although the intelligence dimension of Portuguese towns still requires action to improve infrastructure and accessibility, urban networks (belonging to *inter* and *intra* networks) in those towns are a positive aspect, as a reflection of adopting open, participative governance aiming to improve urban performance. Urban networks as predictors of improved city performance were emphasized by Cohen et al. (2016), Echebarria et al. (2016), Ferraris et al. (2018), in which creativity stimulates the creation of urban networks as a consequence of the governance typology adopted, as well as those networks increasing synergies between all urban agents, with an economic return in the present and future (Girard, 2011). Nevertheless, the implementation of ICT in Portuguese towns may fall short of expectations, despite significant progress being made in terms of *e-government*. ICT's articulation with cities' governance is fundamental for their improved intelligent performance and for the benefits to be duly enjoyed (Neirotti et al., 2014). In this dimension, it is essential to mention that the statistical results obtained were influenced by the lack of data at the Portuguese town level, and so these could be overestimated.

The urban sustainability dimension is visible in the 308 Portuguese towns in a tri-partite way. Economic sustainability (weighting of 0,386) has been strengthened, for example, by entrepreneurship, which has created new business supported by public-private partnerships, such as *living labs*, which has contributed to less urban unemployment. *Living labs,* understood as open networks and collaborative partnerships, have been indicated as a means to extend connectivity inside and outside towns (Girard et al., 2011; Networked Society City Index, 2016), allowing the development and implementation of intangible projects with social, environmental and cultural effects, besides projects with sustainable economic synergies (Anthopoulos, 2017; European Comission, 2011). Standing out in social sustainability (weighting of 0,245) is the development of projects promoting cohesion and social inclusion and actions to improve social infrastructure in Portuguese towns, for example, projects promoted by the healthy town network and others. This type of social project and policies aiming for improved infrastructure is necessary to achieve urban sustainability (Batten, 2016; Bosch et al., 2017; Giffinger et al., 2007; Trivellato, 2016). Finally, environmental sustainability (weighting of 0,369), which locally in Portugal has emphasized waste management and actions to preserve and protect natural resources and the environment in general. However, the circular economy model proposed by the EU is a scenario in need of additional strategies and policies, since it is at an embryonic stage in Portuguese towns. It is clearly necessary for towns to go down this route and thereby improve their environmental performance even more. The importance of this model for cities' improved sustainable performance was explained by Ligorio (2017) and Smol et al. (2017), despite the suggestion that the circular economy should be interlinked with ICT and open governance (intelligence) (Girard, 2011; Neirotti et al., 2014). Neirotti et al. (2014) also argue that cities with urban sustainability predict their performance positively and raise their residents' quality of life, and in the case of Portugal, this dimension's weighting is very close to 0,40.

Summarizing, the results obtained show that cities' performance can be measured in a multi-dimensional and holistic way, without losing relevant information and with scientific quality and robustness. Figure 2 shows the results obtained for the 308 towns and cities in Portugal.

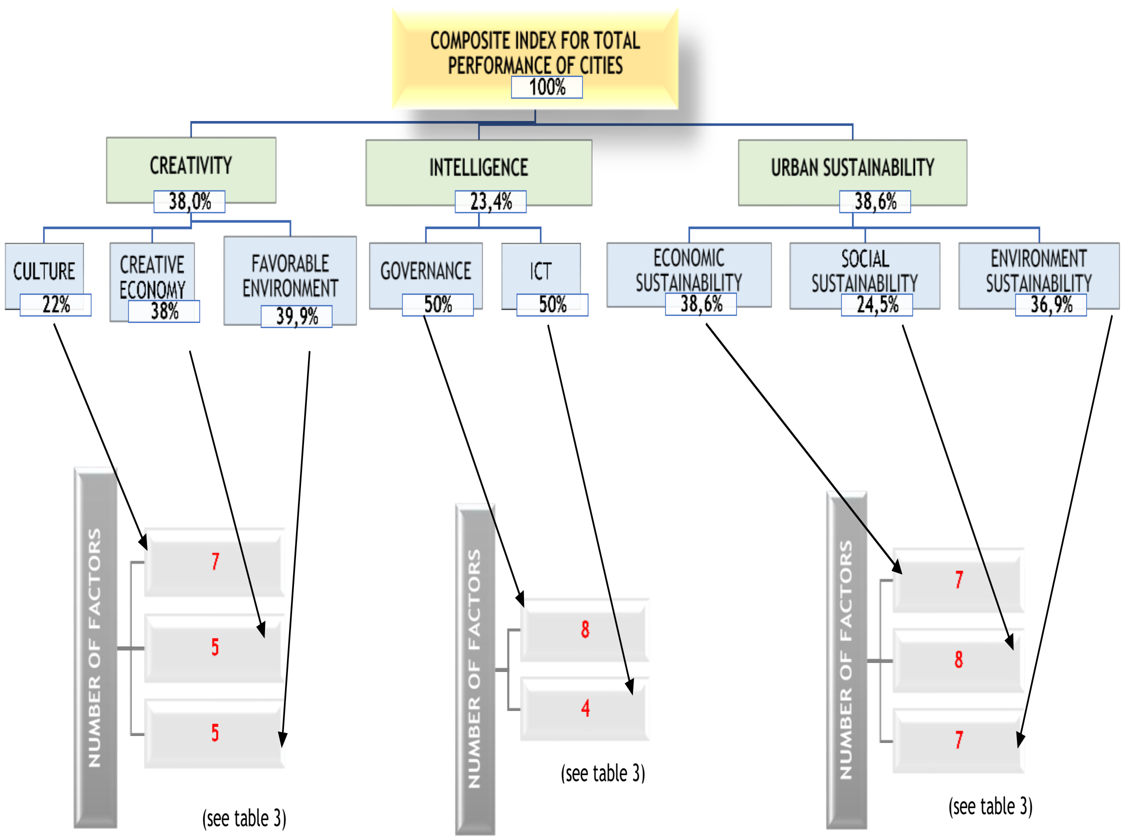

Figure 2 - Composite index for total performance of cities

A reading of Figure 1 reveals that Portuguese towns and cities are moving according to the EU directives towards achieving intelligent, inclusive and sustainable growth (Eurostat, 2015) associated with creativity, culture and urban networks, with the last-named being understood as a new intangible factor of the current model of cities' economic growth and a predictor of improved total performance.

6. Contributions of the study

The contributions arising from the results obtained in this empirical study have relevant implications for theory and practice, allowing the existing gap between both to be filled (Lee et al., 2014), and this is the study's general contribution.

The presentation of a theoretical and holistic framework, the importance of which was already defended by Mora et al. (2017), is the first contribution of this study with implications for theory. The framework (Figure 1) shows that currents towns aim to be simultaneously creative, intelligence and sustainable, and to grow economically in the short and long term to provide their residents with quality of life, well-being and happiness, besides improving their total performance predicted by *inter* and *intra* networks formed in urban spaces, where intangible effects give a financial return today and in the future.

The second contribution, also with implications for theory, lies in the compilation of indicators from various indices in a single index. This index includes indicators for the dimensions of creativity, intelligence and sustainability, divided in 8 sub-dimensions. Concerning theoretical implications, a Composite Indicator with 24 general indicators and 47 specific indicators was developed, filling the gap regarding a single index to measure total performance in all its inseparable dimensions (Borén & Young, 2013; Malecki, 2007), added to which is the volume of the variables used (Çetindamar & Günsel, 2012).

Filling the theoretical gaps was followed by empirical operationalization of the Composite Index. Consequently, the third contribution lies in application of that index in the Portuguese context, with robustness and scientific quality being confirmed through application of EFA (OECD, 2008), for this to be a methodological instrument to be adopted by cities and/or countries to assess and monitor their total performance. It is highlighted that Composite Indices are an instrument increasingly valued by political decision-makers and important in discussing economic growth, this being an implication for practice.

Overall, the main contribution of this study lies in the Composite Index for cities' total performance, with the statistical treatment allowing scientific calculation of the weightings of each dimension studied in cities' holistic performance.

7. Limitations and future research agenda

Like any study, this one is not without limitations. One is the subjectivity present in selecting the indices/indicators used, which were affected by the limited availability of data about towns and the fact of the choice also having to consider the characteristics of a good indicator. Also the unavailability of data when the unit of analysis is the town, whatever its population density, is another limitation.

Given the multiplicity of theoretical concepts and implications for theory and practice, measuring cities' total performance does not end with this study but continues to be a fertile area for future research. The extensive data treatment carried out allows elaboration of a ranking of Portuguese towns and cities by size and total performance, directing future research to analysis of clusters of Portuguese towns. Another future topic would be application of other multivariate statistical techniques, for example, Data Envelopment Analysis (DEA), which allows multiple entries and exits and could establish a model of multifactor measurement of performance and frontiers to measure efficiency. A final suggestion is to apply the Composite Index in other geographical contexts, leading to comparative studies to determine the factors of cities' success and failure. Another study could take countries as the unit of analysis.

8. Conclusions

Creative cities in this century included in the so-called European Cities must ally the creativity dimension to those of intelligence and urban sustainability, so that their growth is supported by holistic, determinant pillars of their total performance. In this context, it was demonstrated that this can be measured scientifically through a Composite Index with the respective weightings, which allows its generalized application in any geographical context and unit of analysis. This generalization transforms this index into a scientific instrument for political decision-makers and town planners. It was also proven that when understood and managed as strategic places, cities are able to respond to the major challenge of being the drivers of a country's economic growth. This means that cities that increase their growth according to the premises inherent to creativity, intelligence and urban sustainability as a whole and without neglecting the importance of urban networks, will show improved total performance.

References

Adnan, Y. M., Hamzah, H., & Alias, A. (2016). An initiatives-based framework for assessing smart city. *Planning Malaysia Journal*, *14*(5), 13-22.

Al Sharmin, A. (2011). *A Composite Index to Assess the Regional Development: A Districts-Level analysis*. VDM Publishing.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 1–19.

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 4–28.

Anthopoulos, L. (2017). Smart utopia VS smart reality : Learning by experience from 10 smart city cases. *Cities*, *63*, 128–148.

Artmann, M., Kohler, M., Meinel, G., Gan, J., & Loja, I. (2017). How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecological Indicators*, (June), 1–13.

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1), 45-64.

Audretsch, D. B. (2003). Managing Knowledge Spillovers: the Role of Geographic Proximity. Advances in Strategic Management, 20, 23–48.

Batten, J. (2016). Sustainable Cities Index 2016. *Arcadis Global*, 10. Available online: https://www.arcadis.com/media/0/6/6/%7B06687980-3179-47AD-89FD-

F6AFA76EBB73%7DSustainable Cities Index 2016 Global Web.pdf.
Bibri, S. E., & Krogstie, J. (2017). On the social shaping dimensions of smart sustainable cities: A study in science, technology, and society. *Sustainable Cities and Society*, *29*, 219–246.
Bifulco, F., Tregua, M., Amitrano, C. C., & D'Auria, A. (2016). ICT and sustainability in smart cities management. *International Journal of Public Sector Management*, *29*(2), 132–147.
Bloom Consulting. (2017). Portugal ConsultingCity Brand Ranking 2016 - Municípios Portugueses. *Bloom Consulting Countries Regions and Cities*, 1–56. Available online: http://www.bloom-consulting.com.
Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.
Borsekova, K., Koróny, S., Vaňová, A., & Vitálišová, K. (2018). Functionality between the size and indicators of smart cities: A research challenge with policy implications. *Cities*, *78*, 17–26.
Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.
Bouk, S. H., Ahmed, S. H., Kim, D., & Song, H. (2017). Named-data-networking-based ITS for Smart Cities, *IEEE Communications Magazine*, *55*(1), 105-111.
Bouton, S., Cis, D., Mendonca, L., Pohl, H., Remes, J., Ritchie, H., & Woetzel, J. (2013). *How to make a city great*. *McKinsey Cities Special Initiative*. Available on line: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/urbanization/how%20to%20make%20a%20city%20great/how_to_make_a_city_great.ashx.
Cabrita, M. D. R., Cruz-Machado, V., & Cabrita, C. (2013). Managing creative industries in the context of knowledge-based urban development. *International Journal of Knowledge-Based Development*, *4*(4), 318–337.
Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: An economy-environment technology nexus. *Ecological Economics*, *24*(1), 103–118.
Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.
Castro-Higueras, A., & de Aguilera-Moyano, M. (2018). Assessing creativity: an index proposal. *Creative Industries Journal*, *11*(1), 102–118.
Cavalcanti, C. (1995). *Sustentabilidade da economia: paradigmas alternativos de realização econômica. Desenvolvimento e natureza: estudos para uma sociedade sustentável*. São Paulo: Cortez.
Çetindamar, D., & Günsel, A. (2012). Measuring the Creativity of a City: A Proposal and an Application. *European Planning Studies*, *20*(8), 1301–1318.
Cohen, B., Almirall, E., Chesbrough, H. (2016). The City as a Lab: open innovation meets the collaborative economy. *California Management Review*, *59*(1), 5–13.
Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.
Danielis, R., Rotaris, L., & Monte, A. (2018). Composite indicators of sustainable urban mobility: Estimating the rankings frequency distribution combining multiple methodologies. *International Journal of Sustainable Transportation*, *12*(5), 380–395.
Davoudi, S., & Sturzaker, J. (2017). Resources , Conservation and Recycling Urban form , policy packaging and sustainable urban metabolism. *Resources, Conservation & Recycling 120*, 55–64.
Della Lucia, M., Trunfio, M., & Go, F. M. (2017). Heritage and Urban Regeneration: Towards Creative Tourism. In *Tourism in the City* (pp. 179-191). Springer, Cham.
Devol, R., Ratnatunga, M., & Bedroussian, A. (2016). Best Performing Cities. *Milken Institute*. Available online: https://assets1c.milkeninstitute.org/assets/Publication/ResearchReport/PDF/BPC-2016-FINAL-WEB.pdf.
Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563.
Dodgson, M., & Gann, D. (2011). Technological Innovation and Complex Systems in Cities. *Journal of Urban Technology*, *18*(3), 101–113.
Durmaz, B., Platt, S., & Yigitcanlar, T. (2010). Creative, culture tourism and place-making :

Istanbul and London film industries. *International Journal of Culture, Tourism and Hospitality Research*, *4*(3), 198–213.
Echebarria, C., Barrutia, J. M., Aguado, I., Apaolaza, V., & Hartmann, P. (2016). Capturing the benefits that emerge from regional sustainability networks: The Castile-La Mancha network of sustainable cities and towns. *Papers in Regional Science*, *95*, S27–S49.
El Gibari, S., Gómez, T., & Ruiz, F. (2018). Building composite indicators using multicriteria methods: a review. *Journal of Business Economics*, 1–24.
Elkington, J. (2004). Enter the triple bottom line. The triple bottom line: Does it all add up. In *Chapter 1* (Vol. 11, pp. 1–16). Available online: http://www.johnelkington.com/archive/TBL-elkington-chapter.pdf.
Ernst & Young. (2016). Rapporto Smart city index. Available online: www.ey.com/...smart...index-2016/.../2016-EY-smart-city-index.
European Commission. (2011). Cities of tomorrow - Challenges, visions, ways forward. Available online: *ec.europa.eu/.../citiesoftomorrow/citiesoftomorrow_final.pdf*.
European Commission. (2014). Reference framework for European sustainable cities. Available online: http://www.rfsc.eu/.
European Union. (2017). *The Cultural and Creative Cities Monitor*. European Union: Brussels, Belgium.
Eurostat. (2015). *Smarter, greener, more inclusive?* Available online: https://ec.europa.eu/eurostat/statistics explained/index.php/Smarter,_greener,_more_inclusive_-_indicators_to_support_the_Europe_2020_strategy.
Ferraris, A., Santoro, G., & Papa, A. (2018). The cities of the future: Hybrid alliances for open innovation projects. *Futures*, 1-23.
Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.
Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life)*. (Basic Books, Ed.). New York.
Florida, R. (2005). *Cities and the creative class*. Routledge.
Florida, R., Mellander, C., & Stolarick, K. (2008). Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of economic geography*, *8*(5), 615-649.
Furtado, G., & Alves, S. (2012). Cidades criativas em Portugal e o papel da arquitetura : Mais uma estratégia a concertar. *Revista Crítica de Ciências Sociais*, (99), 125-140.
Garau, C., Balletto, G., & Mundula, L. (2017). A Critical Reflection on Smart Governance in Italy: Definition and Challenges for a Sustainable Urban Regeneration. In E. P. Bisello A., Vettorato D., Stephens R. (Ed.), *Smart and Sustainable Planning for Cities and Regions. SSPCR 2015. Green Energy and Technology* (p. 435).
García Suárez, J. A., & Pulido Fernández, J. I. (2015). Creacity , una propuesta de índice para medir la creatividad turística . Aplicación en tres destinos urbano-culturales españoles. *Revista de Estudios Regionales*, (13), 69–108.
Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf*.
Girard, L. F., Baycan, T., & Nijkamp, P. (2011). *Sustainable City and Creativity: Promoting Creative Urban Initiatives*. Ashgate Publishing.
Girard, L. F. (2011). Creativity and the human sustainable city: Principles and approaches for nurturing city resilience. In P. Girard, L. F., Baycan, T., & Nijkamp, P. (Ed.), *Sustainable city and creativity: Promoting Creative urban initiatives*. (pp. 55–96).
Grant, J. L., & Kronstal, K. (2010). The social dynamics of attracting talent in Halifax. *Canadian Geographer, 54*(3), 347–365.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Hartley, J., Potts, J., & MacDonald, T. (2012). The CCI creative city index 2012. *Cultural Science Journal*, *5*(1), 138.
Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or

entrepreneurial? *City*, *12*(3), 303–320.

Hospers, G.-J., & Pen, C.-J. (2008). A View on Creative Cities Beyond the Hype. *Creativity and Innovation Management*, *17*(4), 259–270.

Huovila, A., Penttinen, T., Airaksinen, M., Pinto-Seppä, I., Piira, K., & Penttinen, T. (2016). Smart city performance measurement system. In Proceedings of the 41th IAHS World Congress Sustainability Innovation for the Future, Algarve, Portugal, 13–16 September; pp. 1–10.

Irungbam, R. S. (2016). The Model of Smart Cities in Theory and in Practice. *Journal for Studies in Management and Planning*, *2*(4), 156-187.

Joss, S., Cowley, R., & Tomozeiu, D. (2013). Towards the "ubiquitous eco-city": An analysis of the internationalisation of eco-city policy and practice. *Urban Research and Practice*, *6*(1), 54–74.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.

Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.

Kľúčik, M., & Haluška, J. (2008). Construction of Composite Leading Indicator for the Slovak Economy. *Stiin Ńe Economice*, *55*, 362–370.

Kong, L. (2014). From cultural industries to creative industries and back? Towards clarifying theory and rethinking policy. *Inter-Asia Cultural Studies*, *15*(4), 593–607.

Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.

Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.

Landry, C. (2013). Creative city index; comfortable or captivating, assessment report of Palmerstone North. Available online: https://www.pncc.govt.nz/media/2096880/creative_city_index_report__web_document_.pdf.

Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.

Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.

Ligorio, V. (2017). New economic development pattern: from a linear to a circular economy, a challenge for eu's economy. *Міжнародний Науковий Журнал Інтернаука International Scientific Journal of International Science*, *1*(2), 20–23.

Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation*, *25*(2), 137–149.

Madeira, G., Guimarães, T., & Mendes, L. (2016). Assessing some models for city e-government implementation : a case study. *Electronic Government, An International Journal*, *12*(1), 86–105

Malecki, E. J. (2007). Cities and regions competing in the global economy : knowledge and local development policies. *Environment and Planning C: Government and policy*. *25*, 638–655.

Mardikyan, S., Yıldız, E., Ordu, M., & Şimşek, B. (2015). Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA*, *2015*, 1–10.

Marôco, J. (2014). *Análise estatística com o SPSS Statistics*.

Mcgranahan, D. & Wojan, T. (2007). Recasting the Creative Class to Examine Growth Processes in Rural and Urban Counties. *Regional Studies*, 41(2), 197-216.

Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.

Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research : A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3-27.

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis, EUR 21682* (December), 134.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). *Current trends in smart city initiatives: Some stylised facts*. *Cities* 38, 25-36.

Networked Society City Index (2016). *Cities play key role in sustainable development. Available onlibe: https://www.ericsson.com/assets/local/trends-and-insights/consumer-*

insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.
Nijkamp, P., & Kourtit, K. (2013). The “New Urban Europe”: Global Challenges and Local Responses in the Urban Century. *European Planning Studies, 21*(3), 291–315.
OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.
Ortegel, M. (2017). “Creative city” policy mobilities as transformation of dispositives - Arrangements of “networking” in the European Metropolitan Region of Nuremberg. *Geographica Helvetica*, *72*(2), 157–169.
Panal, G., & Yáñez, C. (2012). Industrias culturales en ciudades españolas . Un primer acercamiento . Cultural industries in Spanish cities . A first approach. *Revista de Estudios*, *94*, 71–103.
Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS*.
Picard, R. G., Grönlund, M., & Toivonen, T. (2003). Means for overall assessment of cultural life and measuring the involvement of the cultural sector in the information society. *Publications of the Ministry of Education, Finland*, *17*.
Pozdniakova, A. (2017). Smart sustainable cities: the concept. *Acta Innovations*, *22*, 5–19.
Pratt, A. C. (2008). Creative cities: The cultural industries and the creative class. *Geografiska Annaler, Series B: Human Geography*, *90*(2), 107–117.
Priano. F., & Guerra, C. (2014). A framework for measuring smart cities. In *Proceedings of the 15th Annual International Conference on Digital Government Research,* Aguascalientes, Mexico (pp. 44-54). ACM.
Rahbarianyazd, R., & Doratli, N. (2017). Assessing the contribution of cultural agglomeration in urban regeneration through developing cultural strategies. *European Planning Studies*, *25*(10), 1714–1733.
Ratiu, D. E. (2013). Creative cities and/or sustainable cities: Discourses and practices. *City, Culture and Society*, *4*(3), 125–135.
Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities*. Routledge.
Romein, A., & Trip, J. (2009). Key elements of creative city development: an assessment of local policies in Amsterdam and Rotterdan. *City Futures’ 09, 4-6,Madrid*.
Romero-Padilla, Y., Navarro-Jurado, E., & Malvárez-García, G. (2016). The potential of international coastal mass tourism destinations to generate creative capital. *Journal of Sustainable Tourism*, *24*(4), 574–593.
Saisana, M., & Tarantola, S. (2002). *State-of-the-art report on current methodologies and practices for composite indicator development* (p. 214). European Commission, Joint Research Centre, Institute for the Protection and the Security of the Citizen, Technological and Economic Risk Management Unit.
Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.
Scott, A. J. (2006). Creative cities: Conceptual issues and policy questions. *Journal of Urban Affairs, 28*(1), 1–17.
Shapiro, J. M. (2006). Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital. *The Review of Economics and Statistics*, *88*(2), 324–335.
Skavronska, I. (2017). Creative industries in Ukraine: Analysis and prospects of the development. *Economics and Sociology*, *10*(2), 87–106.
Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy*, *19*(3), 669–678.
Staníčková, M., & Melecký, L. (2018). Understanding of resilience in the context of regional development using composite index approach: the case of European Union NUTS-2 regions. *Regional Studies, Regional Science*, *5*(1), 231–254.
Stevens, J. (1986). Chapter 11 - Exploratory and Confirmatory Factor Analysis. In L. E. Associates. (Ed.), *Applied multivariate statistics for the social sciences*. New Jersey. USA.
Tabachnick, B. G., & Fidell, L. S. (1996). *sing Multivariate Statistics*. (3rd ednHarper Collins. New York, Ed.).
Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.
Trivellato, B. (2016). How can ‘ smart ’ also be socially sustainable ? Insights from the case of Milan. *European Urban and Regional Studies*, 24(4), 337-351.
United Nations. (2015). *Smart Sustainable Cities Indicators*. United Nations: New York, NY,

USA.
United Nations Commission on Science and Technology for Development. (2016). *Economic and Social Council Report of the Partnership on Measuring Information and* (Vol. 4). Available online: http://www.tandfonline.com/doi/abs/10.3846/16111699.2012.754375.
Walker, R. M., & Hills, P. (2012). Partnership Characteristics, Network Behavior, and Publicness: Evidence on the Performance of Sustainable Development Projects. *International Public Management Journal*, *15*(4), 479–499.
Wheeler, S., & Beatley, T. (2014). *The Sustainable Urban Development Reader*. Routledge.

CHAPTER 8

TAXONOMY OF THE HOLISTIC PERFORMANCE OF CURRENT CREATIVE CITIES: AN EMPIRICAL STUDY

ABSTRACT

The measurement of cities' holistic performance is complex but fundamental to conclude about the economic growth of regions and countries. In addition, the results of this measurement allow classification of cities through grouping them in clusters with homogeneous characteristics. In this connection, the aim of this study is to present a taxonomy for cities in terms of homogeneity and similarity for the geographical context analysed. The transversal study carried out covered all Portuguese towns and cities (N = 308), considering a wide range of dimensions, sub-dimensions, indicators and variables, and followed a quantitative research method. Through Exploratory Factor Analysis (EFA), Principal Components Analysis (PCA) and Hierarchical Cluster Analysis (HCA), the results obtained determined the grouping of towns and cities in 12 clusters, which were classified in the taxonomy defined for cities' holistic performance – excellent, high, mean and weak, according to their position in the various rankings extracted (Composite Indices of holistic performance, creative performance, intelligent performance and sustainable performance). This classification by taxonomical profile of clusters is the main contribution of the study. Finally, other implications for theory and practice are presented, as well as suggesting relevant lines of future research.

KEY-WORDS: Composite Index, Creativity, Intelligence, Urban Sustainability, Performance, Clusterization of cities, Taxonomy

1. Introduction

For decades, cities were understood as places of potential problems, but the recent economic and financial crisis has modified this assumption. Specifically, the European Union has recognized cities as vital for economic, social and environmental matters, not implying that the potential problems have disappeared (e.g., poverty, crime), but that urban policies begin to be defined in order to exploit all the benefits offered by cities and operationalized through the 2020 Strategy to achieve intelligent, inclusive and sustainable growth (European Comission & UN Habitat, 2016). Although cities have a crucial role in countries' prosperity, they are more than mere centres of population, economic activity and employment (Haberstroh & Pinkwart, 2018), i.e., they are the drivers of tangible and intangible global growth (Dahiya, 2012; UN-

HABITAT, 2013), where there is evidence of a positive correlation between growth and rapid urban development (Kumar & Dahiya, 2017).

Furthermore, cities are multi-dimensional places, in which the concepts of creativity, intelligence and urban sustainability emerge as fundamental conditions, where intelligence is seen as the result of creative and knowledge-intensive strategies associated with sustainability issues (Kumar & Dahiya, 2017). From this perspective, it is perceived that the dimensions of creativity (e.g., Florida, 2002, 2005; Grant & Kronstal, 2010; Hospers & Pen, 2008; Kakiuchi, 2016; Kong, 2014; Landry, 2000; Pratt, 2008; Ratten, 2017; Scott, 2000), intelligence (e.g., Bouk et al., 2017; Dodgson & Gann, 2011; Letaifa, 2015; Mardikyan et al., 2015; Nam & Pardo, 2011; Ratten, 2017) and urban sustainability (e.g., Camagni, Capello, & Nijkamp, 1998; Cavalcanti, 1995; Elkington, 2004; Pozdniakova, 2017; Wheeler & Beatley, 2014) are inseparable from cities, which in this study are called **current creative cities** (**CCC**). So CCCs are defined as pluralist and multifaceted places characterised by curiosity, imagination, creativity, culture, knowledge, innovation and cooperation (networks) (e.g., Florida, 2002, 2005; Landry, 2000; Letaifa, 2015).

This paradigmatic change in current cities' role in economic growth has also triggered the development of indices to measure their performance as regards their creativity (e.g., European Union, 2017; Florida, Mellander, & Stolarick, 2008; Giffinger et al., 2007; Kakiuchi, 2016), intelligence (e.g., Angelidou, 2017; Ernst & Young, 2016; Picard, Grönlund, & Toivonen, 2003) and sustainability (e.g., European Commission, 2014; Irungbam, 2016; Trivellato, 2016).

However, the literature on this topic still contains gaps in need of research, namely those between theory and practice (Hatuka et al., 2018; Lee, Hancock, & Hu, 2014), and Mora, Bolici, and Deakin (2017) recommend more studies designing holistic models of how CCCs are constructed, which should be preceded by scientific instruments to help all the actors involved in that construction and in assessing and monitoring CCCs' holistic performance (Huovila et al., 2016; Priano & Guerra, 2014). Hatuka et al.(2018) also state that there is still a minimum holistic relationship between theory and practice regarding implementation of the concepts of creativity, intelligence and sustainability, among others, in practical terms on the ground as an integrated whole, and that the academic community has continued to follow an individual approach or in comparative terms rather than as a mix. Robust studies going beyond exploratory and qualitative approaches are also necessary (e.g., case studies) (Della Lucia & Trunfio, 2018).

Aiming to fill the gap between theory and practice found in measuring cities' holistic performance and in their profile, this study intends to present a taxonomy for towns and cities in terms of homogeneity and similarity for the geographical context analysed, that of Portugal.

Standing out among the various contributions of this study is the use of various multivariate statistical techniques to produce robust empirical results of scientific quality on the performance of CCCs, allying theory and practice and consequently revealing the inherent implications for scientific knowledge, the academic community and political decision-makers.

2. Literature review

2.1. Performance indices for CCCs

Recently, Hatuka et al. (2018) argued that studies on cities should focus on the various concepts involved in them as a mix, since a holistic perspective is crucial in order to provide a global, eclectic tool to help a city's development. Standing out among these concepts are creativity, intelligence and urban sustainability, which cover normative and ideological ideas, and distinct spatial and social configurations. The same authors argue that if addressed in a pluralist and multifaceted way, they will illustrate social and environmental changes (urban sustainability), growth and economic efficiency (creativity and intelligence). However, this approach should be supported by a growth policy (Caragliu, Del Bo, & Nijkamp, 2011) that stimulates intelligent organisation of cities' tangible and intangible facilities/amenities, the introduction of information and communication technology (ICT) allied to creativity and innovation, which taken together with cities' urban design will stimulate their economic viability (performance) (Neirotti, et al., 2014; Networked society city index, 2016), network connection with the involvement of all actors to create value and sustainability (Networked society city index, 2016; Pinnegar, Marceau, & Randolph, 2008).

These three dimensions of cities have directed the scientific literature towards the theoretical development of city typologies, with certain types of cities seen as more popular than others (Khan & Zaman, 2018). Within this typology, the creative city, intelligent city and sustainable city stand out, and their premises and characteristics are shown in Table 1.

Table 1 – Typology of cities

Type	Description	Authors
Creative cities	➢ Attraction, retention and mobilisation of creative resources	Hatuka et al. (2018)
	➢ Supported by the creative class	Florida (2002, 2005)
	➢ Tolerant, diversified and open city environment	
	➢ Proposing the 3Ts model - Technology, Talent and Tolerance	
	➢ Places are attractive for people and firms, due to a favourable environment	Esmaeilpoorarabi, Yigitcanlar, and Guaralda (2018); He, Huang, and Xi (2018); He and Huang (2018); Landry (2000); Landry and Bianchini (1995); Mommaas (2004)
	➢ Economic growth promoted by the creative classes	Bayliss (2007); Florida (2002, 2005)
	➢ Creative economy, with productive systems emphasizing networks and market flexibility	Przygodzki and Kina (2015); Scott (2006)

Table 1 – Typology of cities (cont.)

Type	Description	Authors
	➢ Creative and cultural industries (CCI) are characteristic sui generis	Augusto Mateus and Associados (2010)
	➢ Multiple activities generating wealth and employment	Correa-Quezada et al. (2018); Howkins (2001); Silva and Araújo (2010)
	➢ CCIs contribute to urban regeneration	Bayliss (2007); Lewis and Donald (2010); Martone, Pennella, and Sepe (2014); Scott (2006)
	➢ Urban regeneration emphasizes cultural amenities	
	➢ Culture promotes urban entrepreneurship and networks	Grodach (2017); Liu and Silva (2018); Schaller and Guinand (2018)
	➢ Culture and urban regeneration also promote economic growth and are a brand image	Hesse and Lange (2012); Krueger and Buckingham (2009); Martí-Costa and Miquel (2012); Okano and Samson (2010); Sabaté and Tironi (2008)
Intelligent cities	➢ Good governance and ICT are determinant	Angelidou (2017); Batty et al.(2012); Chourabi et al. (2012)
	➢ ICT promotes urban economic growth	Gabrys (2014); Hatuka et al. (2018); Buck and While (2017); Watson (2015)
	➢ ICT stimulates urban regeneration and increases urban efficiency	Hatuka et al. (2018)
	➢ Open, participative governance	Bolívar and Meijer (2016); Giffinger et al.(2007)
	➢ Citizens' involvement and commitment	López-Quiles and Bolívar (2018); Odendaal (2003); Paskaleva (2009)
	➢ Accessibility is important	David et al.(2013); Dijkstra, Garcilazo, and Mccann (2013)
	➢ Emphasizes collaboration/network processes	Fernandes and Gama (2008); Gouvea, Kapelianis, and Kassicieh (2017); Ratten (2017); Networked Society City Index (2016); Snow, Håkonsson, and Obel (2016)
	➢ Places of learning, adaptation and innovation	Caragliu et al. (2011)
	➢ Favourable environment for creative people	Ryser (2014)
Sustainable cities	➢ Balance between human activity and the environment	Jabareen (2006)
	➢ Urban ecosystems	Haughton (1999)
	➢ Concentrating on the rights of present and future generations	Haughton (1999); Jabareen (2006)
	➢ Implying the transformation and restructuring of basic infrastructure	Hatuka et al. (2018)
	➢ Preservation of ecosystems associated with urban regeneration and economic growth	Dempsey et al. (2010)
	➢ ICT is also crucial	Bifulco et al.(2016); Funk (2015); Wang, Chen, and Benitez-Amado (2015); Wu and Raghupathi (2015)
	➢ Economic sustainability and collaboration processes	Elkington (1994); Kirchberg and Kagan (2013); Pozdniakova (2017)
	➢ Open innovation networks (e.g., living labs)	Asheim, Coenen, and Vang (2007); Banks et al. (2000); Cohen and Munoz (2015); Ratten (2017); Sharma and Kearins (2011); Siegel (2016); Vinodrai (2006)
	➢ Social sustainability	Andreotti, Mingione, and Polizzi (2012); Dempsey et al. (2011); Livert and Gainza (2017); Pitarch-Garrido (2018); Vadrevu and Kanjilal (2016)

Table 1 – Typology of cities (cont.)

Type	Description	Authors
	➢ Emvironmental sustainability	Ghisellini, Cialani, and Ulgiati (2016); Lilja (2015); Sepe (2013); Smol, Kulczycka, and Avdiushchenko (2017)

Source: Own elaboration

This description of cities' typology reveals the dynamism, complementarity and flexibility rooted in these concepts (Hatuka et al., 2018), with the common aim of improving city residents' quality of life (Fahy & Cinnéide, 2006; Fainstein, 2015; Martone et al., 2014), besides being supported by collaborative processes in participative and open governance (Hatuka et al., 2018). In other words, the complementarity between these concepts is noted, and so addressing them through a holistic vision is desirable in order to improve cities' economic growth (Lombardi & Vanolo, 2015).

2.2. Measuring the holistic performance of CCCs

This typology of cities has been widely studied in the academic world, leading to the emergence of numerous models and indices to measure cities' performance in terms of creativity (e.g., Saisana & Montalto, 2016; Stano & Węziak-Białowolska, 2017; Wu et al., 2008), intelligence (e.g., Arroub et al., 2016; Caragliu et al., 2011; Castelnovo, Misuraca, & Savoldelli, 2016; Viale-Pereira et al., 2017) and urban sustainability (e.g., Addanki & Venkataraman, 2017; Ahmad & Mehmood, 2015; Dizdaroglu, 2017; Skrede, 2016), *per se*.

Given this dispersion and fragmentation of performance indices, and recognizing that not all existing indices, indicators and proxies to measure cities' global performance have been explored, Table 2 summarises the most studied sub-dimensions of cities regarding their creativity, intelligence and urban sustainability together with their respective general indicators.

Table 2 - Index of creativity, intelligence and urban sustainability

Typology	Sub-dimension	General indicator	Source
Creative city	Culture	Places of culture and facilities	Bosch et al. (2017); Durmaz, Platt, and Yigitcanlar (2010); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley, Potts, and MacDonald (2012); Kakiuchi, 2016; Lombardi et al. (2012)
		Cultural participation and attractiveness	
	Creative economy	Creativity and employment	Bosch et al. (2017); Caragliu et al. (2011); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Joss, Cowley, and Tomozeiu (2013); Landry (2013); Kakiuchi (2016); Lombardi et al. (2012); Panal and Yáñez (2012); Skavronska (2017)
		Intellectual property and innovation	
	Favourable environment	Human capital and education	Caragliu et al. (2011); Dhingra and Chattopadhyay (2016); European Union (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Hartley et al. (2012); Landry (2013); Skavronska (2017); United States Environment Protection Agency (2016)
		Openness, tolerance and trust	
		Local and international connections	
		Governance	
Smart city	Governance	Implementation	Landry (2013); United Nations (2015)
		Strategy	Angelidou (2017); Bosch et al. (2017); Landry (2013); Madeira, Guimarães, and Mendes (2016)
		Democratic	Angelidou (2017); Bloom Consulting (2017); Garau, Balletto, and Mundula (2017); García Suárez and Pulido Fernández (2015); Giffinger et al. (2007); Lombardi et al. (2012)
	ICT infrastructure and networks	Telecommunications	Ernst and Young (2016); Networked society city index (2016)
		Transport	Ernst and Young (2016)
		Energy	
		Environment	
		Sensors	
	ICT accessibility	Tariffs	Networked society city index (2016)
		Mobility	Ernst and Young (2016)
	Use of ICT	of technology	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
		Individual	Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016)
		Public	Bloom Consulting (2017); Caragliu et al. (2011); Giffinger et al. (2007); Lombardi et al. (2012); Madeira et al. (2016); Ernst and Young (2016); Networked society city index (2016)
	Vitality	Individual and public	Ernst and Young (2016)
Sustainable city	Economic	Competitiveness	Adnan, Hamzah, and Alias (2016;) Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Caragliu et al. (2011); Devol, Ratnatunga, and Bedroussian (2016); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
		Economic activity	Angelidou (2017); Bloom Consulting (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)

Table 2 – Index of creativity, intelligence and urban sustainability (cont.)

Typology	Sub-dimension	General indicator	Source
	Social	Population	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Trivellato (2016); United States Environment Protection Agency (2016)
		Education	Batten (2016); Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012)); Networked society city index (2016); Trivellato (2016); United States Environment Protection Agency (2016)
		Inclusion and cohesion	Bosch et al. (2017); Giffinger et al. (2007); Trivellato (2016)
		Social infrastructure	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Lombardi et al. (2012); Networked society city index (2016); Trivellato (2016)
	Environmental	Basic infrastructure	Batten (2016); Bosch et al. (2017); Lombardi et al. (2012); Networked society city index (2016)
		Emission and production of atmospheric pollution	Bloom Consulting (2017); Bosch et al. (2017); Giffinger et al. (2007); Joss et al. (2013); Lombardi et al. (2012); Networked society city index (2016)
		Circular economy	Ligorio (2017); Smol et al. (2017)
		Urbanism	Artmann et al. (2017); Batten (2016); Bloom Consulting (2017); Dhingra and Chattopadhyay (2016); Lombardi et al. (2012); Networked society city index (2016); United States Environment Protection Agency (2016)

Source: Own elaboration

The multidimensional complexity shown in the table above implies that determining the weight of each dimension in cities' holistic performance, through an index compiling all the indicators and proxies – **Composite Index** -, should be carried out by applying them in more detail, as mentioned by Borén and Young (2013) and Flores and Teixeira (2017), with the final results allowing clustering of cities in a given geographical context to make it possible to determine the impact of policies implemented for urban economic development in harmony with the sustainable, inclusive and intelligent growth aimed for by the European Union (Franchi-Arzola, Martin-Vide & Henríquez, 2018).

3. Research methodology

3.1. Population, data collection and definition of a taxonomy of performance

The population covered in this study is all Portuguese towns and cities (N = 308), belonging to 7 different regions, with the North, Centre and Lisbon Metropolitan Area having greatest population density.

In Portugal there is no single database including the statistical data necessary to measure the performance of the dimensions of creativity, intelligence and urban sustainability, and so the data come from the National Statistics Institute (INE), Pordata and the official websites of various institutions, added to the insufficiency of data related to cities. This study's unit of analysis is the city, whose importance as such was highlighted by Erkkilä and Piironen (2018).

The unavailability and dispersion of data delimited the choice of indicators and their proxies (variables), while ensuring they have the essential characteristics of a good indicator, which are clarity, simplicity, reproduction, scientificity, salience, credibility, legitimacy and comparability (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005). It is also crucial that systematized indicators have these characteristics, as the quality of a composite index depends on these criteria (Saisana & Tarantola, 2002; Staníčková & Melecký, 2018), as well as the choice of research method. The systematization of the research method, namely the different multivariate statistical techniques, aims to overcome the heterogeneity of the units of measurement and periods of reference of the data, due to using multiple indicators to ensure the results obtained are scientific, robust and relevant (Kľúčik & Haluška, 2008; OECD, 2008).

Therefore, it is noted that to measure the global performance of the 308 Portuguese towns and cities the aggregation and weighting methods defined by the OECD (2008) are used, i.e., EFA, with the final results allowing application of HCA to respond to the aim of this study.

Given the high number of sub-dimensions (8), indicators (24 general indicators and 47 specific) and proxies used, corresponding to 157 variables to measure the creative, intelligent and sustainable performance – **holistic performance** – forming the final database for HCA – **clusterization of the 308 Portuguese towns and cities** -, it was decided not to present here a detailed compilation of the variables. However, the indicators and inherent variables reflect the connection between each dimension and CCCs performance.

HCA allows the definition of groups for the population analysed, with homogeneity in relation to the variables studied (Marôco, 2014; Mooi & Sarstedt, 2011). The Ward method was used to combine elements (Marôco, 2014; Mooi & Sarstedt, 2011) and the Squared Euclidian Distance to calculate the distance between the elements of the population analysed (Marôco, 2014; Mooi & Sarstedt, 2011). The choice of this technique is related to working with measurable data to obtain a taxonomy (Bailey, 1994).

Finally, the need to perform EFA for each sub-dimension and dimension is due to the importance of drawing up a city ranking for them (a large amount of information and therefore not presented), thereby classifying the clusters obtained in the taxonomy shown in Figure 2 as the result of Figure 1.

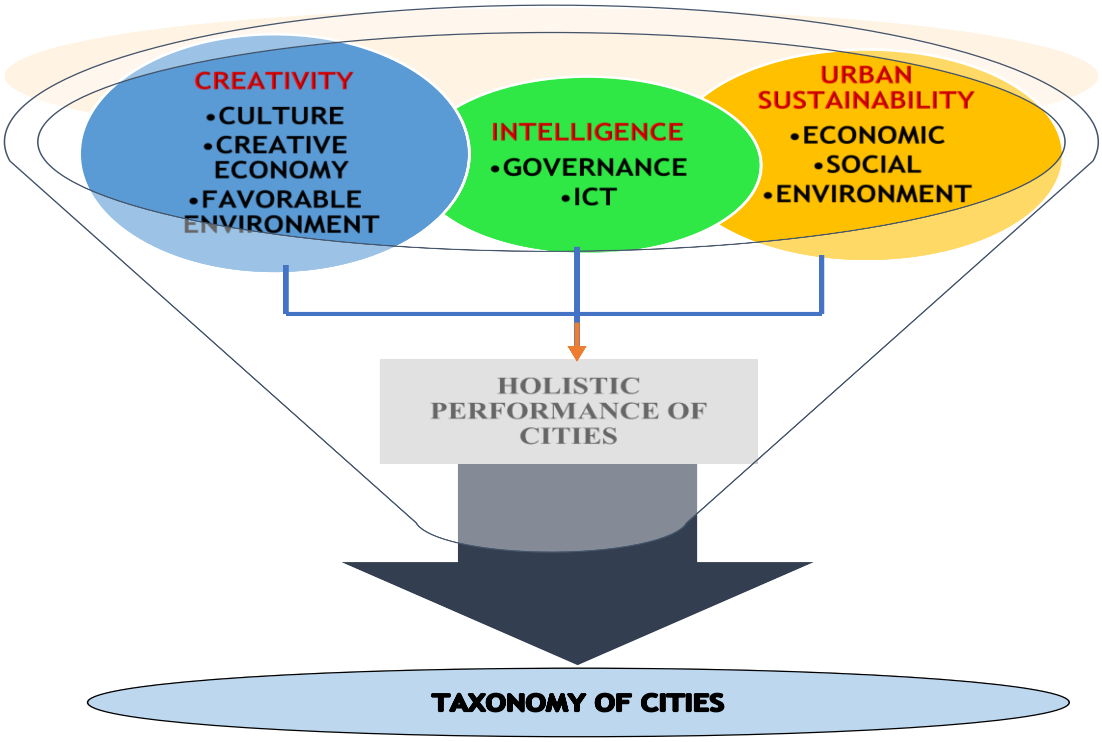

Figure 1 – Model of cities' holistic performance (**Source:** Own elaboration)

3.2. Data treatment and results

Statistical treatment of the data gathered for the 308 Portuguese towns and cities was carried out using IBM SPSS (version 25.0) software and covered various distinct stages, as summarised in Table 3.

Table 3 – Stages of statistical treatment of data

Stages	Description of methodological procedures	Presentation of results obtained
1) Determining the validity of observations	**1)** The 308 observations represent five times the number of variables studied, as recommended by Marôco (2014).	Validated observations
2) Descriptive statistics	**2.1)** The heterogeneity of the units of measurement and periods of reference required normalization of the 154 variables, opting for *Z-scores*, whose descriptive statistics took the value of zero for the mean and one for the standard deviation (El Gibari, Gómez, & Ruiz, 2018; Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; OECD, 2008). **2.2)** The descriptive analysis is not presented, due to the use of *Z-scores* (Marôco, 2014; OECD, 2008).	Conversion of variables to a common scale
3) Calculating the weightings of the sub-dimensions in the dimension	**3.1)** Application of EFA and PCA to obtain a robust composite index of scientific quality per dimension (Al Sharmin, 2011; El Gibari et al., 2018; Guimarães & Sarsfield Cabral, 2010; Hair et al., 1995; OECD, 2008; Pestana & Gageiro, 2014;). **3.2)** EFA was preceded by verification of its applicability by carrying out the KMO (Kaiser, 1974)	Table 4

Table 3 – Stages of statistical treatment of data (cont.)

Stages	Description of methodological procedures	Presentation of results obtained
	and Bartlett Sphericity (Marôco, 2014) tests, but the Cronbach Coefficient Alpha was not calculated.[21]	
4) Calculation of the values observed	4.1) Determined by the sum of the product between the value of each variable normalized by the weighting coefficient obtained for each of them in the previous stages (1st, 2nd, 3rd) (OECD, 2008). The data obtained in this stage are the variables to be analysed in the following stage, where the determination process is according to that described by the OECD (2008).	Formulas 1 and 2 Entered in SPSS
5) Calculating the weightings of each dimension in the Composite Index	**5.1)** Application of EFA to the dimensions of creativity, intelligence and urban sustainability to obtain the total weight of each in the Composite Index of the total performance of Portuguese towns and cities, in which the first three stages described above are repeated. **5.2)** For the values observed per town and per dimension, their descriptive analysis was carried out (Marôco, 2014).	Tables 5 and 6
6) Clusterization of cities	**6.1)** Application of HCA to identify the groups of the population analysed with homogeneity in relation to the variables studied (Marôco, 2014; Mooi & Sarstedt, 2011), to the data obtained in 4). **6.2)** Use of the Ward method to combine the elements whose connection increases the global variation within the cluster as little as possible (Marôco, 2014; Mooi & Sarstedt, 2011). **6.3)** Squared Euclidian Distance was used to measure the distances between the elements of the population analysed (Marôco, 2014; Mooi & Sarstedt, 2011). The categorization or grouping provided by HCA is supported by measurable data, and so the designation of a taxonomy for cities is an appropriate classification (Bailey, 1994).	Tables 7, 8 and 9 Appendix 1

Source: Own elaboration

Carrying out the procedures (third stage) mean t obtaining a large amount of statistical information for the dimensions of creativity, intelligence and urban sustainability and the respective sub-dimensions, but as this is not the main objective of the study it is not presented. Nevertheless, it is important to mention that the values obtained in the KMO tests for the sub-dimensions (8) regarding each dimension (Kaiser, 1974) shows data quality to vary between reasonable, average and good, meaning that EFA can be applied to them (Marôco, 2014). In addition, the communalities extracted (h^2) respect the minimum required of 0,32 (Costello & Osborne, 2005; Tabachnick & Fidell, 1996) in all the sub-dimensions (8) analysed. Similarly, the 154 variables analysed present loadings above the required minimum of 0,40, and so the explained variances have significant values (Marôco, 2014). Finally, EFA and PCA retained a

[21] In order to verify the internal consistency of the (sub)dimensions used, it is usual to calculate the Cronbach Alpha, however, in this study the Cronbach Coefficient Alpha was not considered because "correlations do not necessarily represent the real influence of the individual indicators on the phenomenon expressed by the composite indicator" (OECD, 2008: 27).

total of 51 factors for the dimensions of creativity (17), intelligence (12) and urban sustainability (22). The figures obtained for each factor led to calculation of the *"weights from the matrix of factor loadings after rotation, given that the square of factor loadings represents the proportion of the total unit variance of the indicator which is explained by the factor"* (Kubrusly, 2001; OECD, 2008: 90). Based on these results, the conditions are joined for determination of the weightings associated with each variable, obtained from the product between the normalized loadings raised to the square and the value of the explained variance for each factor. Briefly, this stage allowed determination of the weight of each sub-dimension in the respective dimension, as shown in Table 4.

Table 4 - EFA of sub-dimensions and weights

Subdimensions	h^2	Factor - Creativity	Weights
Culture	0,446	0,668	0,220
Creative Economy	0,772	0,878	0,380
Favourable Environment	0,810	0,900	0,399
Eigenvalue		2,03	
% Explained variance		67,59	
Total explained variance		67,59	
Varimax Rotation; N = 308; KMO = 0,607; Bartlett Sphericity Test= 299,642; gl = 3; p < 0,000			
Subdimensions	**h^2**	**Factor - Intelligence**	**Weights**
Governance	0,566	0,752	0,500
ICT	0,566	0,752	0,500
Eigenvalue		1,13	
% Explained variance		56,55	
Total explained variance		56,55	
Varimax Rotation; N = 308; KMO = 0,500; Bartlett Sphericity Test = 5,290; gl = 1; p < 0,000;			
Subdimensions	**h^2**	**Factor - Urban Sustainability**	**Weights[22]**
Economic sustainability	0,621	0,788	0,386
Social sustainability	0,393	0,627	0,245
Environmental sustainability	0,593	0,770	0,369
Eigenvalue		1,61	
% Explained variance		53,60	
Total explained variance		53,60	
Varimax Rotation; N = 308; KMO = 0,598; Bartlett Sphericity Test = 83,775; gl = 3; p < 0,000;			

Source: Adapted from outputs of SPSS

The weightings obtained for the 157 variables obtained in stage 3 allowed determination of the value observed per town, which was obtained by summing the product of each normalized variable (*Z-scores*) obtained with IBM SPSS software by the weighting (fourth stage). These calculations were made for all the dimensions (3) and sub-dimensions (8) analysed. For example, the numerical value of the creativity dimension for a town was obtained as follows:

$$\sum(Zscore\ \ i\times\ weighting\ i)+\cdots(Zscore\ i\times weighting\ i)$$
$$=value\ observed\ for\ a\ town\ in\ the\ culture\ sub$$
$$-\ dimension\ (1{,}61926)\ \ [Formula\ 1]$$

(i = LIC1 to DM1, where i = 23 variables; Z-scores obtained through SPSS)

[22] Example of calculation for Economic sustainability: 0,788^2/1,61 = 0,386

It was then necessary to determine the numerical value per town in each dimension, from the sum of the product between the value observed per town for each sub-dimension and the weighting of each sub-dimension in the dimension. As an example, for the creativity dimension, the formula is as follows:

$$Culture(1{,}619 \times 0{,}22) + Creative\ Economy(4{,}987 \times 0{,}38) + Favourable\ Environment(3{,}171 \times 0{,}396) = Creativity(3{,}5158)[Formula\ 2]$$

Finally, the values obtained from formula 2 for the 308 Portuguese towns and cities represent the numerical data to enter in SPSS of the dimension of creativity (variable 1), intelligence (variable 2) and urban sustainability (variable 3) for application of EFA (Table 6), aiming to obtain the composite weighting of each dimension in the total performance of Portuguese towns and cities (fifth stage), and preceded by a descriptive analysis (Table 5).

Table 5- Descriptive statistics of the population

Dimensions	N	Mean	Standard Deviation	Minimum	Maximum
Creativity	308	0,000	0,383	-0,3077	3,5158
Intelligence	308	0,000	0,261	-0,6105	0,9299
Urban Sustainability	308	0,000	0,230	-0,4519	1,5015

Source: Adapted from outputs of SPSS

Table 6 - EFA for the dimensions of creativity, intelligence and urban sustainability

Dimensions	h^2	Factor Total Performance	Weights[23]
Creativity	0,692	0,832	0,380
Intelligence	0,426	0,652	0,234
Urban Sustainability	0,702	0,838	0,386
Eigenvalue		1,82	
% explained variance		60,65	
Total explained variance		60,65	
Varimax Rotation; N = 308; KMO = 0,613; Bartlett Sphericity Test =162,366; gl = 3; p < 0,000			

Source: Adapted from outputs of SPSS

The results presented in Table 6 show that the KMO test reveals reasonable data quality and that the communalities (**h^2**) extracted are above 0,40 as required (Marôco, 2014).

Extraction of these results means conditions are joined to present the results of HCA (12 clusters for N = 308) shown in Tables 7, 8 and 9.

Table 7 shows the clusters obtained by the dendrogram drawn by HCA in SPSS (see Appendix 1 with the cluster composition).

[23] Example of calculation for creativity: 0,832^2/1,821628 = 0,380

Table 7 – Taxonomy of towns (N = 308)

Cluster	Number of towns	%	Cluster	Number of towns	%
1	52	16,9	7	16	5,2
2	29	9,4	8	3	1
3	116	37,7	9	33	10,7
4	23	7,5	10	1	0,3
5	6	1,9	11	19	6,2
6	6	1,9	12	4	1,3

Source: Adapted from outputs of SPSS

The taxonomical profile of the 12 clusters obtained (Table 10) is presented based on the diagram of holistic performance (Figure 2).

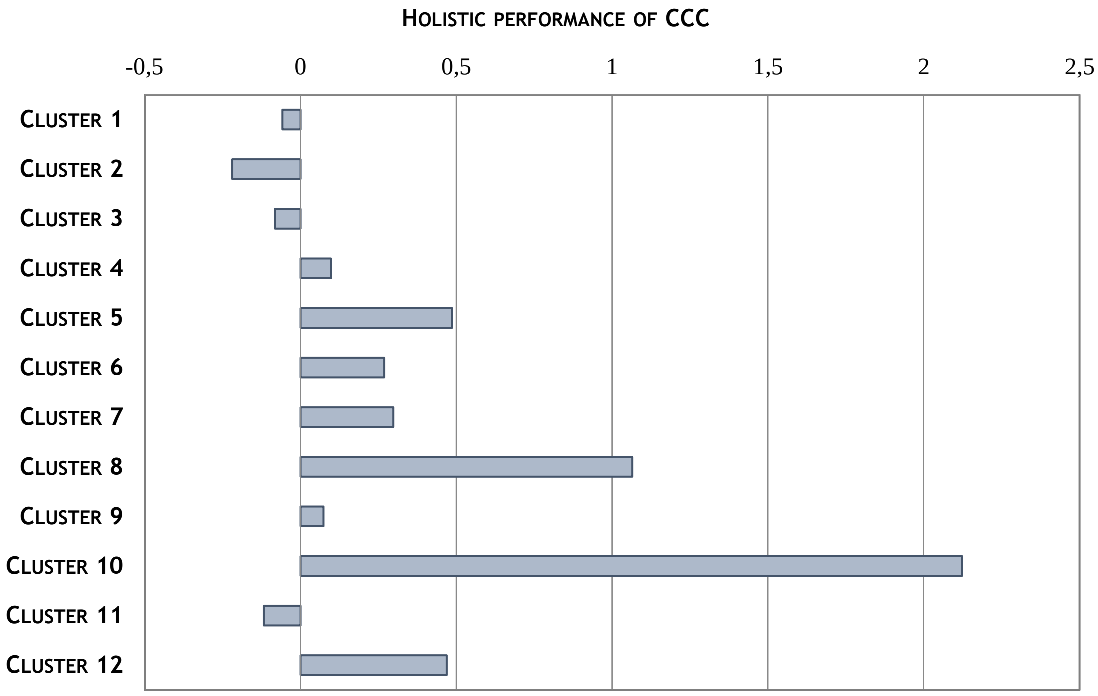

Figure 2 – Holistic performance by clusters

Table 8 shows the average values of holistic performance, dimensions and sub-dimensions, and Table 9, the ranking per cluster.

Table 8 – Mean value per cluster

Cluster	Holistic performance	Creativity	Sub-dimension			Intelligence	Sub-dimension		Urban sustainability	Sub-dimension		
			Culture	Creative economy	Favourable environment		Governance	ICT		Economic	Social	Environmental
1	-0,0581	-0,1456	-0,0912	-0,1844	-0,1393	0,1167	0,3325	0,0994	-0,0779	0,0062	0,1639	-0,1091
2	-0,2191	-0,1892	-0,2458	-0,1787	-0,1687	-0,3051	-0,0703	0,5393	-0,1965	-0,1826	0,0971	-0,2768
3	-0,0820	-0,1237	-0,1154	-0,1226	-0,1295	-0,1399	-0,1862	0,0934	-0,0060	-0,0090	0,0186	0,0056
4	0,0976	0,2158	-0,0048	0,1356	0,4144	-0,0682	-0,1371	0,0008	0,0817	0,0968	0,1654	0,0106
5	0,4869	1,0441	0,3449	1,0514	1,4258	0,0989	0,0214	0,1763	0,1734	0,1984	0,3453	0,0334
6	0,2691	0,5507	-0,0731	1,5032	-0,0102	0,0063	-0,0362	0,0489	0,1510	0,3744	0,0166	0,0280
7	0,2974	0,2082	0,4048	0,1943	0,1133	0,2385	0,0103	0,4664	0,4208	0,3476	0,0833	0,7210
8	1,0652	2,1405	0,6629	2,3501	2,7627	0,2164	-0,0933	0,5257	0,5209	0,6539	0,6074	0,3242
9	0,0731	-0,0559	0,1767	-0,0817	-0,1595	0,3679	0,1414	0,5937	0,0214	-0,1320	0,0059	0,1924
10	2,1231	3,5158	1,6191	4,9867	3,1703	0,8860	0,4378	1,3327	1,5015	2,5591	0,8479	0,8269
11	-0,1186	-0,0283	0,0479	-0,0952	-0,0055	0,0359	0,2173	0,1455	-0,3012	-0,3077	0,1476	-0,5916
12	0,4683	0,4935	1,7293	-0,0246	0,3079	0,4437	0,1166	0,7700	0,4585	0,1189	0,1810	0,9980

(confidence interval of 95%)
Source: Adapted from outputs of SPSS

Table 9 – Position of clusters in the rankings

Cluster	Holistic performance	Creativity	Sub-dimension			Intelligence	Sub-dimension		Urban sustainability	Sub-dimension		
			Culture	Creative economy	Favourable environment		Governance	ICT		Economic	Social	Environmental
10	1	1	2	1	1	1	1	1	1	1	1	2
8	2	2	3	2	2	5	10	4	2	2	2	4
5	3	3	5	4	3	7	6	6	5	5	3	6
12	4	5	1	7	5	2	5	2	3	6	4	1
7	5	7	4	5	6	4	7	5	4	4	7	3
6	6	4	9	3	8	9	8	7	6	3	9	7
4	7	6	8	6	4	10	11	8	7	7	5	8
9	8	9	6	8	11	3	4	3	8	10	8	5
1	9	11	10	12	10	6	2	10	10	8	12	10
3	10	10	11	10	9	11	12	9	9	9	10	9
11	11	8	7	9	7	8	3	11	12	12	6	12
2	12	12	12	11	12	12	9	12	11	11	11	11

Source: Own elaboration

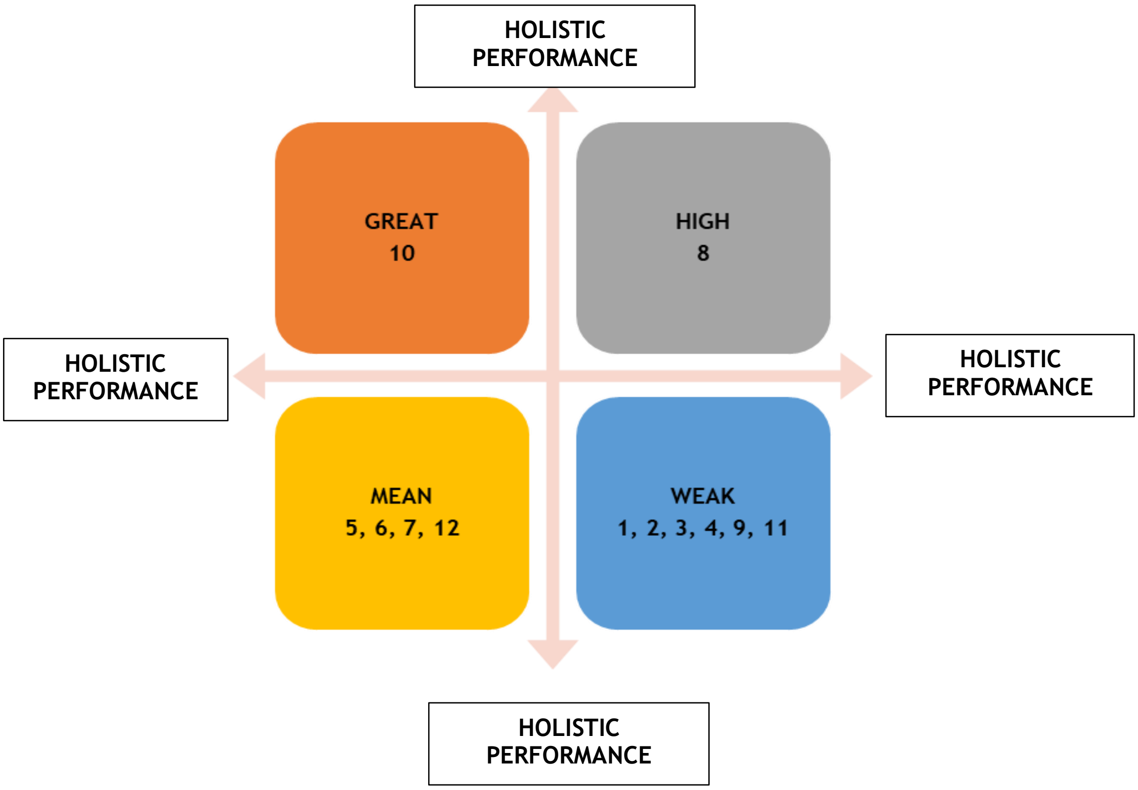

Figure 3 – Classification of taxonomical profiles (taxonomy) of Portuguese towns and cities (**Source:** Own elaboration)

4. Discussion of the results

The results presented in the previous section reveal that Portugal still needs more incentives and actions directed towards achieving better holistic performance in most towns, except for cluster 10 which shows excellent performance (above 2) achieved by strategies of creativity, intelligence and urban sustainability understood as mutually connected axes promoting their growth and the individual and collective participation of all resident actors. In other words, the city of Lisbon is supported by a growth policy (Caragliu et al., 2011) based on the mix of intangible and tangible resources used creatively, intelligently and sustainably as referred to in the literature (e.g., Neirotti et al., 2014) and on collaboration processes (Pinnegar et al., 2008).

Specifically, clusters 1, 2, 3 and 11 present a negative holistic performance (weak taxonomy), which from their composition does not allow association with low population density or an inland location. For example, cluster 11 includes Odivelas, cluster 2 includes Guimarães which was European Capital of Culture, and cluster 1 includes Fundão, well-known for belonging to national and international networks and for the Cova da Beira *Living Lab*. In these clusters, performance per dimension is similar (Table 9), highlighting cluster 11 in 8th position in creative performance and intelligence and cluster 1 in 6th position in the intelligence dimension. Interpretation of these results is *sui generis*, for two reasons. The first is due to the strategies implemented not being assessed and monitored appropriately by local authorities, and so corrective measures are not taken for their effect to be reflected in economic growth. The second reason is related to the fact that strategies should be adapted to each city's exogenous and endogenous characteristics rather than the same static applications to all places.

Clusters 4 and 9 present a positive performance, albeit weak. For example, they include towns with relevant historical and cultural heritage, with tourist attractions (e.g., Viana do Castelo, Idanha-a-Nova) and activities appreciated by Portuguese nationals and foreigners together with a pleasant climate (e.g., Castanheira de Pera, Peniche, Silves). This means that local authorities should take even greater advantage of their tangible and intangible amenities to improve their holistic performance. Towns included in clusters 4 and 9 adopt creative policies that place them in 6th and 9th position, intelligent policies in 10th and 3rd position and sustainable policies in 7th and 8th position respectively. These results show that the policies implemented do not manage to produce positive and visible reflections in the growth and performance of towns included in these clusters (e.g., Franchi-Arzola et al., 2018), although in some of these towns partnerships associated with culture are seen to be relevant in facing the challenge to grow. Indeed, these have been mentioned as drivers of economic growth in urban areas (e.g., Asheim et al., 2007; Grodach, 2017; Pitarch-Garrido, 2018; Ratten, 2017).

Towns such as Matosinhos, Braga and Oeiras are included in clusters presenting mean holistic performance (clusters 5, 6, 7 and 12). These clusters occupy relevant positions in the performance ranking per dimension, although with different levels, meaning that concentrating on strategies of creativity, intelligence and urban sustainability represents different levels of importance. Different levels of importance given to each dimension *per se* are an obstacle to these towns seeing potential improvement in their holistic performance, because as argued by Lombardi and Vanolo (2015), the complementarity between these dimensions should not be ignored, just as the question of being pluralist spaces that should promote creativity in harmony with technological innovation, sustainability and partnerships (e.g., Landry, 2000; Letaifa, 2015), to become effective CCCs.

Finally, cluster 8 including only Porto, Aveiro and Coimbra have a high holistic performance, i.e., cities belonging to regions with different resources and that are appropriately managed by the local authorities, so that the joint return is reflected in improved holistic performance. In this case, we have strategies that are defined to solve urban problems through an approach that values the mix of the three dimensions (e.g., Hatuka et al., 2018).

Overall, the results obtained show that towns in different region (NUTS II) present similarities in the strategies adopted to become creative, intelligent and sustainable, with effects on their holistic performance. Nevertheless, a great difference is found in the levels of performance obtained by all the towns analysed. This difference means that although political decision-makers in Portugal recognize towns as vital for growth, their benefits are not yet completely exploited, as these are a way to operationalize intelligent, inclusive and sustainable growth (European Comission & UN Habitat, 2016; Haberstroh & Pinkwart, 2018).

In most of the clusters obtained, the three dimensions of holistic performance are seen to occupy different positions in the ranking (Table 9), possibly related to local governments' strategic options with regard to their tangible and intangible resources. From another perspective, except for cluster 10, these results contradict studies made by consultants (e.g., Bloom Consulting; Inteli) triggered by the paradigmatic change in the role cities are taking on in countries' growth (Florida, 2002, 2005), which has led to measurement of their performance being somewhat insurmountable (e.g., European Union, 2017; Kakiuchi, 2016; Trivellato, 2016), the explanation lying in the fact of not adopting a holistic approach and using a limited number of variables to classify towns as creative, intelligent and sustainable, i.e., existing studies classify towns per dimension individually and not as a whole, as claimed by (Hatuka et al., 2018). This argument is visible from observation of Table 9 and Figure 3, which clearly shows that:

- **Group 1)** cluster 1 is characterised by concentrating on the intelligence dimension focused on the governance sub-dimension (position 2); cluster 2 has not managed to implement strategies that give results in terms of a positive performance in any dimension (mostly position 12); cluster 3 presents only minimal effects in any of the dimensions (positions between 9 and 11); cluster 4 presents impacts on performance regarding creativity focused on the creative economy and a favourable environment and on sustainable performance with a balance between economic and social, rather than environmental, sustainability, while the intelligence dimension (position 10) has not produced any effect on growth; cluster 9 has directed actions towards intelligence, focusing especially on the ICT sub-dimension (position 3) and cluster 11 begins to show signs of following policies focused on practices of good governance (position 3) and social sustainability (position 6);
- **Group 2)** cluster 5 is characterised fundamentally by improving its performance through implementing policies focused on the creative economy (position 4) and on a favourable environment (position 3); cluster 6 focuses on a creative economy to raise its performance associated with economic sustainability (position 3); cluster 7 presents little focus on the governance sub-dimension and on social sustainability (position 7), unlike environmental sustainability (position 3), and cluster 12 clearly concentrates on creativity based on cultural resources (position 1) to impact its performance;
- **Group 3)** cluster 8 shows a high emphasis on the creativity dimension and on urban sustainability (position 2) rather than on intelligence (position 5);
- **Group 4)** cluster 10 clearly concentrates on all urban dimensions holistically (position 1).

Summarising, it is concluded that **group 1** has not yet managed to follow strategies that reflect taking advantage of its own resources to generate economic growth, and thereby combat the negative aspects of an inland location, decline and others; **group 2** concentrates on the creativity dimension to grow and improve its performance, **group 3** emphasizes the dimensions of creativity and urban sustainability as pillars of its growth and **group 4** presents a holistic, integrated performance.

5. Contributions, limitations and future lines of research

The main contribution of this study lies in obtaining empirical evidence to allow definition of a taxonomy for towns and cities according to their holistic performance, which despite being carried out in Portugal can be applied to any geographical context. This contribution responded to the aim of the study, with the database constructed and its analysis through several multivariate statistical techniques giving it the robustness and scientific quality this type of taxonomy requires.

Therefore, the gap remaining between theory and practice was filled (Hatuka et al., 2018) and a methodological and holistic tool was constructed to assess and monitor the performance of CCCs in the 21st century (Huovila et al., 2016; Priano & Guerra, 2014), through quantitative methodology as suggested by Della Lucia and Trunfio (2018).

Regarding theory, this study contributed to confirmation of a connection and complementarity between the concepts inherent to creativity, intelligence and urban sustainability supported by the inclusion of tangible and intangible factors and/or amenities with mediating effects on towns' holistic performance and determining their classification in the taxonomy presented. The approach adopted to validate the indicators is also an implication for theory, as their robustness, scientificity and internal and external validity are corroborated by an appropriate quantitative research methodology, leading to a new vision of how to measure that performance besides using traditional methods and factors, through a Composite Index. Furthermore, this index leads to obtaining numerical data to allow the clustering of towns with a view to their classification according to taxonomical profile.

An original study is presented, both in the geographical context chosen and the volume of indicators and variables used. Specifically, a large sample was used, associated with the great number of variables for each indicator, revealing that Portugal still needs to strengthen the emphasis on the axes forming its growth policy at the macro level, these being applied at the city level. This means that if the intention is to minimize the regional differences and asymmetries caused by the isolated location and demographic decline of some towns, crucially that policy must be duly assessed and monitored in terms of its final result – holistic performance – so that towns do not understand the level of their own (tangible and intangible) resources as preventing their improved performance. That exploitation of own resources does not mean that specific local investment is not necessary, but this can be conjugated with existing amenities and provide synergies to raise performance. Finally, the methodological tool presented in this study allows local authorities to assess their policies and improve their position by taking corrective measures regarding their weaknesses and in so doing continuously improve their performance.

Despite these contributions, the study presents limitations that can originate future lines of research. The first limitation is in relation to the geographical context of the study, towns and cities in a single country, which does not allow comparison of the results with those of another country of a similar size, and so a subsequent study with more countries is suggested in order to provide even more relevant results and implications. The second limitation has to do with the chronology of the information about the towns due to the unavailability of recent data for many of the variables analysed, which suggests longitudinal studies to determine the chronological evolution of performance. The third limitation concerns the use of only quantitative rather than mixed data, as qualitative research methodology in the form of single or multiple case studies will help perception of “how” and “why” a given town is included in cluster X and not Y. In addition, the strategies adopted are those referenced by the academic community, but without visible effects on performance, which can be yet another line of future research.

6. Conclusions

Measuring the holistic performance of CCCs is a complex process, but essential to classify towns and cities in a taxonomy based on measurable data. This cannot be defined only through traditional factors such as employment, the number of firms created, level of education and others, but must cover those factors where their intangible nature does not prevent them being translated into numerical data, such as the number of *intra* and *inter* networks towns belong to, if they concentrate or not on collaboration processes, if they adopt a creative economy, and many others. Consequently, this study showed this to be possible, and produced reliable and robust results.

The study also demonstrated that the conceptual framework of towns and cities based on creativity, intelligence and urban sustainability is an approach allowing practical implementation and subsequent measurement by a composite index which serves as the basis for their clusterization. Moreover, this study did not exhaust the possibilities for future research, but increased theoretical and practical understanding of this complex phenomenon involving CCCs.

References

Addanki, S. C., & Venkataraman, H. (2017). Greening the economy: A review of urban sustainability measures for developing new cities. *Sustainable cities and society*, *32*, 1-8.

Adnan, Y. M., Hamzah, H., & Alias, A. (2016). An initiatives-based framework for assessing smart city. *Planning Malaysia Journal*, *14*(5), 13-22.

Ahmad, N., & Mehmood, R. (2015). Enterprise systems: are we ready for future sustainable cities. *Supply Chain Management: An International Journal*, *20*(3), 264-283.

Al Sharmin, A. (2011). *A Composite Index to Assess the Regional Development: A Districts-Level analysis*. VDM Publishing.

Andreotti, A., Mingione, E., & Polizzi, E. (2012). Local Welfare Systems: A Challenge for Social Cohesion. *Urban Studies*, *49*(9), 1925–1940.

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 4–28.

Arroub, A., Zahi, B., Sabir, E., & Sadik, M. (2016). A literature review on Smart Cities: Paradigms, opportunities and open problems. *Proceedings - 2016 International Conference on Wireless Networks and Mobile Communications, WINCOM 2016: Green Communications and Networking*, 180–186.

Artmann, M., Kohler, M., Meinel, G., Gan, J., & Loja, I. (2017). How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecological Indicators*, (June), 1–13.

Asheim, B., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670.

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1), 45-64.

Augusto Mateus & Associados. (2010). O setor cultural e criativo em Portugal. *Lisboa: GPEARI-Ministério da Cultura*.

Bailey, K. (1994). *Typologies and taxonomies: An introduction to classification techniques* (Vol 102). *Sage*.

Banks, M., Lovatt, A., O'Connor, J., & Raffo, C. (2000). Risk and Trust in the Cultural Industries. *Geoforum* , *31*(4), 453–464.

Batten, J. (2016). Sustainable Cities Index 2016. *Arcadis Global*, 10. Available online: https://www.arcadis.com/media/0/6/6/%7B06687980-3179-47AD-89FD-F6AFA76EBB73%7DSustainable Cities Index 2016 Global Web.pdf.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., & Bazzani, A. (2012). Smart cities of the future, *The European Physical Journal Special Topics*, *214*(1), 481-518.

Bayliss, D. (2007). The Rise of the Creative City: Culture and Creativity in Copenhagen. *European Planning Studies*, *15*(7), 889–903.

Bifulco, F., Tregua, M., Amitrano, C. C., & D'Auria, A. (2016). ICT and sustainability in smart cities management. *International Journal of Public Sector Management*, *29*(2), 132–147.

Bloom Consulting. (2017). Portugal ConsultingCity Brand Ranking 2016 - Municípios Portugueses. *Bloom Consulting Countries Regions and Cities*, 1–56. Available online: http://www.bloom-consulting.com.

Bolívar, M. P. R., & Meijer, A. J. (2016). Smart governance: Using a literature review and empirical analysis to build a research model. *Social Science Computer Review*, *34*(6), 673-692.

Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, 37(5), 1799–1815.

Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). CITYkeys CITYkeys list of city indicators. Available online: http://nws.eurocities.eu/MediaShell/media/CITYkeyslistofcityindicators.pdf 2017.

Bouk, S. H., Ahmed, S. H., Kim, D., & Song, H. (2017). Named-data-networking-based ITS for smart cities. *IEEE Communications Magazine*, *55*(1), 105-111.

Buck, N., & While, A. (2017). Competitive urbanism and the limits to smart city innovation: The UK Future Cities initiative. *Urban Studies*, *54*(2), 501–519.

Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: An economy-environment technology nexus. *Ecological Economics*, *24*(1), 103–118.

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.

Castelnovo, W., Misuraca, G., & Savoldelli, A. (2016). Smart cities governance: The need for a holistic approach to assessing urban participatory policy making. *Social Science Computer Review*, *34*(6), 724-739.

Cavalcanti, C. (1995). *Sustentabilidade da economia: paradigmas alternativos de realização econômica. Desenvolvimento e natureza: estudos para uma sociedade sustentável.* São Paulo: Cortez.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., ... & Scholl, H. J. (2012, January). Understanding smart cities: An integrative framework. In *System Science (HICSS), 2012 45th Hawaii International Conference on* (pp. 2289-2297). IEEE.

Cohen, B., & Muñoz, P. (2015). Toward a Theory of Purpose-Driven Urban Entrepreneurship. *Organization & Environment*, *28*(3), 264-285.

Correa-Quezada, R., Álvarez-García, J., del Río-Rama, M. D. L. C., & Maldonado-Erazo, C. P. (2018). Role of Creative Industries as a Regional Growth Factor. *Sustainability*, *10*(5), 1649.

Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.

Dahiya, B. (2012). Cities in Asia, 2012: Demographics, economics, poverty, environment and governance. *Cities*, *29*(2), S44–S61.

David, Q., Peeters, D., Van Hamme, G., & Vandermotten, C. (2013). Is bigger better? Economic performances of European cities, 1960-2009. *Cities*, *35*, 237–254.

Della Lucia, M., & Trunfio, M. (2018). The role of the private actor in cultural regeneration: Hybridizing cultural heritage with creativity in the city. *Cities*, 2-10.

Dempsey, N., Bramley, G., Power, S., & Brown, C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable development*, *19*(5), 289-300.

Dempsey, N., Brown, C., Raman, S., Porta, S., Jenks, M., Jones, C., & Bramley, G. (2010). Elements of urban form. In *Dimensions of the sustainable city* (pp. 21-51). Springer, Dordrecht.

Devol, R., Ratnatunga, M., & Bedroussian, A. (2016). Best Performing Cities. *Milken Institute*. Available online: https://assets1c.milkeninstitute.org/assets/Publication/ResearchReport/PDF/BPC-2016-FINAL-WEB.pdf.

Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563.

Dijkstra, L., Garcilazo, E., & Mccann, P. (2013). The Economic Performance of European Cities and City Regions : Myths and Realities. *European Planning Studies*,*21*(3), 334-354.

Dizdaroglu, D. (2017). The role of indicator-based sustainability assessment in policy and the decision-making process: A review and outlook. *Sustainability*, *9*(6), 1018.

Dodgson, M., & Gann, D. (2011). Technological Innovation and Complex Systems in Cities. *Journal of Urban Technology*, *18*(3), 101–113.

Durmaz, B., Platt, S., & Yigitcanlar, T. (2010). Creative, culture tourism and place-making : Istanbul and London film industries. *International Journal of Culture, Tourism and Hospitality Research*, *4*(3), 198–213.

El Gibari, S., Gómez, T., & Ruiz, F. (2018). Building composite indicators using multicriteria methods: a review. *Journal of Business Economics*, 1–24.

Elkington, J. (1994). Towards the sustainable corporation: win-win-win business strategies for sustainable development. *California Management Review*, *36*(2), 90–100.

Elkington, J. (2004). Enter the triple bottom line. The triple bottom line: Does it all add up. In *Chapter 1* (Vol. 11, pp. 1–16). Available online: http://www.johnelkington.com/archive/TBL-elkington-chapter.pdf.

Erkkilä, T., & Piironen, O. (2018). From Global to Local: Regional-and City-Level Alternatives to Global Rankings. In *Rankings and Global Knowledge Governance* (pp. 177-217). Palgrave Macmillan, Cham.

Ernst & Young. (2016). Rapporto Smart city index. Available online: www.ey.com/...smart...index-2016/.../2016-EY-smart-city-index.

Esmaeilpoorarabi, N., Yigitcanlar, T., & Guaralda, M. (2018). Place quality in innovation

clusters: An empirical analysis of global best practices from Singapore, Helsinki, New York, and Sydney. *Cities*, *74*, 156–168.
European Comission, & UN Habitat. (2016). *The state of European cities 2016: Cities leading the way to a better future*. Available online : http://ec.europa.eu/regional_policy/sources/policy/themes/cities-report/state_eu_cities2016_en.pdf.
European Commission. (2014). Reference framework for European sustainable cities. Available online: http://www.rfsc.eu/.
European Union. (2017). *The Cultural and Creative Cities Monitor*. European Union: Brussels, Belgium.
Fahy, F., & Cinnéide, M. Ó. (2006). Community-based quality of life indicators for urban areas as derived in Galway City, Ireland. *WIT Transactions on Ecology and the Environment*, *93*, 691-702.
Fainstein (2014) The just city. International Journal of Urban Sciences, 18(1), 1-18.
Fernandes, R., & Gama, R. (2008). A Criatividade Territorial Em Portugal: Dos Indicadores Aos Territórios Criativos. Available online: https://core.ac.uk/download/pdf/19133326.pdf.
Flores, L. E. B., & Teixeira, C. (2017, October). Cidades Sustentáveis e Cidades Inteligentes: Uma análise dos rankings Arcadis e european smart cities. In *Congresso Nacional de Inovação e Tecnologia*. Available online: http://www.revistas.udesc.br/index.php/reavi/article/view/2316419006092017068.
Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life).* (Basic Books, Ed.). New York.
Florida, R. (2005). *Cities and the creative class*. Routledge.
Florida, R., Mellander, C., & Stolarick, K. (2008). Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of economic geography*, *8*(5), 615-649.
Franchi-Arzola, I., Martin-Vide, J., & Henríquez, C. (2018). Sustainability Assessment in Development Planning in Sub-National Territories: Regional Development Strategies in Chile. *Sustainability*, *10*(5), 1398.
Funk, J. L. (2015). IT and sustainability: New strategies for reducing carbon emissions and resource usage in transportation. *Telecommunications Policy*, *39*(10), 861–874.
Gabrys, J. (2014). Programming environments: Environmentality and citizen sensing in the smart city. *Environment and Planning D: Society and Space*, *32*(1), 30–48.
Garau, C., Balletto, G., & Mundula, L. (2017). A Critical Reflection on Smart Governance in Italy: Definition and Challenges for a Sustainable Urban Regeneration. In E. P. Bisello A., Vettorato D., Stephens R. (Ed.), *Smart and Sustainable Planning for Cities and Regions. SSPCR 2015. Green Energy and Technology* (p. 435).
García Suárez, J. A., & Pulido Fernández, J. I. (2015). Creacity , una propuesta de índice para medir la creatividad turística . Aplicación en tres destinos urbano-culturales españoles. *Revista de Estudios Regionales*, (13), 69–108.
Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy : the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11-32.
Giffinger, R.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N. . M. E. (2007). *Smart cities Ranking of European medium-sized cities. Final Report. Centre of Regional Science, Vienna UT. Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf*.
Gouvea, R., Kapelianis, D., & Kassicieh, S. (2017). Assessing the nexus of sustainability and information & communications technology. *Technological Forecasting and Social Change*, *130*, 39-44.
Grant, J. L., & Kronstal, K. (2010). The social dynamics of attracting talent in Halifax. *Canadian Geographer*, *54*(3), 347–365.
Grodach, C. (2017). Urban cultural policy and creative city making. *Cities*, *68*, 82–91.
Guimarães, R. C. & Sarsfield Cabral, J. A. (2010). *Estatística* (2ª edição). Verlag Dashöfer.
Haberstroh, M. M., & Pinkwart, A. (2018). Increasing the Innovative Capacity of European Cities : Making Use of Proven Concepts from the National Level. In H. Springer, Berlin (Ed.), *European Cities in Dynamic Competition* (pp. 19–53).
Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. (1995). *Multivariate data analysis with readings*. (Prentice-Hall, Ed.). New Jersey. USA.
Hartley, J., Potts, J., & MacDonald, T. (2012). The CCI creative city index 2012. *Cultural*

Science Journal, *5*(1), 138.

Hatuka, T., Rosen-Zvi, I., Birnhack, M., Toch, E., & Zur, H. (2018). The Political Premises of Contemporary Urban Concepts: The Global City, the Sustainable City, the Resilient City, the Creative City, and the Smart City. *Planning Theory and Practice*, *19*(2), 160–179.

Haughton, G. (1999). Environmental justice and the sustainable city. *Journal of Planning Education and Research*, *18*(3), 233–243.

Hawkes, J. (2001). The Fourth Pillar of Sustainability: Culture's essential role in public planning. *Common Ground*.

He, J., & Huang, X. (2018). Agglomeration, Differentiation and Creative Milieux: A Socioeconomic Analysis of Location Behaviour of Creative Enterprises in Shanghai. *Urban Policy and Research*, *36*(1), 79–96.

He, J., Huang, X., & Xi, G. (2018). Urban amenities for creativity: An analysis of location drivers for photography studios in Nanjing, China. *Cities*, *74*, 310–319.

Hesse, M., & Lange, B. (2012). Paradoxes of the Creative City. Contested Territories and Creative Upgrading - the Case of Berlin, Germany. *Erde*, *143*(4), 351–371.

Hospers, G.-J., & Pen, C.-J. (2008). A View on Creative Cities Beyond the Hype. *Creativity and Innovation Management*, *17*(4), 259–270.

Howkins, J. (2001). *The Creative Economy: How people make from ideas.* (Allen Lane., Ed.).

Huovila, A., Penttinen, T., Airaksinen, M., Pinto-Seppä, I., Piira, K., & Penttinen, T. (2016). Smart city performance measurement system. In Proceedings of the 41th IAHS World Congress Sustainability Innovation for the Future, Algarve, Portugal, 13–16 September; pp. 1–10.

Irungbam, R. S. (2016). The Model of Smart Cities in Theory and in Practice. *Journal for Studies in Management and Planning*, *2*(4), 156-187.

Jabareen, Y. R. (2006). Sustainable urban forms: Their typologies, models, and concepts. *Journal of Planning Education and Research*, *26*(1), 38–52.

Joss, S., Cowley, R., & Tomozeiu, D. (2013). Towards the "ubiquitous eco-city": An analysis of the internationalisation of eco-city policy and practice. *Urban Research and Practice*, *6*(1), 54–74.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.

Kakiuchi, E. (2016). Culturally creative cities in Japan: Reality and prospects. *City, Culture and Society*, *7*(2), 101–108.

Khan, S., & Zaman, A. U. (2018). Future cities: Conceptualizing the future based on a critical examination of existing notions of cities. *Cities*, *72*, 217–225.

Kirchberg, V., & Kagan, S. (2013). The roles of artists in the emergence of creative sustainable cities: Theoretical clues and empirical illustrations. *City, Culture and Society*, *4*(3), 137–152.

Kľúčik, M., & Haluška, J. (2008). Construction of Composite Leading Indicator for the Slovak Economy. *Stiin Ńe Economice*, *55*, 362–370.

Kong, L. (2014). From cultural industries to creative industries and back? Towards clarifying theory and rethinking policy. *Inter-Asia Cultural Studies*, *15*(4), 593–607.

Krueger, R., & Buckingham, S. (2012). Towards a "Consensual" Urban Politics? Creative Planning, Urban Sustainability and Regional Development. *International Journal of Urban and Regional Research*, *36*(3), 486–503.

Kubrusly, L. S. (2001). Um procedimento para calcular índices a partir de uma base de dados multivariados. *Pesquisa Operacional*, *21*(1), 107–117.

Kumar, T. V., & Dahiya, B. (2017). *Smart Economy in Smart Cities*. In *Smart Economy in Smart Cities* (pp. 3-76). Springer, Singapore.

Landry, C. (2000). *The creative city: A toolkit for urban innovators*. Earthscan.

Landry, C. (2013). Creative city index; comfortable or captivating, assessment report of Palmerstone North. Available online: https://www.pncc.govt.nz/media/2096880/creative_city_index_report__web_document_.pdf.

Landry, C., & Bianchini, F. (1995). *The creative city* (Vol. 12). Demos.

Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.

Letaifa, S. Ben. (2015). How to strategize smart cities : Revealing the SMART model. *Journal of Business Research*, *68*(7), 1414–1419.

Lewis, N. M., & Donald, B. (2010). A new rubric for "creative city" potential in Canada's smaller

cities. *Urban Studies*, *47*(1), 29–54.
Ligorio, V. (2017). New economic development pattern: from a linear to a circular economy, a challenge for eu's economy. *Міжнародний Науковий Журнал Інтернаука International Scientific Journal of International Science*, *1*(2), 20–23.
Lilja, R. K. (2015). Policy instruments for promoting material efficiency: case of Finland. *Clean Technologies and Environmental Policy*, 17(7), 2029–2040.
Liu, H., & Silva, E. (2018). Examining the dynamics of the interaction between the development of creative industries and urban spatial structure by agent-based modelling: A case study of Nanjing, China. *Urban Studies*, *55*(5), 1013–1032.
Livert, F., & Gainza, X. (2017). Distributive politics and spatial equity: the allocation of public investment in Chile. *Regional Studies*, *52*(3), 403–415.
Lombardi, P., & Vanolo, A. (2015). Smart city as a mobile technology: critical perspectives on urban development policies. In *Transforming city governments for successful smart cities* (pp. 147-161). Springer, Cham.
Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation*, *25*(2), 137–149.
López-Quiles, J., & Rodríguez Bolívar, M. (2018). Smart Technologies for Smart Governments : A Review of Technological Tools in Smart Cities. In *In Smart Technologies for Smart Governments . Springer, Cham.* (pp. 1–18).
Madeira, G., Guimarães, T., & Mendes, L. (2016). Assessing some models for city e-government implementation : a case study. *Electronic Government, An International Journal*, *12*(1), 86–105.
Mardikyan, S., Yıldız, E., Ordu, M., & Şimşek, B. (2015). Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA*, *2015*, 1–10.
Marôco, J. (2014). *Análise estatística com o SPSS Statistics.*
Martí-Costa, M., & Miquel, M. P. i. (2012). The knowledge city against urban creativity? Artists' workshops and urban regeneration in Barcelona. *European Urban and Regional Studies*, *19*(1), 92–108.
Martone, A., Pennella, G., & Sepe, M. (2014). Improving quality of life through cultural regeneration and urban development: The marseille euroméditerranée renewal project. *Journal of Urban Regeneration and Renewal*, *7*(4), 351–362.
Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.
Mommaas, H. (2004). Cultural clusters and the post-industrial city: Towards the remapping of urban cultural policy. *Urban Studies*, *41*(3), 507–532.
Mooi, E., & Sarstedt, M. (2011). Understanding cluster-analysis. *A Concise Guide to Market Research. The Process, Data, and Methods Using IBM SPSS Statistics*, 259-283.
Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research : A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3-27.
Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.
Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis*, *EUR 21682* (December), 134.
Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). *Current trends in smart city initiatives: Some stylised facts. Cities* 38, 25-36.
Networked Society City Index (2016). *Cities play key role in sustainable development. Available onlibe: https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index-infograph.pdf.*
Odendaal, N. (2003). Information and communication technology and local governance : understanding the difference between cities in developed and emerging economies. *Computers, Environment and Urban Systems*, *27*(6), 585-607.
OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.
Okano, H., & Samson, D. (2010). Cultural urban branding and creative cities: A theoretical framework for promoting creativity in the public spaces. *Cities*, *27*(SUPPL1), S10–S15.
Panal, G., & Yáñez, C. (2012). Industrias culturales en ciudades españolas . Un primer acercamiento . Cultural industries in Spanish cities . A first approach. *Revista de Estudios*, *94*, 71–103.

Paskaleva, K. (2009). Enabling the smart city : the progress of city e-governance in Europe. *International Journal of Innovation and Regional Development*, *1*(4), 405–422.

Pestana, M. H., & Gageiro, J. N. (2014). *Análise de dados para ciências sociais: a complementaridade do SPSS*.

Picard, R. G., Grönlund, M., & Toivonen, T. (2003). Means for overall assessment of cultural life and measuring the involvement of the cultural sector in the information society. *Publications of the Ministry of Education, Finland, 17*.

Pinnegar, S., Marceau, J., & Randolph, W. (2008). *Innovation and the city: challenges for the built environment industry*. City Futures Research Centre.

Piro, G., Cianci, I., Grieco, L. A., Boggia, G., & Camarda, P. (2014). Information centric services in Smart Cities. *Journal of Systems and Software*, *88*(1), 169–188.

Pitarch-Garrido, M. D. (2018). Social Sustainability in Metropolitan Areas: Accessibility and Equity in the Case of the Metropolitan Area of Valencia (Spain). *Sustainability*, *10*(2), 371.

Pozdniakova, A. (2017). Smart sustainable cities: the concept. *Acta Innovations*, *22*, 5–19.

Pratt, A. C. (2008). Creative cities: The cultural industries and the creative class. *Geografiska Annaler, Series B: Human Geography*, *90*(2), 107–117.

Priano. F., & Guerra, C. (2014). A framework for measuring smart cities. In *Proceedings of the 15th Annual International Conference on Digital Government Research,* Aguascalientes, Mexico (pp. 44-54). ACM.

Przygodzki, Z., & Kina, E. (2015). Virtual Community for A Creative City. *Quaestiones Geographicae*, *34*(2), 65–73.

Ratten, V. (2017). *Entrepreneurship, Innovation and Smart Cities. Routledge.*

Ryser, J. (2014). reviewed paper Planning Smart Cities ... Sustainable, Healthy, Liveable, Creative Cities ... Or Just Planning Cities? Judith Ryser. Plan Smart Cities, *8*, 447–456.

Sabaté, J., & Tironi, M. (2008). Rankings, creatividad y urbanismo. *EURE (Santiago)*, *34*(102), 5–23.

Saisana, M., & Montalto, V. (2016). *The Cultural and Creative Cities Monitor (C3 Monitor) 2016 Edition*. Available online: https://www.politico.eu/wp-content/uploads/2017/07/CulturalCreativeCitiesIndex.pdf October 2016.

Saisana, M. and Tarantola, S., (2002). "State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development", European Commission, Joint Research Centre, Ispra, Italy, EUR 20408 EN.

Schaller, S., & Guinand, S. (2018). Pop-up landscapes: a new trigger to push up land value? *Urban Geography*, *39*(1), 54–74.

Scott, A. (2000). *The cultural economy of cities: essays on the geography of image-producing industries*. Sage.

Scott, A. J. (2006). Creative cities: Conceptual issues and policy questions. *Journal of Urban Affairs, 28*(1), 1–17.

Sepe, M. (2013). Urban history and cultural resources in urban regeneration: a case of creative waterfront renewal. *Planning Perspectives*, *28*(4), 595–613.

Sharma, A., & Kearins, K. (2011). Interorganizational collaboration for regional sustainability: What happens when organizational representatives come together? *Journal of Applied Behavioral Science*, *47*(2), 168–203.

Siegel, K. (2016). Can Regional Cooperation Promote Sustainable Development? In J. Grugel & D. Hammett (Eds.), *The Palgrave Handbook of International Development* (pp. 713–730).

Silva, F., & Araújo, H. (2010). *Indicador de desenvolvimento da economia da cultura*. Brasília: Ipea.

Skavronska, I. (2017). Creative industries in Ukraine: Analysis and prospects of the development. *Economics and Sociology*, *10*(2), 87–106.

Skrede, J. (2016). What may culture contribute to urban sustainability? Critical reflections on the uses of culture in urban development in Oslo and beyond. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *9*(4), 408-425.

Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy*, *19*(3), 669–678.

Snow, C. C., Håkonsson, D. D., & Obel, B. (2016). A Smart City Is a Collaborative Community: Lessons from smart Aarhus. *California Management Review*, *59*(1), 92–108.

Staníčková, M., & Melecký, L. (2018). Understanding of resilience in the context of regional development using composite index approach: the case of European Union NUTS-2 regions. *Regional Studies, Regional Science*, *5*(1), 231-254.

Stano, P. M., & Węziak-Białowolska, D. (2017). Measuring Cultural and Creative Activities in European Cities: Challenges and Practical Problems with Existing Indices. *Creativity Research Journal*, *29*(3), 292–303.
Tabachnick, B. G., & Fidell, L. S. (1996). *sing Multivariate Statistics.* (3rd ednHarper Collins. New York, Ed.).
Trivellato, B. (2016). How can ' smart ' also be socially sustainable ? Insights from the case of Milan. *European Urban and Regional Studies*, 24(4), 337-351.
UN-HABITAT. (2013). *State of the World's Cities 2012/2013: Prosperity of cities*. Available online:
https://sustainabledevelopment.un.org/content/documents/745habitat.pdf.
United Nations (2015). *Smart Sustainable Cities Indicators*.
United States Environment Protection Agency. (2016). *Framework for Creating a Smart Growth Economic Development Strategy : a Tool for Small Cities and Towns*. Available online: https://www.epa.gov/smartgrowth/framework-creating-smart-growth-economic-development-strategy.
Vadrevu, L., & Kanjilal, B. (2016). Measuring spatial equity and access to maternal health services using enhanced two step floating catchment area method (E2SFCA) - A case study of the Indian Sundarbans. *International Journal for Equity in Health*, *15*(1), 1–12.
Viale-Pereira, G., Cunha, M. A., Lampoltshammer, T. J., Parycek, P., & Testa, M. G. (2017). Increasing collaboration and participation in smart city governance: a cross-case analysis of smart city initiatives. *Information Technology for Development*, 23(3), 526-553.
Vinodrai, T. (2006). Reproducing Toronto's Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. *Economic Geography*, *82*(3), 237–263.
Wang, Y., Chen, Y., & Benitez-Amado, J. (2015). How information technology influences environmental performance: Empirical evidence from China. *International Journal of Information Management*, *35*(2), 160–170.
Watson, V. (2015). The allure of 'smart city' rhetoric: India and Africa. *Dialogues in Human Geography*, *5*(1), 36–39.
Wheeler, S., & Beatley, T. (2014). *The Sustainable Urban Development Reader*. Routledge.
Wu, M. C., Wen, C. T., Wu, S. H., & Lin, B. (2008). The social context of creativity at third places: an exploratory study. *International Journal of Management and Enterprise Development*, *5*(1), 30.
Wu, S. J., & Raghupathi, W. (2015). The Strategic Association between Information and Communication Technologies and Sustainability: A Country-Level Study. *Journal of Global Information Management*, *23*(3), 92–115.

CHAPTER 9

IMPORTANCE OF LIVING LABS IN URBAN ENTREPRENEURSHIP: A PORTUGUESE CASE STUDY

ABSTRACT

From a network perspective, the main objective of this study is to analyse how *living labs* contribute to promoting urban entrepreneurship in towns and cities and their sustainability. To achieve this aim, a qualitative research approach was adopted, specifically an exploratory case study of a *living lab* in a Portuguese town. As data collecting instruments, semi-structured interviews were held with key people in charge of this incubator, the incubated firms, public partners and citizens/people. Additional documentation was obtained for data triangulation in content analysis. The empirical evidence obtained leads to concluding on the need to continue study of urban entrepreneurship and its connection with *living labs* in towns. The results also showed that *living labs* are the "cradle" for this type of entrepreneurship and a vehicle for economic and social development and sustainability. From the evidence obtained, we were able to detect three units/factors of *living labs* to promote urban entrepreneurship: (1) open network, (2) entrepreneurship and (3) benefits/results. The insights gained from this explorative case study have several theoretical and practical implications.

Key-words: Cities, Urban entrepreneurship, Green economy, Sustainability, Networks, Living labs

1. Introduction

A network consists of a set of interlinked actors (Echebarria et al., 2016), in which these actors are independent but oriented towards a common goal and producing a collective result (Alter & Hage, 1993). One of the purposes of business networks is to provide benefits for the actors involved, through partnerships, innovation and active participation by all parties. *Living labs* have emerged as an open business network based on innovation and entrepreneurship (Nyström et al., 2014). These authors define *living labs* as physical regions, virtual realities or spaces of interaction, where all stakeholders join together to create, develop, test and implement new products and services in a real-life context. This concept is interlinked with the concept of a smart city, which can be understood as a community, in which citizens, firms, institutions and public bodies (for example, local authorities) collaborate with each other to achieve an integrated and efficient system (the existence of a common commitment), aiming to provide quality of life (Snow, Håkonsson, & Obel, 2016).

This context gives rise to the concept of urban entrepreneurship, defined here as a source of opportunities, to incorporate and develop entrepreneurial and innovative ideas linked to sustainable regional development (Cohen & Munoz, 2015); something which occurs in an urban space and/or where products and services are provided, involving legal, social and logistic questions, which leads to the concept of business networks (Osorio & Cordero, 2014).

Urban areas provide many entrepreneurship opportunities, finding an almost direct inter-relationship between entrepreneurship, location and urban growth (Glaeser, Rosenthal, & Strange, 2010; Freire-Gibb & Nielsen, 2013). Then again, Feldman (2001) concludes that entrepreneurship is a regional phenomenon, and for Freire-Gibb and Nielsen (2013), geographical location is a pillar for entrepreneurship, where population density is suggested in various studies as a factor maximizing individuals' willingness to initiate business (Shane, Locke, & Collins, 2003; Sternberg, 2009). Also due to the rapid urban growth witnessed, local authorities face difficulties in ensuring high levels of infrastructure and quality of life, which in itself is a challenge for these organisations (Cohen & Muñoz, 2015). Urban entrepreneurship is an emerging phenomenon, but its borders still require some definition (Muñoz & Cohen, 2016).

Despite the existence of many studies on entrepreneurship at the country level, there is a shortage of studies at the city level (Glaeser & Ponzetto, 2014). Audretsch and Belitski (2013) and Florida, Mellander, and Stolarick (2007) note that entrepreneurship at the micro (regional) level is a driver of creativity, technology, human capital and knowledge. Then again, Cohen and Munoz (2015) consider that urban entrepreneurship has been neglected from a management perspective. There is a shortage of studies interlinking *living labs* with urban entrepreneurship and discussing the empirical result of this relationship (Almirall & Wareham, 2011; Dekkers, 2011; Eriksson et al., 2005).

In these circumstances, given the economic and social importance of *living labs* and urban entrepreneurship phenomena for sustainable urbanization and to fill these gaps in the literature, this study aims to answer the following research question from a network perspective: *Do living labs contribute to promoting urban entrepreneurship in cities where they are implanted?* To answer this question, a case study is presented– the Cova da Beira *living lab*-implemented in a Portuguese town. Therefore, this study's contribution lies in showing how *living labs* are an important tool to promote urban entrepreneurship in cities and towns. More precisely, we outline which factors should be considered in *living labs* to promote urban entrepreneurship in cities and their sustainability.

2. Literature review

2.1. Living labs as networks

Tripartite (public-private-people) collaboration lets cities and local authorities implement networks, favouring the integration of existing resources with those provided by other network actors, allowing them to satisfy their residents' needs (Echebarria et al., 2016). Highlighted as benefits of these territorial/regional networks are greater citizen participation, elaboration of a medium and long-term regional/local plan, and sharing risks and knowledge, as all are working towards a common objective (Davies, 2002) and information flows, and tangible and intangible resources are common to all (Furmankiewicz, Macken-Walsh, & Stefańska, 2014). However, the success of networks at the regional level depends on the intensity of relationships between their actors and on their internal structure, synergies and degree of interconnection (Dawson et al., 2014; Furmankiewicz et al., 2014).

As a consequence of increasing urban transformations, all infrastructure tends to be concentrated around cities (Nevens et al., 2013), but they must be sustainable, and it is local authorities' responsibility to ensure that sustainability (Burstrm & Korhonen, 2001). Sustainability implies that continuous and dynamic inter-relations are established between all stakeholders – networks (Geels & Schot, 2007). In this context, *living labs* are part of these dynamic networks, as a new way to organise innovation activities, and face opportunities as well as socio-economic and technological challenges (Leminen, 2015). *Living labs* are intermediaries in the process of open innovation (Baltes & Gard, 2016). These are open environments of innovation in real life contexts, where innovation is oriented towards the user and completely integrated in the process of co-creating new services, products and social infrastructure in a regional context, as a way to capture/attract/benefit from networks and the existing business fabric (Santoro & Conte, 2009). These authors also consider that *living labs* can be implemented locally through exploiting synergies between local authorities and regional entities.

The highly positive impact of innovation arises from networks that include different types of partners, among them *living labs* (Nieto & Santamaría, 2007; Zeng, Xie & Tam, 2010). In the same line of thought, Chesbrough and Crowther (2006) argue that *living labs* should be studied as networks, since the innovation is open and participants collaborate voluntarily, albeit according to defined rules. The involvement of all actors is important, as this is the nucleus of the *living lab* (Almirall & Wareham, 2008), in which public-private-people partnerships (4Ps) are commonly used (Walravens, 2012) simultaneously with citizens' involvement (Veeckman & Graaf, 2015).

According to the 4P model, *living labs* are defined as physical areas or virtual realities, where stakeholders form public-private-people partnerships (Westerlund & Leminen, 2011) and users act as sources of information and creativity (Nyström et al., 2014). Specifically, and according to this model, local authorities gather all the necessary conditions in terms of the various resources to create this synergy all along the value chain implicit in the values inherent to *living labs*, originating their sustainability and success at the regional level (Santoro & Conte, 2009).

Generically, four standards characterise *living labs*, namely, reciprocity, multiplicity, temporality and competences (Nyström et al., 2014). These authors consider that these standards stimulate individuals' personal motivations to engage in processes implicit in *living labs* and thereby contribute to their success. However, as with any organisation, the implantation of *living labs* includes relevant steps and aspects that must be considered, such as active collaboration, the definition of rules, operational responsibilities and scenarios, establishing professional groups to support projects, so that there is maximization of knowledge and a greater impact on the socio-economic context (Santoro & Conte, 2009). The configuration of a *living lab*, as an ecosystem, must be based on networks (partnerships). Therefore, *living labs* can become a platform for cities, since they provide a vehicle for entrepreneurial citizens (Cohen, Almirall, Chesbrough, 2016).

2.2. Urban entrepreneurship

Creativity and innovation contribute to urban development, which reflects entrepreneurial activities, namely business creation at the regional level (Audretsch, Belitski, & Desai, 2015). This emergence of innovative ideas leads to entrepreneurial initiatives and commitment by all parties involved, whether public, private or civic (Johnston & Blenkinsopp, 2017). This commitment leads to implementation of the *living lab*, which is an instrument of regional economic growth, and measures have been taken to increase entrepreneurship at the local and regional level. Entrepreneurship also aims to combine resources and people (public and private) in order to obtain effective results in social and economic terms, through developing regional business, social and academic activities (Lundqvist & Middleton, 2010).

With entrepreneurship being a driver of economic growth in a country, region or city, European urban policy has encouraged the growth of entrepreneurial initiatives (Szerb et al., 2013), particularly through incubators (Audretsch & Fritsch, 2002), the creation of infrastructure, financial incentives (Bosma & Sternberg, 2014) and the introduction of new regulations (Audretsch et al., 2015). Muñoz and Cohen (2016) show that urban entrepreneurship creates solutions that result in economic benefits for the urban ecosystem, society and entrepreneurship. These authors also conclude that this form of entrepreneurship uses the city as a *living lab*, where collaboration and innovation are fundamental, i.e., the city is the host and destination of urban entrepreneurship. For Lundqvist and Middleton (2010), urban entrepreneurship is necessary for communities and cities to continue growing (Osorio &

Cordero, 2014). Indeed, urban entrepreneurship can be directed to a country, city or neighbourhood (Cohen & Muñoz, 2015).

In this context, the core of the 4P's Model is the urban entrepreneur (individual or collective), who orients the whole system. This means that this entrepreneur is committed to improving citizens' well-being through seeking opportunities that involve some risk (Muñoz & Cohen, 2016). For these authors, these entrepreneurs can emerge from the public and/or private sector and/or be ordinary citizens with entrepreneurial ideas, i.e., entities/people who identify an opportunity to grasp and make a success of.

At the regional level, cities provide scale economies and agglomerations, economic and social infrastructure, through which many entrepreneurial businesses are born and incubated (Daniels, 2004). Urban entrepreneurs manage to take advantage of a town's resources and produce a positive impact on its quality of life. These synergies are reflected in the formation of local networks/partnerships and promote collaborative business models. Briefly, the 4Ps model transforms citizens' challenges in urban business opportunities, requiring pro-active interaction with citizens, in which entrepreneurial attitudes are at the core (Muñoz & Cohen, 2016).

This leads us to the strategy of urban development aiming to create smart cities (Tranos & Gertner, 2012) with the following characteristics: urban development, social inclusion, the role of creative firms in urban growth, network functioning, social capital (knowledge and technology) and urban sustainability (Tranos & Gertner, 2012). This means that smart cities articulate socio-economic questions, ranging from administrative efficiency to improved networks and technology, and that urban development should be oriented towards firms and always pay attention to the inclusion and cohesion of all social classes (Fu & Zhang, 2017). This articulation enables tripartite socio-economic sustainability to be achieved (Cohen et al., 2016; De Jong et al., 2015), by incentivising relationships between public and private actors (Batty, 2008).

To create solutions, it is necessary to identify and focus on opportunities (a process that includes discovery, assessment and exploitation), as opportunities lie at the core of entrepreneurship (Austin & Stevenson, 2006; Muñoz & Cohen, 2016; Shane & Venkataraman, 2007). It is easily seen that the problems and changes faced by cities are a source of opportunity for individuals of an entrepreneurial nature who consequently engage in economic and social activities (Muñoz & Cohen, 2016). Governments have approached the question of cities' problems through the 4Ps model, aiming to stimulate economic development and improve the services provided to citizens (Muñoz & Cohen, 2016). According to these authors, this model arises from the need for alternatives to traditional financing of public projects, so that the private sector is also involved in regional and local projects. In this way, new pillars of public management emerge, such as collaborative governance and entrepreneurship (Hjorth, 2013;

Kapucu, Yuldashev, & Bakiev, 2009; McGuire, 2006; Woolthuis et al., 2013). This means that the provision of public services to citizens is no longer only the responsibility of a government, but the result of combined efforts (Klein et al., 2010), in which collaborative governance facilitates the existence of networks that can solve citizens' problems (McGuire, 2006).

With cities being contexts allowing the operationalization of a *living lab*, the fact of them becoming smart cities allows critical problems in urban areas to be solved (Lee, Hancok, & Hu, 2014). In this respect, local authorities, as smart cities, must identify and develop forms of participation by all stakeholders (Nam & Pardo, 2011), i.e., citizens, agents from the private sector, universities, research centres and public institutions (Bifulco, Tregua, & Amitrano, 2017). This means there must be intelligent governance of cities (Johnston & Hansen, 2011), understood as a set of emerging principles regarding the relationship between private and public agents, emphasizing the collaboration and involvement of all, including citizens (Bifulco et al., 2017). To achieve this objective, *living labs* are there to promote smart cities (Hielkema & Hongisto, 2013), which once again represent a form of collaborative management between local authorities and other stakeholders to create an environment oriented towards innovation (Bifulco et al., 2017).

In addition, *living labs* will be sustainable by being directed to future development of a green economy, through sustainable patterns of production (minimum use of resources) and consumption that are supported by innovation, participation, cooperation and interaction in the course of creating value in the process chain, taking on a crucial role as drivers for implementing the desired green economy (Baedeker, Liedtke, & Welfens, 2017). These arguments corroborate Liedtke et al. (2012), who define *living labs* as a combined laboratory system of services, products and innovations that are centred on people's needs and aim to develop those innovations sustainably, i.e., with greater efficiency in the use of resources.

3. Research methodology

3.1. Type of study and case selection

Given the exploratory character of this investigation and the research question, we adopted a qualitative research study and conducted a case study, in order to gain an in-depth understanding (Yin, 2015) of the interface between *living labs* and urban entrepreneurship. When a scientific field is still underexplored and substantial preliminary field research is lacking on the subject, exploratory case studies are recommended (Yin, 2015). Methodological procedures are fundamental in a case study, which implies that any research question is duly supported by the literature review (Yin, 2015). In this connection, Berg and Lune (2004) stated that case studies need a theoretical framework that supports and is adjusted to the research question.

A single case or multiple cases can be selected. This study focused on a single case study: Cova da Beira *Living Lab* (Local Authority of Fundão), the unit of analysis being this incubator and the actors involved. This *living lab* and town were selected as a specific case study because in 2015 this incubator was awarded the European prize for business environment development, and in 2016 Fundão was named the local authority (town) of the year in Portugal.

3.2. Context of analysis

Geographically, the town of Fundão is situated in the Central Region of Portugal, in the area known as Cova da Beira, on the north-facing slopes of the Serra da Gardunha mountain range, covering an area of 700 Km2 and divided into 23 parishes. It is characterised by an uneven spread of population, with urban areas where commerce is the main economic activity contrasting with rural areas given over to agriculture, pasture and forestry, for the production of fruit, olive oil and wine. There is also important wolfram mine. The town has a population of approximately 10 000 habitants.

Cova da Beira *Living Lab* was formed on 17 October 2012 on signing a proposal of a cooperation agreement between Fundão Local Authority and various partners, aiming to "*complete the region's existing strategies for collective efficiency based on various territorially based cooperation networks*" (CMF-Fundão Local Authority, 2012). The *living lab* has transformed the town of Fundão in the first completely open local authority in Portugal – open to creativity, innovation, entrepreneurship, urbanism and quality of life -, which currently uses the slogan" *Move to Fundão*".

3.3. Data collection and data analysis

Despite the existence of various manuals of methodological procedures for research in social science, the case study follows its own methodological perspective, with no single method of data collection (Ryan, Scapens, & Theobold, 2002). Therefore, the sources of empirical evidence used in this exploratory case study were personal semi-structured interviews (primary sources) as well as documents and materials (secondary sources). The semi-structured interview is one of the most commonly used methods in qualitative research, aiming for thorough comprehension of a given social phenomenon, based on interviewees' personal experiences (Patton, 1990).

For this case study, several extensive interviews were held in March and May 2017 with the following key informants: (1) the Vice-President of Fundão Local Authority (hereafter named as Interviewee E1), (2) the Operational Manager (Interviewee E2), (3) two entrepreneurs of start-ups (Interviewees E3 and E4); (4),four citizens/people (Interviewees E5, E6, E7 and E8) and (4) two public institutions (Science and Technology Park and Commercial and Industrial Association – Interviewees E9 and E10, respectively). It should be noted that the first three interviewees belong to the human resources of Fundão Local Authority, having been given these functions by the mayor. Given their strategic role/involvement in the *living lab* and their comprehensive knowledge about this incubator, these interviewees were the most likely to provide the information needed, being considered key informants (Kumar, Stern, & Anderson, 1993). At their request, the interviews were not recorded, and so it was necessary to make detailed notes that were later organised and transcribed. Table 1 presents the profile of the interviewees.

Table 1 - Description of the Interviewees

Code	Gender	Age	Years of experience	Formation	Function	Duration of the interviews
E1	Male	35	10	Master's in business administration	Advisor to the mayor of Fundão Local Authority (in charge of Cova da Beira *Living Lab*) – Incubator. This person's function is to manage all the *living lab's* activities according to the decisions made by the mayor.	60 minutes
E2	Female	35	12	Degree in Management	In charge of Operational Management of the services of Cova da Beira *living lab* – Incubator. Her duties cover functional management of all the start-ups included in the *living lab*, as well as management of new incubating projects.	45 minutes
E3	Female	42	18	Degree in Tourism	In charge of Management of the Producers' Club - Incubated entity 1 -, which includes current management of all its members' operational activities;	30 minutes
E4	Male	28	5	Degree in Photography	Manager in Francisco Sanches Photography - Incubated entity 2-, in charge of managing the firm and operationalizing all its inherent activities.	30 minutes
E5	Female	35	10	Degree in Arts and Heritage	Manager in Migusta-Atelier de Costura	25 minutes
E6	Female	28	6	Secondary (12thYears	Manager in Cricork- Design	20 minutes
E7	Male	21	0	12thYear	Student	15 minutes
E8	Male	40	10	Degree in Agronomy	Manager in Quinta do Olival	30 minutes
E9	Female	44	5	Degree in Management	Project Manager of Science and Technology Park	25 minutes
E10	Male	51	11	Degree in Management	President of Commercial and Industrial Association	35 minutes

Source: Own elaboration

Written documentation was also obtained from Fundão Local Authority referring to the Multi-Centre Urban Incubator of Firms and Business (IUPEN) – *living lab* -, operating standards, regulations of the strategic plan for innovation, *living lab* partnership agreement and strategic programme for urban regeneration. The purpose of these documents was data triangulation (Blaikie, 2000) and so greater external validity of the results (Eisenhardt, 1989; Yin, 2015). Compilation of the information contained in these documents with the interviews, using content analysis, allowed more complete information about the case study selected.

The material was subject to content analysis (Weber, 1990), which let us define and analyse categories/themes of information. For this purpose, we demarcated segments within the transcribed text, codified the relevant information with a word or short phrase and summarized/compared the codes obtained across the interviews (Glaser & Strauss, 1967). This methodological procedure will allow the detection of units/factors.

4. Findings and discussion

The case study shows that the characteristics in the *living lab* studied here can be categorized in three themes: (1) *living lab* as an open network, (2) *living lab* to promote urban entrepreneurship and (3) benefits/results of the *living lab*. From the evidence obtained, we were also able to detect some units/factors associated with *living labs* that are presented at the end of this section.

4.1. Living lab as an open innovation

The current mayor of Fundão Local Authority has a strategic plan of innovation for this town, aiming to attract investment, support innovation, stimulate entrepreneurship and reposition environmental sustainability. This means that this local authority has an intermediary for the process of open network directed towards its economic and social users and applied in a real context.

With the *living lab* set up here "*it is possible to involve people and form a network of territorial and business partnerships, which facilitate third party investment in Fundão (for example the case of the Altran firm in 2013) and the response to start-ups*" (Vice-President of Fundão Local Authority - Interviewee E1). This idea agrees with the answer obtained from the operational manager (E2) who states that "*citizens' involvement in this is a dimension that is being worked on at the present time, although there is already the dimension of the participative budget and that of civic economy, as there is still some cultural resistance to the change*". However, this situation is present in the literature, where it is argued that standards of operation are necessary (Nyström et al., 2014).

Some of the citizens/people interviewed(E4, E5, E6 and E8) even stated that in carrying out their business activity, although they are not formally integrated in the *living lab,* this incubator is seen as an open network that has provided informal contacts leading to participation in events publicizing their business. For the student interviewed (E7), this *living lab* provides "*an opening to young people, for creativity and innovation. It is a space open to new cultures, new ways of living in a place that is easily associated with a context of urban and rural life, where natural, patrimonial and historical resources are a bonus for improved quality of life*".

For the project manager of the Science and Technology Park – public partner (E9), this *living lab* "has provided premises, infrastructure and reception services in restored buildings for innovative technology-based firms. This incubator allows "*communicating and promoting the share of existing services to attract new investment, new residents (…)*, this public partner also mentions.

Also for another public institution – Commercial and Industrial Association – and its president (E10), the *living lab* is "*an open network because it works and functions with partners and for (external) third parties. The living lab studied here is seen as "an open network in that it provides the know-how and organisational and productive capacity existing in the living lab. This means it's a network shared with third parties, outside (…). This shared and open network functions as a factor attracting new organisational and institutional partners".*

Interviewee E1 also sees the *living lab* as a space with formal and informal relationships between all those involved in the process, where functioning as an open network is crucial and requires the participation of all, citizens and firms. In addition, according to the operational manager (E2), the fact there is trust and transparency in the relations created lets the network be open to all the entrepreneurial ideas of citizens who choose to start their own business.

Still regarding this involvement, it has been found that "*the most active users of the living lab are firms, schools and universities, at the macro level; at the micro level, we have young entrepreneurs, as they have free access to premises, equipment, support for development of their projects and bonuses arising from the existence of a business and territorial network; also very active users are agents related to technological, food-producing and metal-mechanics firms*", states the operational manager (E2). This involvement at the micro level was highlighted by Chesbrough and Crowther (2006) regarding the need for voluntary collaboration in *living labs*, and the fact they should be seen as networks (Nieto & Santamaría, 2007; Zeng et al., 2010). For Johnston and Blenkinsopp (2017) and Lundqvist and Middleton (2010), this stakeholder commitment leads to establishing networks.

Briefly, for the interviewee (E1), there are specific protocols with the *living lab* that are not formalized but which allow "*the existence of training according to investors' needs in all sectors as a factor of attraction, as the costs of training in resources are lower, besides the* *tax benefits of investing in the town. We also have financing for the start-ups assured by the Caixa de Crédito Bank*".

For the local authority advisor (E1), the objective of this *living lab* is also "*to make Fundão a smart city, through creating synergies obtained by its integration in international, national and regional networks, promoting the concept of creative cities, stimulating entrepreneurship (of whatever kind – economic, social, cultural, urban) and innovation*". This conclusion is reflected in the argument that urban development creates smart cities (Tranos & Gertner, 2012), aiming for the integration of all socio-economic matters (Fu & Zhang, 2017) and consequently ensuring sustainability (De Jong et al., 2015).

Looking to the future, "*the creation of Design Factoring is forecast, which is still at the stage of conceptual definition, but this aims to strengthen collaborative innovation and the 4P model (public-private-people partnerships); the creation of an Experimentation Centre and the IoT (Internet of Things)*", the operational manager (E2) states. This reference to the 4Ps model is emerging in the literature, where the local authority role is crucial (Westerlund & Leminen, 2011) and users are relevant (Nyström et al., 2014).

The businessman (E4) from the Francisco Sanches Photography start-up also considers that the network around the *living lab* provides access to other firms with which it is possible to form partnerships, "*as in our case with the firm of Workshop– Improbable Objects, which develops Kraftdesign and my firm carries out its personalization with laser technology, to create wedding design, which allows modernizing and innovating in the form and capacity to respond to our clients*". As a reflection of this modernization patented through innovation and allowed by network operation, "*my firm participated in the IGNITE YOUR FUTURE event, supported by the living lab, where various seminars on photography were presented*", concludes this urban businessman (A4). Based on this statement, it can be concluded that the *living lab* is important for the success of an innovative idea and that the network it implemented has the desired effect (see, for example, Dawson et al., 2014).

For the operational manager (E2) of the *living lab* studied here, this serves "*as a consortium, from the methodological and strategic point of view between all stakeholders, as an ecosystem supported by a network. Its services are diverse, and end up being a link between the whole and its elements. These services include the Square Incubator (business sector, social development, artistic workshop), the FabLab (providing resources for project support), the Business and Service Centre (concentrating particularly on technological firms) and the food-producing area in the Fundão industrial estate*." These services are therefore found to be integrated and part of a network working towards a common goal, corroborating the arguments that local authorities can serve to integrate resources (Davies, 2002; Echebarria et al., 2016; Furmankiewicz et al., 2014).

Through its different services, the *living lab* creates other positive collateral effects that are a feature of the dominant strategy, playing a determinant role in connecting the different agents of development (schools, firms, sector associations, craftspeople, collective organisations and social welfare organisations, among others) aligning their actions and results. These objectives defined by Fundão local authority agree with what is pointed out by Muñoz and Cohen (2017) concerning a *living lab*, where there is a spirit of innovation and collaboration/network.

Briefly, the *living lab* studied here is based on a logic of extended cooperation and involvement, by sharing experiences at several levels, aiming to create new, innovative solutions for the problems of the town's community. This is a laboratory of social innovation, involving all interested parties in formulating and implementing solutions that improve people's/residents' quality of life.

4.2. Living lab to promote urban entrepreneurship

The general objective of the innovation plan in Fundão is to "respond to territorial needs". This corroborates the argument that local authorities possess all the conditions to create bonuses with *living labs* and to be successful, as well as creating a vehicle for urban entrepreneurship (Cohen et al., 2016; Santoro & Conte, 2009). In general, *living labs* are a form of organising innovation and opportunities (Leminen, 2015), and so Cova da Beira *Living Lab* is created as an ecosystem.

Urban entrepreneurship is closely related to public-private-people partnerships (4Ps), which in the case of the town studied here is visible in the link between its strategy of economic growth and that of urban planning(CMF-Fundão Local Authority, 2012, 2016). This means that the *living lab*, "*through the local authority, provides and refurbishes run-down urban areas to set up new businesses for local urban entrepreneurs, in order to encourage them to remain in the region*", notes the advisor at Fundão Local Authority (E1), and also allows urban entrepreneurs from other regions to move there, with their competences and talents being important for the region's economic and social development. In this connection, and from practical application of various services of the *living lab*, standing out are the Producers' Club– a food-producing service - (start-up 1) and the commercial service of new ideas – Francisco Sanches Photography– (start-up 2), and the interviews with those in charge show the mportance of this *living lab* and its network operation.

The Producers' Club (start-up 1) is a relevant and significant undertaking for the local authority, and so the person in charge considers this "*has autonomy in relation to the living lab, but they share a common strategy*". This club is currently formed of 18 producers of regional products, such as cheese (e.g., Beiralact, Soalheira Alves), charcuterie (e.g, Enchidos da Gardunha, Casa Quintela), wine (e.g, Quinta dos Currais, Adega do Fundão), jams (e.g, Cerfundão, Sabores da Gardunha) and olive oil (e.g., Loca, Cooperativa dos Olivicultores do Fundão), according to information from the interviewee (E3). She also highlighted that, "*the growth of these businesses is stimulated by the living lab and through these business-people having an economic entrepreneurial spirit, but above all by being motivated to be urban entrepreneurs and wanting to take advantage of the urban resources provided by the council and contribute to its growth*". The spirit of business-people is stressed by Muñoz and Cohen (2017), where opportunities supplied aim for urban well-being. This association's objective "*is to support the region's food producers, in matters related to their internationalization (endogenous products), with the effect of that support being promotion, value creation, logistics and the contact network, and as a final support, participation in representative trade fairs with selected quality products*," the person in charge of the Producers' Club (E3) also states.

For interviewee E8, agriculture has always been his area of interest, and with Fundão being a town that lives from agriculture, among other activities, he developed his own agricultural project with regional products (cherries, milk, other fruit). The idea behind this project, which has now come to fruition, was to be a supplier for some of the producers included in the Producers' Club (A3) and in this way provide additional resources to regional producers of jams and cheese. For this interviewee, "*the support of the living lab is obvious and crucial for the success of my business*".

Start-up2 (Francisco Sanches Photography) is a photography, video and design project, which "*in the last three years has shown positive development, as it has found support in the ecosystem in the living lab to respond to its customers, namely in the FAB LAB*", stated this businessman interviewed (A4).Therefore, this start-up has participated in photography seminars to spread the benefits of the *living lab* in this town, particularly how a town's urban development can be associated with regional growth, through entrepreneurial spirit (Tranos & Gertner, 2012).

As for the benefits of the *living lab's* resources, "*this concerns wrapping for products (development and manufacture), varied support for participation in national and international trade fairs and exhibitions, and many members are start-ups at the living lab. This means the club functions in a network with the living lab, obtaining synergies and bonuses that would not be possible otherwise*", claims the interviewee from the Producers' Club (A3).The Commercial and Industrial Association is an institutional partner of the *living lab*, and so in the words of its president (E10), "*it uses its resources to attract business investment, to overcome possible logistic and other restrictions, that is, the living lab is a strength in attracting new investments to the region, particularly to Fundão*".

Given the difficulty of finding employment and due to her qualifications (secondary school), citizen E6 decided to create her own business – design in cork. In her own words, "*it was important to be able to rely on the services of Fundão living lab. This means that, initially, I was granted premises at no cost with all the resources necessary to start the business, as well* *as support in publicizing it. At the moment, I'm autonomous (…). Therefore, this living lab is a bonus for all the residents of Fundão*", the citizen adds. This evidence corroborates the innovation plan where the main axes are: (1) "*support and encouragement for entrepreneurship and creativity (installation of new firms with guaranteed support for development of their business) and (2) innovation, promotion and affirmation (which extends beyond the local authority's limits, through stimulating networks between local producers and business-people in different contexts and situations)*" (CMF-Fundão Local Authority, 2016).

This *living lab* is a strategic instrument that intends to activate models clearly oriented towards the real needs of users and consumers, and in this way promote the creation of needs through the appearance of products so innovative that they can act directly on the market. In parallel, it promotes incorporation of new models of social entrepreneurship and provides a favourable environment for receiving firms, particularly technology-based ones and supported on the concept of shared services, which can make a mark on the global market, setting out from Fundão (CMF-Fundão Local Authority, 2016).

The *living lab* studied "*promotes urban entrepreneurship, as providing premises for new businesses leads to the local authority restoring abandoned buildings and continuing with that policy*", says the vice-president (E1). Indeed, this *living lab* supports and encourages entrepreneurship and creativity, through incentives for new firms moving into the redeveloped buildings provided and others. In this sense, for E10, "*the living lab allows companies to set up within Fundão and lets young business-people (entrepreneurs) set up outside the living lab, which means the population and town in rejuvenated by abandoned buildings being occupied, either rented or bought, as well as increased consumption in the town*". In this connection, "*abandoned urban infrastructure has been used to implement the incubated firms and firms outside the incubator, and in this way, they improve the town's image*", interviewee E9 also highlights. For those in charge of these public institutions, this means that urban entrepreneurship fits in with this town's motto, which is to be creative by using existing amenities and competences, some of them being transformed to respond to the objective of the *living lab* associated with urban entrepreneurship.

4.3. Benefits/Results of the living lab

All the interviewees declared that this *living lab* is a competitive advantage for the town of Fundão, with the results being visible. Specifically, the Vice-President of Fundão Local Authority (E1) highlighted that creating this *living lab* allowed: "(1) the setting up of two multinational firms (ALTRAN and YDREAMS), which have provided jobs and brought new residents to the town;(2) around 50 start-ups, which have already created around 60 new jobs; (3) around 10 technology-based firms, besides the two multinationals already mentioned, which have created over 500 jobs". From another perspective, for two citizens interviewed (E5 and E7), "*the synergies inherent to a living lab have originated population growth in Fundão and* *increased tourism, due to the entities involved organising interesting events which attract people from other areas to Fundão and animating the town*".

In addition, according to the Vice-President (E1), this *living lab* has enhanced green economic development: "*assuming, respecting and valuing its strong connection with the surrounding rural environment and defines how people are and act, in a relationship of respect for, and connection with the land in harmony with the urban area, thereby establishing an inclusive town in relation to its surroundings, its green landscape and faithful to its bio-diversity. It is also intended that the town of Fundão should grow sustainably, but never forgetting the reduction of greenhouse gases and reducing pollution, minimizing waste production and efficient use of natural resources*". Giffinger et al. (2007) and Giffinger and Gudrun (2010) corroborate these ideas, arguing that towns should prevent the pollution of natural conditions and promote environmental protection and sustainable resource management.

The citizens interviewed (E6 and E8) also see the *living lab* as a positive instrument in the town. These people consider the town now has more young people, and that this *living lab* has given dynamics to the town's life, both socially and culturally. Interviewee E6 also gave as an example, "*the case of the Cerca Design Hotel, which was redeveloped by people from outside the town of Fundão and which is now a centre of attraction for rural tourism for all age-groups*".

For E1, "*the region's economic development involves concentrating on urban and territorial promotion founded on regeneration processes to attract economic, institutional, social and civic investment, including the creation of a value chain and creating a competitive regional territory*". Also for the operational manager, the *living lab's* function "*has been to attract investment, i.e., make Fundão attractive for business, renew the local business sector, attract new talent (entrepreneurship and innovation), create an ecosystem and lead stakeholders to re-think the area. All this with the aim of revitalizing the area and creating conditions for people to settle here*". These statements correspond to the arguments that cities are the pillars of development (Daniels, 2004) and that *living labs* have a dominant role in cities/regions (Cohen & Munoz, 2015; Lundqvist & Middleton, 2010; Osorio & Cordero, 2014).

The person in charge of the Producers' Club (E3) and the businessman (E4) also believe that the *living lab* has made investment in the region possible, allowing the promotion of quality of life, the quality of food products and promotion of culture and art (photography). In relation to this association, this businessman and the role of the *living lab*, it is considered they use the network created (Santoro & Conte, 2009) and the 4P's model is applied (see also Bilgram et al., 2008; Nevens et al., 2013; Pallot et al., 2010).

For another citizen also interviewed (E5), "*the existence of the living lab in Fundão is positive, as it provides access to resources linked to my area of training, for example, musical shows,* *theatre and exhibitions*". This interviewee also states: "*… the professional activity I carry out is related to fashion, and I could take advantage of the synergies embedded in the various aspects of this living lab, particularly in publicizing the premises I have open to the public and participation in various events organised by Fundão Local Authority to exhibit clothes I made. I also received support in registering my own brand, which was absolutely crucial for the growth of my business locally*". Regarding personal involvement and participation, for two other interviewees (E6 and E7), this *living lab* has made it possible to attend cultural events which otherwise would not have been possible, besides being able to participate in the participative budget of Fundão Local Authority. She states that "*the cost/benefit analysis is being carried out and I'm sure the objectives were reached and that the effects are noted, but it is necessary to define where we're going*." It is clear there are still some failings in the operationalization of the *living lab* regarding how it grew, allowing the argument that there is still a need for the local authority to adopt smart governance in keeping with a future smart city (Bifulco et al., 2017; Hielkema & Hongisto, 2013; Lee et al., 2014; Nam & Pardo, 2011).

Interviewee E2 also summarized as the benefits of this *living lab* the fact of supporting, sharing and creating, i.e., transforming ideas in business, developing an environment conducive to new company growth, sharing services between firms, stimulating the town centre and local commerce (urban entrepreneurship) and urban redevelopment (urban entrepreneurship through regeneration and revitalization).She states also that "*the cost/benefit analysis is being carried out and I'm sure the objectives were reached and that the effects are noted, but it is necessary to define where we're going*." It is clear there are still some failings in the operationalization of the *living lab* regarding how it grew, allowing the argument that there is still a need for the local authority to adopt smart governance in keeping with a future smart city (Bifulco et al., 2017; Hielkema & Hongisto, 2013; Lee et al., 2014; Nam & Pardo, 2011).

Also for E1, this *living lab* has "*provided premises, infrastructure and reception services, through adapting and redeveloping existing buildings, in order to take on new functions devoted to welcoming entrepreneurs and innovative, technology-based firms*". In this way, besides adding value to the existing heritage through renovation, low-cost infrastructure is provided to both the community and firms. According to the project manager of the Science and Technology Park (E9), "*this living lab captures benefits/results since it supports the innovation applied to endogenous products of excellence, seeking new markets and internationalization; it promotes Nature Tourism; it supports applications for funding through negotiation with banks in order to facilitate financial instruments, particularly the micro-credit system destined to specific, local, entrepreneurial initiatives*".

Summarizing, in the view of various interviewees, setting up an incubator such as the one studied here has made it possibleto attract investment, retain population, capture innovation and create value, which is facilitated by incentives in relation to providing locations and infrastructure, knowledge and services associated with the process of transforming an idea in a business model. All this social and economic activity is supported on a basis of very strong sustainability. The *living lab* studied here also plays an important role in operationalizing and implementing a green economy based on sustainability, since these incubators allow social and technological innovation to be developed and tested in a living laboratory environment.

4.4. Factors of living lab to promote urban entrepreneurship: a synthesis

After exploring and discussing the evidence obtained from the *living lab* as the case selected, we elaborated a synthesis of the most determinant aspects in establishing the *living lab* to promote urban entrepreneurship. As shown in Table 2, we identified three units/factors: (1) open network, (2) entrepreneurship and (3) benefits/results, which are likely to determine the success of *living labs* in the field of urban entrepreneurship.

Table 2 - Factors Associated with the Living Lab

Determinant Aspects	Living Lab Factors
• Relational capital • Formal and personal contacts • Professional experience • Partnerships and protocols • Citizens and firms' involvement • Collaborative projects	➔ Open network
• Opportunities and creation of start-ups • Creativity and innovation • Employment • Investment and financing • Regional development • Stimulate urban entrepreneurship	➔ Entrepreneurship
• Creation of synergies and value • Increase in tourism • Training facilities • Cultural and participative events • Product and service quality • Green economy • Quality of life and sustainability	➔Benefits/Results

Source: Own elaboration

5. Conclusions and implications

In response to the research question initially defined, from a network perspective it is concluded that the *living lab* studied here is an incentive for urban entrepreneurship in Fundão and its sustainability. Achieving this purpose implies that all stakeholders come together around a strategy and a common objective. This evidence is clear in the *living lab* studied here, which is based on an open network and involves an open spirit in all domains.

Concerning urban entrepreneurship, the evidence obtained from this case indicates there is a focus on entrepreneurship in this town to stimulate the region's economic development, which is allied to development and urban entrepreneurship. This local authority intends its growth to be sustainable economically, socially and environmentally (De Jong et al., 2015), aiming to be a smart city. In addition, the growth of this town through new residents arising from new investment created urban entrepreneurship. This *living lab* also allows the setting up of small firms and multinationals in the region and the creation of a business network, where resource-sharing is crucial for the success of the entrepreneurial and innovative ideas of citizens motivated to do business and collaborate actively in the region's management and growth.

Associated with benefits/results, its multiple services and the flexibility of its structure allows this *living lab* to present quality in the products and services commercialized/provided, which will be a differentiating factor leading to competitive positioning. In addition, the impacts of this *living lab* on the town studied here is territorial, economic and social. It is therefore argued that the transversal nature of this platform includes urban entrepreneurship, regional development, attracting foreign and national investment (from start-ups to multinationals), retaining population, increasing tourism, quality of life, concentrating on innovation and creating value, among other results.

Based on this case study results, we also conclude that both tangible and intangible resources are crucial to develop the sustainability of urban entrepreneurship, where collective integration provides synergies that transform opportunities into successful business. This integration in the town studied involves a *living lab* as a tool and/or instrument available to the local authority to revitalize the locality, through public-private-people partnerships (4Ps model).

From the evidence obtained, we were able to detect three units/factors: (1) open network, (2) entrepreneurship and (3) benefits/results. These insights gained from our explorative case study have several theoretical and practical implications. For the former, our study contributes to the existing literature on urban entrepreneurship as it enhances knowledge on the potential interface between *living labs* and this type of entrepreneurship in cities. The exploratory character of our research enabled us to comprehend these particular factors associated with *living labs* that influence urban entrepreneurship for sustainable urban development. The insights gained should be tested in quantitative approaches and allow outlining new streams for future investigations.

Concerning practical implications, the *living lab* studied is a platform grouping a number of economic, social and territorial services, with the aim of stimulating creativity/innovation and entrepreneurship at the regional level, while simultaneously forming various networks and promoting urban development through the regeneration of existing premises, which was seen to be possible in practical terms. Managerially speaking, Cova da Beira *living lab* has the potential to promote research and development projects, applied research, advanced training, pilot-projects in areas such as food production, tourism, information and knowledge, the environment, polishing, information technology and robotics. The aim is to stimulate the development of new business concentrating on a differentiated approach to the local situation, to allow the creation of new methodologies for treating the region's difficulties and potential, framed in the implementation of an open innovation model that lets the consumer take on an active and central role in the processes of research, development and innovation, thereby becoming a user.

Due to the benefits/results of *living labs*, it is therefore up to each town's local authority to create the facilitating conditions to make this possible, for example, through tax incentives and providing infrastructure. In this way, those in charge of local authorities and public and private policy should be aware that fulfilling these objectives has an economic impact on a town, namely in creating local employment. This research shows that policy-makers should create public policies to promote the concentration of competitive firms in a given region/town, since this type of programme can stimulate that region's transformation to become even more competitive. Benefiting from those positive externalities, these will simultaneously tend to attract other firms, through the contagion effect, in this way stimulating regional competitiveness. In these circumstances, local authorities, as smart cities, must identify and develop forms of participation by all, i.e., citizens, agents from the private sector, universities, research centres and public institutions (Bifulco et al., 2017). Finally, society as a whole shares the collateral benefits of a *living lab* in a town, as a strong link is found between the different agents of local development, such as firms, schools, associations and others. *Living labs* also demonstrate a good environmental record and commitment to generating green growth. These types of incubators develop citizens' environmental awareness and involvement, as well as acting as a 'green ambassador' and encouraging better sustainability. *Living labs* should recognize environmental policies and promote inhabitants' quality of life.

Living Labs oriented to developing a green economy should act in several aspects, namely social (society in general), business (economic) and ecosystems (environmental and green). Therefore, there should be integration of all relevant actors in places/towns so that the innovations provided by *living labs* to develop the green economy give rise to structural, social and technical change in business models, value chains and life-styles.

This study is not without limitations. The most noteworthy one has to do with the research design: While the choice of the case study method provides exhaustive and specific information about the phenomenon subject to analysis, its results and conclusions cannot be generalised. This is aggravated by the fact that the insights gained are restricted to only one case (Cova da Beira *Living Lab*). The need remains to further analyse several *living labs* in other cities with entrepreneurial behaviour in order to confirm, refine and adapt the outcomes of our case study. The insights gained should be tested in quantitative approaches and allow outlining new streams for future investigations. Another limitation is the result of having gathered information from only two start-ups. Therefore, suggested as indications for future research are multiple case studies in various local authorities around the country, to allow a comparative study that could be generalized. One more future topic is related to extending this study to all the services included in the *living lab* analysed here, as well as case studies of the successful start-ups.

Finally, we hope that our findings and conclusions contribute to better understanding of the drivers/factors of *living labs* to promote urban entrepreneurship in other national and foreign cities, a phenomenon of great economic and social importance.

References

Almirall, E., & Wareham, J. (2008). Living labs and open innovation: Roles and applicability. *The Electronic Journal for Virtual Organization & Networks*, *10*(3), 21–46.

Almirall, E., & Wareham, J. (2011). Living Labs: arbiters of mid and ground-level innovation. *Technology Analysis & Strategic*, *23*(July), 87–102.

Alter, C., & Hage, J. (1993). *Organizations working together* (Vol. 191). Sage Publications, Inc.

Audretsch, D. B., & Belitski, M. (2013). The missing pillar : the creativity theory of knowledge spillover entrepreneurship. *Small Business Economics*, *41*, 819–836.

Audretsch, D. B., Belitski, M., & Desai, S. (2015). Entrepreneurship and economic development in cities. *Annals of Regional Science*, *55*(1), 33–60.

Audretsch, D. B., & Fritsch, M. (2002). Growth Regimes over Time and Space. *Regional Studies*, *36*(2), 113–124.

Austin, J. &Stevenson, H. (2006). Social and Commercial Entrepreneurship: Same, Different, or Both? *Entrepreneurship Theory and Practice*, *30*(1), 1–22.

Baedeker, C., Liedtke, C., & Welfens, M. J. (2017). Green Economy as a Framework for Product-Service Systems Development: The Role of Sustainable Living Labs. In: Keyson D., Guerra-Santin O.,& Lockton D. (eds). *Living Labs*. Springer, Cham.

Bakici, T., Almirall, E., & Wareham, J. (2013). A Smart City Initiative: The Case of Barcelona. *Journal of the Knowledge Economy*, *4*(2), 135–148.

Baltes, G., & Gard, J. (2016). Living Labs as intermediary in open innovation: On the role of entrepreneurial support. In *2010 IEEE International Technology Management Conference, ICE 2010*, (November).

Batty, M. (2008). The size, scale, and shape of cities. *Science*, *319*(5864), 769–771.

Berg, B.& Lune, H. (2004). *Qualitative research methods for the social sciences.*Boston.

Bifulco, F., Tregua, M., Amitrano, C. (2017). Co-governing smart cities through living labs. Top evidences from EU. *Transylvanian Review of Administrative Sciences*, 13(*50)*, 21–37.

Bilgram, V., Brem, A., & Voigt, K.-I. (2008). User-centric innovations in new product development — Systematic identification of lead users harnessing interactive and collaborative online-tools. *International Journal of Innovation Management*, *12*(3), 419–458.

Blaikie, N. (2000). *Designing Social Research*. Cambridge: Polity Press.

Bosma, N., & Sternberg, R. (2014). Entrepreneurship as an urban event? Empirical evidence from European cities. *Regional Studies*, *48*(6), 1016–1033.

Burstrm, F., & Korhonen, J. (2001). Municipalities and industrial ecology: Reconsidering municipal environmental management. *Sustainable Development*, *9*(1), 36–46.

CMF-Câmara Municipal do Fundão. (2016.). *Plano Estratégico de Reabilitação Urbana - Delimitação da Área de Reabilitação Urbana FUNDÃO*.

CMF-Câmara Municipal do Fundão (2012). Protocolo de cooperação: criação da Living Lab Cova da Beira.

Chesbrough, H. W., & Crowther, A. K. (2006). Beyond high-tech: early adopters of Open Innovation in other industries. *R&D Management*, *36*(3), 229–236.

Cohen, B., Almirall, E., Chesbrough, H. (2016). The City as a Lab: Open Innovation Meets the Collaborative Economy. *California Management Review*, *59*(1), 5–13.

Cohen, B., & Muñoz, P. (2015). Toward a Theory of Purpose-Driven Urban Entrepreneurship. *Organization & Environment*, *28*(3), 264-285.

Daniels, P. W. (2004). Urban challenges: The formal and informal economies in mega-cities. *Cities*, *21*(6), 501–511.

Davies, A. R. (2002). Power, politics and networks: shaping partnerships for sustainable communities. *Area*, *342*(34), 190–203.

Dawson, B. K., Young, L., Tu, C., & Chongyi, F. (2014). Co-innovation in networks of resources - A case study in the Chinese exhibition industry. *Industrial Marketing Management*, *43*(3), 496–503.

De Jong, M., Joss, S., Schraven, D., Zhan, C., & Weijnen, M. (2015). Sustainable-smart-resilient-low carbon-eco-knowledge cities; Making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production*, *109*, 25–38.

Dekkers, R. (2011). Perspectives on Living Labs as innovation networks. *International Journal of Networking and Virtual Organisations*, *9*(1), 58-85.

Echebarria, C., Barrutia, J. M., Aguado, I., Apaolaza, V., & Hartmann, P. (2016). Capturing the benefits that emerge from regional sustainability networks: The Castile-La Mancha network of sustainable cities and towns. *Papers in Regional Science*, *95*, S27–S49.

Eisenhardt, K.M. (1989), Building theories from case study research, *Academy of Management Review*, 4(4), 532-550.

Eriksson, M., Niitamo, V., Oyj, S., & Kulkki, S. (2005). State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation - a European approach . *Technology*, *1*(13), 1–13.

Feldman, M. (2001). The entrepreneurial event revisited: firm formation in a regional context. *Industrial and Corporate Change*, *10*(4), 861–892.

Florida, R., Mellander, C., & Stolarick, K. (2008). Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of economic geography*, *8*(5), 615-649.

Freire-Gibb, L. C., & Nielsen, K. (2013). Entrepreneurship Within Urban and Rural Areas: Creative People and Social Networks. *Regional Studies*, *48*(1), 139–153.

Fu, Y., & Zhang, X. (2017). Trajectory of urban sustainability concepts: A 35-year bibliometric analysis. *Cities*, *60*, 113–123.

Furmankiewicz, M., Macken-Walsh, Á., & Stefańska, J. (2014). Territorial Governance, Networks and Power: Cross-Sectoral Partnerships in Rural Poland. *Geografiska Annaler: Series B, Human Geography*, *96*(4), 345–361.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417.

Giffinger, R., Fertner, C., Kramar, H., & Meijers, E. (2007). City-ranking of European medium-sized cities. Centre of Regional Science, Vienna University of Technology, 1-12.

Giffinger, R., & Gudrun, H. (2010). Smarter cities ranking: an effective instrument for the positioning of cities? *ACE: Architecture, City and Environment*, 12, 7-25.

Glaeser, E. L., Rosenthal, S. S., & Strange, W. C. (2010). Urban economics and entrepreneurship. *Journal of Urban Economics*, *67*(1), 1–14.

Glaeser E. L, Ponzetto G, T. (2014). Cities, Skills and Regional Change. *Regional Studies*, *48*(1), 7–43.

Glaser, B. G., & Strauss, A. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. *Chicago*, IL: Aldine Publishing Co.

Hielkema, H., & Hongisto, P. (2013). Developing the Helsinki smart city: The role of competitions for open data applications. *Journal of the Knowledge Economy*, *4*(2), 190–204.

Hjorth, D. (2013). Public Entrepreneurship: Desiring Social Change, Creating Sociality. *Entrepreneurship & Regional Development*, *25*(1-2), 34-51.

Johnston, E. W., & Hansen, D. L. (2011). Design Lessons for Smart Governance Infrastructures. *Transforming American Governance: Rebooting the Public Square*, 197–212.

Johnston, L., & Blenkinsopp, J. (2017). Partnerships Challenges for civil society involvement in civic entrepreneurship : a case study of local enterprise partnerships. *Public Money & Management*, *37*(2), 89-96.

Kapucu, N., Yuldashev, F., & Bakiev, E. (2009). Collaborative Public Management and Collaborative Governance : Conceptual Similarities and Differences. *European Journal of Economic and Political Studies*, *2*(1), 39–60.

Klein, P. G., Mahoney, J. T., McGahan, A. M., & Pitelis, C. N. (2010). Toward a theory of public entrepreneurship. *European management review*, *7*(1), 1-15.

Kumar, N., Stern, L.W., & Anderson, J.C. (1993). Conducting interorganizational research using key informants, *Academy of Management Journal*, 36(6), 1633-1651.

Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, *89*, 80–99.

Leminen, S. (2015). Living Labs as Open Innovation Networks. Available online: https://aaltodoc.aalto.fi/bitstream/handle/123456789/17899/isbn9789526063751.pdf?sequence=1.
Liedtke, C., Welfens, M. J. Rohn, H., & Nordmann, J. (2012). Living lab:user-driven innovation for sustainability, *International Journal of Sustainability in Higher Education*, 13(2), 106-118.
Lundqvist, M. A., & Middleton, K. L. W. (2010). Promises of societal entrepreneurship: Sweden and beyond. *Journal of Enterprising Communities: People and Places in the Global Economy*, *4*(1), 24–36.
McGuire, M. (2006). Collaborative public management: Assessing what we know and how we know it. *Public Administration Review*, *66*(SUPPL. 1), 33–43.
Muñoz, P., & Cohen, B. (2016). The making of the urban entrepreneur. *California Management Review*, 59(1), 71-91.
Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation: Focusing on management, policy, and context. In *5th International Conference on Theory and Practice of Electronic Governance (ICEGOV2011)*.
Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: Co-creating transformative action for sustainable cities. *Journal of Cleaner Production*, *50*, 111–122.
Neuman, W. L. (2010). *Social research methods: qualitative and quantitative methods, qualitative and quantitative approaches*, Boston, Allyn and Bacon Cop.
Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, *27*(6–7), 367–377.
Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495.
Patton, M. Q. (1990). *Qualitative interviewing, in: Qualitative evaluation and research methods*, 2nd ed. (pp. 277-367), London, Sage.
Osorio, A. E., & Cordero, J. A. (2014). Entrepreneurship Education in Practice: The Development of a Hybrid Training Model in an Urban Environment. In *Innovative Pathways for University Entrepreneurship in the 21st Century* (pp. 171-208). Emerald Group Publishing Limited.
Pallot, M., Trousse, B., Senach, B., & Scapin, D. (2010). Living Lab Research Landscape : From User Centred Design and User Experience towards User Cocreation. *Technology Innovation Management Review*, *1*, 19–25.
Ryan, B., Scapens, R. W., & Theobold, M. (2002). Research Methods and Methodology in Finance and Accounting.
Santoro, R., & Conte, M. (2009, June). Living labs in open innovation functional regions. In *Technology Management Conference (ICE), 2009 IEEE International* (pp. 1-8). IEEE.
Shane, S., Locke, E. A., & Collins, C. J. (2003). Entrepreneurial motivation. *Human Resource Management Review*, *13*, 257–279.
Shane, S., & Venkataraman, S. (2007). The promise of entrepreneurship as a field of research. *Entrepreneurship: Concepts, Theory and Perspective*, *25*(1), 171–184.
Snow, C. C., Håkonsson, D. D., & Obel, B. (2016). A Smart City Is a Collaborative Community: Lessons from smart Aarhus. *California Management Review*, *59*(1), 92–108.
Sternberg, R. (2009). Regional Dimensions of Entrepreneurship. *Entrepreneurship*, *5*(4), 211–340.
Szerb, L., Ács, Z., Autio, E., Ortega-Argilés, R., & Komlósi, É. (2013). The regional entrepreneurship and development index-Measuring regional entrepreneurship. Available online:
http://real.mtak.hu/21512/1/regional_entrepreneurship_development_index.pdf
Tranos, E., & Gertner, D. (2012). Smart networked cities? *Innovation: The European Journal of Social Science Research*, *25*(2), 175–190.
Veeckman, C., & Graaf, S. Van Der. (2015). The City as Living Laboratory : Empowering Citizens with the Citadel Toolkit. *Technology Innovation Management Review*, *5*(March), 6–17.
Walravens, N. (2012). Mobile business and the smart city: Developing a business model framework to include public design parameters for mobile city services. *Journal of Theoretical and Applied Electronic Commerce Research*, *7*(3), 121–135.
Weber, R. P. (1990). *Basic content analysis*. Thousand Oaks, Sage.
Westerlund, M., & Leminen, S. (2011). Managing the Challenges of Becoming an Open Innovation

Company: Experiences from Living Labs. *Technology Innovation Management Review*, *1*(1), 19–25.

Woolthuis, R. K., Hooimeijer, F., Bossink, B., Mulder, G., & Brouwer, J. (2013). Institutional entrepreneurship in sustainable urban development: Dutch successes as inspiration for transformation. *Journal of Cleaner Production*, *50*, 91–100.

Yin, R. (2015). *Case study research: design and methods - Applied social research methods series*. Thousand Oaks, CA: Sage Publications, Inc.

Zeng, S. X., Xie, X. M., & Tam, C. M. (2010). Relationship between cooperation networks and innovation performance of SMEs. *Technovation*, *30*(3), 181–194.

CHAPTER 10

CONCLUSIONS AND IMPLICATIONS

1. General conclusions

The pertinence and conceptual complexity of cities is not completely covered in the extensive literature about them, and so countless studies have indicated emerging gaps, such as the need to ally networks to cities' performance and study cities from a multidimensional and holistic perspective (e.g., Hatuka et al., 2018), through a Composite Index (e.g., Borén & Young, 2013; Malecki, 2007; Mora, Bolici, & Deakin, 2017) with a high number of variables (e.g., Çetindamar & Günsel, 2012).

Therefore, filling these gaps was the motivation behind this research, which is clear in the general objective defined, where the intention was to delineate a proposal of a holistic model for Current Creative Cities (CCCs), validated empirically in Portugal by constructing a Composite Index to assess the holistic performance of the 308 Portuguese towns and cities. Dominant in this general objective are networks as a construct predicting the holistic performance of CCCs.

Chapter 2 gives the response to the first objective defined, by mapping the topics most commonly studied by the academic community, where the constructs in question were networks, creative cities and performance, and by identifying pertinent and emerging gaps in these constructs. The research methodology used in this chapter was the systematic literature review by applying a bibliometric analysis. The bibliometrics presented was obtained by using *Vosviewer* software, which was preceded by a descriptive analysis (*Microsoft Excel*) and a lexical analysis (*NVIVO 11*). The results reveal growing interest in the concept of creative cities, identifying two clusters: (1) Creative cities and their connection with the creative class and culture; and (2) Creative/cultural clusters and networks. Content analysis of these clusters and the 102 scientific documents at their origin revealed the transversality of developing a dynamic, wide-ranging model for CCCs and of future studies to measure their performance, showing the factors determining improved economic growth, as is the case of networks. Furthermore, the systematic literature review allowed elaboration of a framework for CCCs, highlighting the constructs implicit in creativity – creative industries, creative class, culture, urban regeneration -, which illustrate and value the soft, hard, social and cultural amenities of CCCs. Consequently, the constructs and these amenities allow association with the dimensions of intelligence and urban sustainability in CCCs. This holistic association directs CCCs to new models of governance, to the importance of stimulating network formation and urban entrepreneurship, which together improve cities' economic growth.

The evidence obtained in this first study directed this research to a response to the second objective defined, which aimed to present a proposal of a multidimensional and holistic design for CCCs and identify the indicators to measure their performance. Therefore, **Chapter 3** went on to design a proposal of a model for CCCs, based on an inclusive vision of creativity, intelligence and urban sustainability at the same level of importance, since their dissemination is joint and inseparable. In a concise way, this model fills the gaps that still remained in the literature on this topic, since it compiles: (1) various models for CCCs by dimension *per se* (creativity, intelligence and urban sustainability) and (2) pertinent and commonly used indicators to measure the creative, intelligent and sustainable performance of CCCs. In addition, networks are considered a predictor of CCCs' improved performance.

The third and fourth objectives defined were dealt with in **Chapters 4, 5, 6** and **7,** which proposed empirical validation of the model proposed for each dimension *per se* – Creativity, Intelligence and Urban Sustainability – through a Composite Index of performance for each of them, and subsequently, for holistic performance. These indices were obtained by using the *Handbook on Constructing Composite Indicators: Methodology and Userguide* (OECD, 2008). This multidimensional, holistic model for CCCs was validated empirically in Portugal, in its 308 towns and cities, or local authorities. This validation aims to assess the holistic performance of that population, with the inherent complexity being solved by constructing Composite Indices for the creative (creativity dimension), intelligent (intelligence dimension), sustainable (urban sustainability dimension) and holistic performance of CCCs. The multivariate statistical techniques used (EFA and PCA) allowed calculation of the scientific and robust weightings for each dimension/sub-dimension included in these indices (OECD, 2008). The results obtained with the 4 indices presented are shown in Table 1.

Table 1 - Summary of the results obtained by the Composite Indices *per se*

Dimension	Subdimensions	Weights
COMPOSITE INDEX FOR CREATIVE PERFORMANCE	CULTURE	22,0%
	CREATIVE ECONOMY	38,0%
	FAVOURABLE ENVIRONMENT	39,9%
		100%
COMPOSITE INDEX FOR INTELLIGENT PERFORMANCE	GOVERNANCE	50%
	INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)	50%
		100%
COMPOSITE ÍNDEX FOR URBAN SUSTAINABILITY PERFORMANCE	ECONOMIC SUSTAINABILITY	38,6%
	SOCIAL SUSTAINABILITY	24,5%
	ENVIRONMENTAL SUSTAINABILITY	36,9%
		100%
COMPOSITE INDEX FOR HOLISTIC PERFORMANCE	CREATIVITY (VARIABLE 1/FACTOR 1)	38,0%
	INTELLIGENCE (VARIABLE 2/FACTOR 2)	23,4%
	URBAN SUSTAINABILITY (VARIABLE 3/FACTOR 3)	38,6%
		100%

Source: Own elaboration

The Composite Index of the creativity dimension **(Chapter 4)** showed that Portuguese towns and cities have had the capacity and resilience to re-use their intangible resources to tackle their economic and demographic stagnation or decline, giving them a new significance in terms of use and purpose, besides joining them with their tangible resources to obtain economic and non-economic bonuses. Associated with these urban amenities (resources) are the networks that have been formed in cities as a synergy benefiting their creative performance. These strategies stimulating creativity and their inherence to urban networks are also a driver for cities' urban regeneration through urban entrepreneurship. Summarizing, the creative performance of the 308 towns and cities in Portugal has been raised by focusing on conceiving a creative economy, in which the creative industries, culture and the existence of attractive urban locations plays the main role in improving their economic growth, with the effects being reflected in the macro, micro and meso creative performance of Portugal as a country.

Regarding the weightings (Composite Index) shown for the intelligent performance **(Chapter 5)** of the 308 towns and cities in Portugal, these indicate how their government/management (governance) is carried out and their adaptation/adoption of technological progress (ICT), as unavoidable sub-dimensions to help improve their economic growth. The empirical evidence shown in this research points to a positive evolution in national strategies aiming for cities' intelligent growth, despite the weightings being the same in each sub-dimension. This equality is justified by the unavailability of most of the numerical data necessary for their measurement, when taking cities as the unit of analysis. This setback allows the argument that equal weights can reveal a possible undervaluing of intelligent performance in Portugal. Added to this evidence is the fact that the majority of Portuguese towns belong to international and national network organisations (of towns and others), which has a relevant impact on their intelligent performance. Summarising, intelligence begins to gain prominence in Portugal as an inseparable axis of economic growth, although its effects are not yet very visible in results at the micro (towns) and meso (regions) levels.

Finally, sustainable performance **(Chapter 6)** presents weights (Composite Index) showing some potential for a balance between the economic, social and environmental pillars to be the case in Portuguese towns and cities. Also used in this dimension were indicators that connect culture and creativity to sustainability (cultural pillar) and the effect of open networks (e.g., *living labs*) on the urban sustainability of cities where they exist, as well as indicators related to the most recent focus of the European Union, the circular economy. Furthermore, Portuguese towns' implementation of measures and actions on the ground directed to sustainability has not neglected the importance of their cultural traditions and creativity, and so urban locations continue to be attractive for human, social and financial capital. Moreover, Portuguese towns and cities have banked on open networks and on the collective and individual participation of all urban agents.

After determining the scientific weightings for each sub-dimension included in each dimension analysed, the conditions are joined for measurement of the holistic performance (holistic Composite Index) of Portuguese towns and cities **(Chapter 7)**. The results obtained are encouraging and so economic growth strategies should continue to bank on these dimensions and continue with incentives for these to be implemented at the micro level. This can create the structural and conjunctural bases so that persisting weaknesses can be eliminated, with Portugal continuing to improve steadily its creative, intelligent and sustainable performance.

The great differences between Portuguese towns and cities concerning their location (e.g., inland, coastal) and population density (e.g. rural, metropolitan) directed this research to determining the taxonomical profile of the performance of the 308 towns and cities **(Chapter 8)** analysed, supported by the Composite Indices and the rankings per city/dimension/sub-dimension deductively constructed to respond to the fifth objective defined. To determine this profile, Hierarchical Cluster Analysis was used, since the data were measurable. This statistical technique resulted in 12 clusters, among which cluster 1 is highlighted. The taxonomy of performance (great, high, mean and weak) presented for the Portuguese context is innovative and scientific, with cluster 1 - Lisbon (presenting excellent holistic performance) standing out, and at the other extreme, cluster 3 with 116 towns (e.g., Fundão, Macedo de Cavaleiros, Nazaré) with weak holistic performance. Global analysis of the 12 clusters revealed that the 308 Portuguese towns and cities are divided in four distinct groups regarding their position in the taxonomy of holistic performance, leading to the conclusion that group 1 (6 clusters, 272 towns, weak performance) has not yet managed to follow strategies reflecting the use of their own resources to generate economic growth and thereby combat the negative aspects of an isolated location, decline and others; group 2 (4 clusters, 32 towns, mean performance) focuses on the creativity dimension to grow and increase its performance, group 3 (1 cluster, 3 towns, high performance) emphasizes the dimensions of creativity and urban sustainability as pillars of its growth, and group 4 (1 cluster, 1 city, great performance) presents a holistic, integrated performance. The results obtained for the towns and cities included in groups 1 and 2 underlines that if they aim to improve their holistic performance continuously, they must rethink their strategies and policies, so that these do not expose weaknesses and fragilities by excluding one axis/vector/dimension/sub-dimension in favour of another.

Finally, **Chapter 9** responded to the sixth objective, proposing to demonstrate the effect of *living labs*, as open networks, on the economic growth of CCCs. This involved a single case study (qualitative approach) of a town – Fundão – which presents a taxonomical profile of weak holistic performance, but is widely regarded as a reference in terms of creativity, intelligence and urban sustainability, shown by the various awards received, by belonging to various national and international networks and by having the Cova da Beira *Living Lab*. The last two are essential indicators/proxies and included in the Composite Indices constructed. From a management perspective, this open network has the potential to promote processes involving creativity, technology, advanced training and pilot projects in various areas. In other words, Fundão presents a taxonomical profile of *weak* performance due to the financial situation of its structural debt and to not managing to prevent the new residents attracted to work in the firms set up there from leaving the town at the weekend due to the lack of amenities they consider important. This means that the holistic performance shown by Fundão does not reflect its attempts to become creative, intelligent and sustainable, and so its political decision-makers should review its weaknesses and reconsider how to transform those factors to improve its holistic performance.

The general conclusions mentioned above allow implications to be drawn for theory and practice of interest to the academic community, political decision-makers, local government and urban planners of CCCs.

2. Implications for theory

The evidence obtained in the various studies presented here demonstrated that there must be the perception that a city's creativity is not confined to standard application of the perspective proposed by Florida (2002, 2005), since there are no cities with endogenous and exogenous characteristics, or with social and cultural hard and soft amenities in common that are also standardized. The attempts to apply the *"Florida recipe"*, as a magic formula to overcome the harmful effects of globalization, the recent financial crisis, the demographic decline of some regions and exponential urban development have resulted in deep criticism of this author by the scientific community. It has therefore become urgent to design a multidimensional model for cities, which is flexible enough to overcome the limitations of Florida's theory (e.g., gentrification). This research achieved these goals by drafting a theoretical, holistic model for CCCs. This model takes a multidimensional and pluralist view of CCCs, whose implicit concepts are understood as an inseparable set (mix) integrating the dimensions of creativity, intelligence and urban sustainability at similar levels. In addition, the model proposed shows the indicators commonly used to measure the performance of those dimensions and consequently the holistic performance of CCCs, considering the effect of intangible resources and the predictive impact of networks on their economic growth and improved performance. It was also shown that networks (an intangible asset in cities) can be operationalized by *living labs*, as open networks valuing the social capital generated in urban environments, among other network typologies.

However, measuring dimensional performance *per se* and subsequently holistic performance is a highly complex process, which was resolved by constructing four Composite Indices, forming the main implication for theory for various reasons. The first is the construction of the index itself, i.e., its textual component duly supported by the extensive scientific literature; the second lies in showing the scientific weightings for each dimension/sub-dimension and also of these in the holistic performance of CCCs; the third concerns the applicability of these indices and their weightings in any geographical context, with the due adaptations, i.e., they can be applied generally thanks to their external validity (Firestone, 1987).

Regarding theory, this research was set in the Theory of Networks, the Creative Class, Sustainability and the Circular Economy. This theoretical systematization also brought some implications for the theoretical field. Specifically, Network Theory allowed understanding of cities as a node of connectivity, where the relations created involve all city actors in a common objective, improvement of cities' holistic performance. This means that networks help to solve the urban problem faced by cities today, due to the synergies and externalities provided by *intra* and *inter* bonds created in urban spaces, reflecting the theoretical implication of using this theory. Moreover, this research revealed the importance of cities creating global added value, of being attractive to people and business and having a vibrant urban environment. This attractiveness is associated with the benefits of networks as promoters of cities' intangibility around creativity, which has cultural heritage as a catalyst of economic growth. This argument made it possible to show the link between Network Theory and the Creative Class Theory as yet another theoretical contribution of this research, since the limitations of standard application of the model by Florida (2002, 2005) in cities were overcome by including the predictor effect of networks, the impacts of open, participative governance, culture and technology, simultaneously, on cities' holistic performance. Similarly, cities' sustainability which was always implicit in this research and issupported by Sustainability Theory. This theoretical contribution is clear in the fact of having considered that the pillars of sustainability are not only an individual objective, but a consequence of each other. From another perspective, the consequential sequencing of these pillars lets cities undertake efforts to adopt the Circular Economy Model in defining their strategies of urban sustainability, representing yet another theoretical implication. However, the theoretical implications formed here must be added to the primary purpose of this study, meaning that the multidisciplinary approach and joining the constructs of networks, CCCs and holistic performance, where the final result is greater than the sum of its parts, led to contributing to the enhancement of the theories used.

Using cities as the unit of analysis, the size of the population analysed, and the great number of indicators and variables (proxies) is another contribution with implications for theory, since there was a shortage of this type of study (Çetindamar & Günsel, 2012).

Another contribution to theory lies in adopting a mixed methodological approach – quantitative and qualitative – where the research techniques used (bibliometric analysis, exploratory analysis, EFA, PCA, HCA and case study) are complementary rather than mutually exclusive (Minayo & Sanches, 1993; Patton, 1991; Patton, 2002). Therefore, this approach overcame the weaknesses of the quantitative and qualitative methods, as this triangulation allowed the external and internal validity of the research presented here.

Finally, the internal validation of this research is present in three ways. The first lies in the extensive literature review presented, and the second in the selection of indicators and proxies, since they adhered rigorously to the characteristics of a good indicator (Atabek, Coşar, & Şahinöz, 2005; Mega & Pedersen, 1998; Nardo et al., 2005). Finally, the third lies in carrying out a single case study. Theoretically, this case study enhanced the literature on urban entrepreneurship (one form of creativity in cities) and its interconnection with urban and open networks (*living labs*), as well as its influence on the urban sustainability of CCCs, overcoming the weak internal validity of the quantitative approach (Firestone, 1987).

It is of note that these contributions allowed this research to enhance scientific knowledge about the new models of economic growth proposed for CCCs and how to carry out scientific and robust measurement, in any geographical context, as well as opening up avenues to form implications for practice and additionally for public policies.

3. Implications for practice and public policies

Highlighted throughout this research was the need to measure cities' performance through a compilation of scientific indices, including the new resource of CCCs, intangibility. In other words, measuring CCCs' holistic performance only through traditional economic factors has become obsolete, as these do not reflect the economic synergies provided by the intangible assets of urban spaces. These synergies allow the return on investment made in intangible axes, supported by creativity, culture, technology, sustainability, through network formation and raised by open, participative governance. Despite this intangible nature, the return can be re-invested in the weakest axes of CCCs, creating circular economic growth supported by own resources and seeded by creativity, intelligence and sustainability. Consequently, the empirical contributions of the studies presented here provide practical implications for Portuguese local authorities.

In the geographical context analysed, to obtain results allowing this research to make crucial contributions to practices, the researcher had to carry out previous work of dissemination associated with "*craftsmanship*" (OECD, 2008) of the information existing in Portugal, to construct the database essential for application of the theoretical Composite Indices to the 308 (N) towns and cities in the country. This dissemination is the first contribution with implications for practice, since its annual updating allows measurement of Portuguese CCCs' holistic performance to be the subject of longitudinal and comparative studies. These types of studies are essential for local governments and political decision-makers in Portugal to be able to take corrective measures in the various axes of their urban economic growth strategies at the macro, micro and meso levels to achieve the intelligent, inclusive and sustainable growth aimed for by the European Union.

In practical terms, creative performance in Portugal presents weightings (see Table 1 above) revealing that national strategies, implemented at the city level, have begun to emphasize creativity based on the creative and cultural industries (sub-dimensions of culture and creative economy) and on creating a favourable city environment to attract these industries (more investment), and consequently, the creative and talented people who work in them and create employment for others. The weightings for intelligent performance (see Table 1 above), although identical, may be underestimated given the unavailability of data at the city level, and so it is recommended that the entities responsible for data treatment in Portugal should review the structure of their databases, to allow studies made in the country to show the true situation of towns and cities regarding the implementation of ICT and good governance practices. AS for the weightings of cities' sustainable performance (see Table 1 above), it is suggested that public policies should focus more on social sustainability through more guidelines and measures for effective application on the ground, and also that this pillar should be understood as a consequence, and not merely an individual objective, of strategies aiming to achieve economic and environmental sustainability. Summarising, although national government has implemented the premises of sustainable cities in its public policies, the implementation of more actions at the regional and local level is also recommended, to achieve balance between the three pillars, without any of them being neglected in favour of another. That is, they should receive equal priority – three-fold balanced sustainable development.

The implications for practice described above are perceptible in the weightings of holistic performance (see Table 1 above), which show that the intelligence variable presents a lower percentage than the others.

All these practical implications, as a whole, allow the presentation of a methodological, scientific and holistic tool so that any public/private institution can assess and monitor economic growth in Portugal, meaning that we have an original instrument, representing the final practical contribution of this research – a Composite Index for Holistic Performance.

Furthermore, this instrument gave rise to another crucial instrument, which allows analysis of the taxonomical profile of Portuguese towns and cities' holistic performance. The taxonomy presented is a bonus for political decision-makers and other institutions, since it lets them analyse the global results of measures adopted in the creative, intelligent and sustainable vectors, remedy their weaknesses by implementing corrective action and identify their strengths, aiming to alter their taxonomical profile. In other words, it is suggested that local authorities, regional public entities and national decision-makers, in strategic decision-making processes about what measures to implement to increase urban economic growth, should consider achieving the balance between all the dimensions inherent to that growth. Only with this strategic balance is it possible for CCCs to be completely creative, intelligent and sustainable at a single level.

The case study presented also suggests practical implications. The living lab studied is a platform grouping a number of economic, social and territorial services, with the aim of stimulating creativity/innovation and entrepreneurship at the regional level, while simultaneously forming various networks and promoting sustainable and green urban development through the regeneration of existing premises, which was seen to be possible in practical terms.

In terms of practical implications generalized to any geographical context to be analysed, this research showed that the guides presented in Chapters 4, 5, 6, 7 and 8 can be followed to construct the database required to calculate the Composite Indices to measure the holistic performance of countries, regions and other cities. From a management perspective, these guides allow city governance based on strategic decision-making, supported by the results obtained from scientific assessment of holistic performance.

4. Limitations and future research agenda

Like any research, this is not without limitations, which are described in the following paragraphs.

The first limitation concerns the theoretical framework of reference used, which is not without subjectivity given that many other theories could have been adopted. It is therefore suggested that replications of this study in the same geographical context or elsewhere should use, for example, the Theory of Complexity and the Theory of Absorptive Capacity associated with Network Theory, the Creative Class Theory, Sustainability Theory and the Theory/Model of Circular Economy. This suggestion implies that cities are formed by countless complex systems and ecosystems and characterised by diversity, meaning that Complexity Theory (e.g., Özer & Şeker, 2013; Portugali et al., 2012) is a theoretical field that allows consideration of the heterogeneity of all city actors, their interactions and their capacity to adapt to changes, highlighting the importance of the network construct in cities and its synergetic effects (e.g., Castells, 2010). The Theory of Absorptive Capacity (e.g., Cohen & Levinthal, 1990; Zahra & George, 2002) allows conceptualization of the dynamics involved in cities and their management, as local authorities should have the capacity to recognize new ideas and incorporate them in their strategies aiming to improve the holistic performance of CCCs and their competitive advantage.

The second limitation concerns the subjectivity in selecting the indicators and proxies for the context analysed, dictated by the unavailability of data when the unit of analysis is cities (micro level), and so it is suggested that official entities (e.g., INE) reconsider the structure and content of the data provided, to overcome this deficit in fundamental information so that subsequent studies can give a better reflection of the situation in Portugal in relation to the dimensions of creativity, intelligence and urban sustainability.

The fact of carrying out this research only in Portugal is the third limitation, and so a future agenda should include application of the Composite Index for holistic performance in other geographical contexts in order to form comparisons, to draw other essential conclusions for CCCs.

The fourth limitation has to do with the position adopted by the researcher regarding the inclusion of the sub-dimensions of mobility and urban design in the holistic, multidimensional model proposed for CCCs and the subsequent Composite Indexes developed. Given this scenario, those sub-dimensions are understood as two more crucial dimensions rooted in CCCs, whose nature, complexity and the phenomena involved require the construction of two more composite indices, i.e., the composite index for mobility and the composite index for urban design. This means that their performance should be singled out, since the vectors included are transversal in all the strategies of creativity, intelligence and urban sustainability defined and implemented in CCCs. Therefore, they must be assessed and monitored through their own index and then triangulated with the results of the Composite Index for the holistic performance of CCCs, forming yet another direction for future research.

Use of the multivariate techniques of EFA, PCA and HCA rather than others, is the sixth limitation of this study, and a future suggestion would be to use Data Envelopment Analysis (DEA) or the Analytical Hierarchy Process to construct those indices. In addition, the single case study included in this research is a limitation to be overcome in future qualitative studies in other Portuguese towns and other geographical and economic contexts.

Besides future suggestions arising from the limitations of this research, future studies could also determine the factors of CCC success and failure in implementing their holistic strategies of creativity, intelligence and urban sustainability, and consequently, in the performance results obtained. Another future study could separate rural and urban towns/cities to make a comparative study of their performance, with the control variable being their location and demography.

5. Final considerations

This research is of interest to the Portuguese political class generally, mainly to local authorities, and is an original study in the country. Its final message lies in highlighting the importance of regional policies implemented in towns in improving their economic growth, in solving their everyday problems and satisfying citizens' needs, as long as duly assessed and monitored systematically to be able to identify and correct their weaknesses. In addition, bridges must continue to be built so that the dimensions studied here are a consequence of each other and not of individual policies *per se*. It is also recommended that the network construct is always underlying those dimensions, as networks were demonstrated to be a crucial predictor of holistic performance.

References

Atabek, A., Coşar, E. E., & Şahinöz, S. (2005). A new composite leading indicator for Turkish economic activity. *Emerging Markets Finance and Trade*, *41*(1).

Borén, T., & Young, C. (2013). Getting creative with the "creative city"? Towards new perspectives on creativity in urban policy. *International Journal of Urban and Regional Research*, *37*(5), 1799–1815.

Castells, M. (2011). . *The rise of the network society Vol. 12*. (John Wiley & Sons., Ed.).

Çetindamar, D., & Günsel, A. (2012). Measuring the Creativity of a City: A Proposal and an Application. *European Planning Studies*, *20*(8), 1301–1318.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity : A New Perspective on and Innovation Learning. *Adminstrative Science Quarterly*, *35*(1), 128–152.

Firestone, W. A. (1987). The Rhetoric of Quantitative and Qualitative Research. *Educational researcher*, *16*(7), 16-21.

Florida, R. (2002). *The Rise of the Creative Class (and How It's Transforming Work, Leisure, Community and Everyday Life).* (Basic Books, Ed.). New York.

Florida, R. (2005). *Cities and the creative class.* Routledge.

Hatuka, T., Rosen-Zvi, I., Birnhack, M., Toch, E., & Zur, H. (2018). The Political Premises of Contemporary Urban Concepts: The Global City, the Sustainable City, the Resilient City, the Creative City, and the Smart City. *Planning Theory and Practice, 19*(2), 160–179.

Malecki, E. J. (2007). Cities and regions competing in the global economy : knowledge and local development policies. *Environment and Planning C: Government and policy*. *25*, 638–655.

Mega, V., & Pedersen, J. (1998). *Urban Sustainability Indicators*. Office for Official Publications of the European Communutics.

Minayo, M. C. de S., & Sanches, O. (1993). Quantitativo-qualitativo: oposição ou complementaridade? *Cadernos de Saúde Pública*, *9*(3), 237–248.

Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research : A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3-27.

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). Tools for composite indicators building. *Analysis*, *EUR 21682* (December), 134.

OECD. (2008). *Handbook on Constructing Composite Indicators: Methodology and Userguide*. OECD: Paris, France, 2008.

Özer, B., & Şeker, G. (2013). Complexity Theory and Public Policy : A New Way To Put New Public Management and Governance in Perpspective. *The Journal of Faculty of Economics and Administrative Sciences*, *18*(1), 89–103.

Patton, M. J. (1991). Qualitative research on college students: Philosophical and methodological comparisons with the quantitative approach. *Journal of College Student Development.*, *32:*, 389–396.

Patton, M. Q. (2002). Two Decades of Developments in Qualitative Inquiry: A Personal, Experiential Perspective. *Qualitative Social Work*, *1*(3), 261–283.

Portugali, J., Meyer, H., Stolk, E., & Tan, E. (Eds.). (2012). *Complexity theories of cities have come of age: an overview with implications to urban planning and design*. Springer Science & Business Media.

Zahra, S. A., & George, G. (2002). Absorptive Capacity : a Review, and Extension. *Academy of Management Review*, *27*(2), 185–203.

APPENDICES

CHAPTER 7

Appendix 1 - Index of creativity, intelligence and urban sustainability for cities in Portugal

Index of creativity, intelligence and urban sustainability for cities in Portugal

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
			CREATIVITY			
			I) Culture			
General indicator: 1.1) Places of culture and facilities						
A) Places of historical interest	LIC1	308	1) Places of historical, cultural and artistic interest, such as buildings, religious structures, monuments and statues, churches and cathedrals, bridges, towers and others	Tripadvisor	2018	Number
B) Museums and similar	MA1	308	1) Art galleries: buildings	Pordata	2016	Number
	MA2	287	2) Art galleries: exhibitions			
	MA3	308	3) Number of museums open to the public			
C) Cinema	CIN1	308	1) Capacity			
	CIN2	308	2) Places			
D) Concerts and Shows	CE1	304	1) Number of cultural locations	Pordata	2015	Number
	CE2	179	2) Capacity of cultural locations			
E) Theatres	TEA1	308	1) Theatres	Meloteca.com	2018	Number
F) Restaurants and accommodation	RAL1	308	1) Number of hotel establishments	Pordata	2016	Number
	RAL2	266	2) Number of rooms in hotel establishments			
	RAL3	308	3) Restaurants	Tripadvisor	2018	Number
General indicator: 1.2) Cultural participation and attractiveness						
A) Tourist bednights	DORT1	247	1) Total bednights in hotel establishments	Pordata	2015	Number
	DORT2	244	2) Proportion of foreign guests			%
	DORT3	268	3) Total income from hotel establishments		2016	M.€
B) Museum visitors	VISM1	264	1) Total visitors	Pordata	2016	Number
	VISM2	264	2) Total foreign visitors			

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
C) Cinema attendance	ATENC1	308	1) Nº of spectators	Pordata	2016	Number
	ATENC2	308	2) Ticket sales			M.€
D) concerts and shows	DCE1	147	1) Nº of spectators	Pordata	2016	Number
	DCE2	147	2) Ticket sales			M.€
E) Cultural supply	OCC1	308	1) Total cultural premises (local authority)	Annals by region - INE	2016	Number
F) Local authority/public expenditure	DM1	308	1) Expenditure on cultural activities and similar			
II) Creative Economy						
General indicator: 2.1) Creative Industries						
A) Creative jobs	EC1	308	1) Jobs in creative and cultural activities	INE	2016	Number
B) Impact of creative industries on GDP	ICPIB1	308	1)Turnover of cultural and creative industries	INE	2016	€
	ICPIB2	308	2) % of creative industries in total economic activity			%
	ICPIB3	308	3) Expenses with staff in cultural and creative industries			€
	ICPIB4	308	4) Production of cultural and creative industries			
	ICPIB5	308	5) Intermediate consumption of cultural and creative industries			
	ICPIB6	308	6) Gross added value, at market prices, of cultural and creative industries			
	ICPIB7	308	7) Gross fixed capital formation of cultural and creative industries			
C) Territorial analysis of creative industries	ATIC1	308	1) Total number of cultural and creative industries	INE	2016	Number
	ATIC2	308	2) Number of people employed in creative and cultural companies, divided by the total of people employed in all economic activities and multiplied by 100;	Own calculation		%
	ATIC3	308	3) Total number of industries by city over the total of all cities (concentration) multiplied by 100			%
	ATIC4	308	4) Density per capita of cultural and creative industries (Nº of industries/resident population multiplied by 100)			
	ATIC5	308	5) Weight of cultural and creative industries in the total industries in the city (relevance) multiplied by 100			
General indicator: 2.2) Research & Development						
A) Firms	ID1	308	1) Firms with most expenditure on R&D activities	Dgeec.mec	2016	Number
	ID2	308	2) R&D expenditure of those firms			M.€
	ID3	308	3) Total resources allocated by firms to R&D areas			Number
B) Knowledge transfer	TC1	308	1) R&D units in higher education institutions	Dgeec.mec	2016	Number

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
	TC2	308	2) Total researchers in those units financed by FCT	Dgeec.mec	2016	Number
	TC3	308	3) Higher education establishments	Pordata	2017	
	TC4	308	4) Lecturers in higher education	Pordata	2015	
General indicator: 2.3) Intellectual property and innovation						
A) Patent applications	PP1	308	1) Applications for patents and similar	INPI	2017	Number
	PP2	308	2) Applications for patents from higher education institutions			
	PP3	308	3) Applications for patents from other entities			
III) Favourable Environment						
General indicator: 3.1) Human capital and education						
A) Creative class (talent)	CC1	308	1) Number of higher education students enrolled in arts and humanities courses	Pordata	2016	Number
	CC2	308	2) Higher education graduates in arts and humanities			
	CC3	308	3) Number of higher education students enrolled in ICT courses			2016
	CC4	308	4) Higher education graduates in ICT	Annals by region - INE	2016	Number
	CC5	308	5) Higher education graduates	Pordata	2016	Number
	CC6	308	6) Number of students in higher education			
	CC7	308	7) Number of higher education institutions			
	CC8	308	8) Employed population with average/high qualifications (secondary, post-secondary and higher)		2013	
B) HEIs' presence in rankings	PR1	308	1) HEIs in rankings	Webometrics	2018	Number
General indicator: 3.2) Openness and diversity						
A) Tolerance, social classes and young people	TOL1	308	1) Legally resident foreign population: total	Pordata	2016	Number
	TOL2	308	2) Socio-cultural heterogeneity (social classes) – employees' basic average monthly salary		2013	
	TOL3	308	3) Young population (resident population, estimated at 31 December: 0-25 years)		2016	%
	TOL4	308	4) Marriages solemnized between nationals and foreigners		2017	Number
General indicator: 3.3) Local and international connections						
A) International connections	LI1	308	1) Airports	INE	2017	Number
	LI2	308	2) Passenger arrivals by airport			
B) Local connections	LL1	308	1) Transport and storage companies	INE	2012	Number

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
General indicator: 3.4) Governance						
A) Endogenous factors	FE1	308	1) Concluded building redevelopment (urban regeneration)	Annals by region - INE	2016	Number
	FE2	308	2) Licensed building redevelopment (urban regeneration)			
	FE3	308	3) Annual population variation (global attractiveness for new residents)			%
INTELLIGENCE						
I) Governance						
General indicator: 1.1.) Implementation						
A) E-government	EGOV1	308	1) Use of electronic commerce	Annals by region - INE	2016	Number [24]
	EGOV2	308	2) Public consultation processes available on the website			
	EGOV3	308	3) Online completion and submission of forms			
General indicator: 1.2) Strategy						
A) Finance	FIN1	308	1) Total debt	Annals by region - INE	2016	M.€
	FIN2	308	2) Municipal income per inhabitant			Euros
	FIN3	308	3) Municipal expenditure per inhabitant			
B) Network	RED1	308	1) Members of national networks	http://redemunicipiossaudaveis; *Webpages* municipais; http://www.rni.pt/visa; http://www.inteli.pt www.openlivinglabs.eu;	2018	Number [1]
	RED2	308	2) Members of international networks			
General indicator: 1.3) Citizen participation						
A) Elections	PEL1	308	1) Presidential – Voter turnout	Annals by region - INE	2016	Number
	PEL2	308	2) Central Government - Voter turnout		2015	
	PEL3	308	3) Local Authority - Voter turnout		2013	
	PEL4	307	4) European Parliament - Voter turnout		2014	
General indicator: 1.4) City vitality						
A) Individual	VIND1	308	1) Renewal index of the population of working age	INE	2013	%

[24] 1 - Yes; 0 - No

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
	VIND2	308	2) Population density per residence	INE	2014	Km²
	VIND3	308	3) Newspapers and other regular publications: circulation	Pordata	2016	Number
	VIND4	308	4) Resident population <15 years		2011	
	VIND5	308	5) Inactive population: total		2011	
B) Public	VPUB1	272	1) Area of urban parks and facilities	INE	2013	Ha
	VPUB2	272	2) Land use for tourism			
II) Information and communication technology (ICT)						
General indicator: 2.1) Network infrastructure						
A) Telecommunications	TEL1	308	1) Main public telephones	Pordata	2016	Number
	TEL2	308	2 Residential telephones per thousand inhabitants			%
B) Environment	AMB1	308	1) Quality of the water network for human consumption: safe water	Pordata	2016	%
	AMB2	308	2) Population served by waste water treatment networks (ETAR)		2009	
	AMB3	308	3) Electricity consumption for road lighting	Pordata	2016	Kwh
	AMB4	308	4) Hierarchy index of urban waste management			%
General indicator:2.2) Accessibility						
A) Mail and internet	ACES1	308	1) Post offices per local authority	Annual reports by region - INE	2016	Number
	ACES2	308	2) Access to broadband internet service at a fixed point			
General indicator: 2.3) Use of ICT						
A) Public	PUB1	308	1) Average number of pupils per computer with internet connection in primary and secondary schools: total	Pordata	2016	%
B) Private	IND1	308	1) Companies providing ICT services	INE	2016	Number
URBAN SUSTAINABILITY						
I) Economic Sustainability						
General indicator: 1.1) Competitiveness and economic activity						
A) Economic growth	CREC1	308	1) Purchasing power per capita	Pordata	2015	%
	CREC2	308	2) Exports		2016	Euros
	CREC3	308	3) Imports			
	CREC4	308	4) Town’s employment rate		2011	%
	CREC5	308	5) Total unemployment rate			
B) Business	NEG1	308	1) Firms formed in the period of reference	Pordata	2017	Number
	NEG2	308	2) Firms dissolved			
	NEG3	308	3) Banks and Savings Institutions			
	NEG4	308	4) Non-financial firms		2016	

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
B) Business	NEG5	308	5) Firms	Pordata	2016	Number
	NEG6	308	6) Employees in non-financial firms - total and by economic activity			
	NEG7	308	7) Turnover of non-financial firms: total and by economic activity			M.€
	NEG8	308	8) Gross added value of non-financial firms: total and by sector of economic activity			
	NEG9	308	9) Non-financial firms with under 10 employees as a % of all non-financial firms: by sector of economic activity			%
	NEG10	308	10) Youth unemployment rate - Unemployed registered with job centres and in vocational training (annual average): total and by age-group		2017	
C) Entrepreneurship	EMP1	308	1) % of new firms in activity after 2 years	INE	2015	%
	EMP2	308	2) % of employment with higher competences _ Employees: total and by level of education	Pordata	2013	
	EMP3	308	3) % of self-employment (self-employed, but employers)		2011	
	EMP4	308	4) % of self-employment (self-employed, not employers)			
	EMP5	308	5) Density of established firms	INE	2016	Km^2
	EMP6	308	6) FABlabs, living labs	www.fablabsportugal.pt/;	2018	Number [25]
II) Social sustainability						
General indicator:2.1) Population and citizenship						
A) Demographic changes cultural/historic identity	AD1	308	1) Percentage of population over 65	Pordata	2011	Number
	AD2	308	2) Percentage of population under 15			
	AD3	308	3) Migratory growth – contribution of migratory balance to the population variance		2013	%
	AD4	308	4) Index of dependent elderly		2016	
	AD5	308	5) Index of dependent young people			
	AD6	308	6) Child mortality rate (<1 ano)		2017	
	AD7	308	7) Gross birth rate		2016	
General indicator: 2.2) Education						
A) Infrastructure and competences	ICOM1	308	1) Establishments of pre-school, primary and secondary education	Pordata	2016	Number

[25] 1 – Yes; 0 - No

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
A) Infrastructure and competences	ICOM2	308	2) Pupils enrolled in pre-school, primary and secondary education	Pordata	2016	Number
	ICOM3	308	3) Total literacy rate – Resident population of 15 years and over according to the Census: total		2011	
	ICOM4	308	4) Pupils enrolled in pre-school, primary and secondary education as a % of the resident population		2016	%
	ICOM5	308	5) Rate of completion of levels of education – Pupils in regular basic education completing the year: total			Number
General indicator: 2.3) Inclusion and cohesion						
A) Poverty and inequality	PD1	308	1) Recipients of social benefits – Recipients of Guaranteed Minimum Income and Social Insertion Income from Social Security in total active beneficiaries (%)	Pordata	2017	%
	PD2	308	2) Residents at risk of poverty – Beneficiaries of unemployment subsidy from Social Security: total			Number
	PD3	308	3) Equity and citizenship projects	redemunicipiossaudaveis.com	2018	Number
General indicator: 2.4) Social infrastructure						
A) Health	DSA1	308	1) Number of hospital beds – Hospital accommodation	Pordata	2016	Number
	DSA2	308	2) Health centres: appointments per inhabitant		2012	%
	DSA3	308	3) Inhabitants per health centre		2011	
	DSA4	308	4) General and specialized hospitals		2016	Number
	DSA5	308	5) Promotion of physical and mental well-being	redemunicipiossaudaveis.com	2018	
B) Security	DSE1	308	1) Number of crimes: total	Pordata	2016	Number
	DSE2	308	2) PSP and GNR (police) stations	www.psp.pt.http://www.gnr.pt	2018	
III). Environmental sustainability						
General indicator: 3.1) Basic infrastructure						
A) Energy, Water and Gas	EGA1	308	1) Annual energy consumption per capita – Electricity consumption per inhabitant: total	Pordata	2016	KWH /Inhabitant
	EGA2	308	2) Natural gas consumption per capita - Natural gas consumption per inhabitant			Nm3/Inhabitant
	EGA3	308	3) Annual water consumption per capita – Water distributed/consumed per inhabitant		2015	m^3/ Inhabitant

Index of creativity, intelligence and urban sustainability for cities in Portugal (cont.)

Specific indicator	Variable	N	Proxies	Databases	Period of reference	Unit of measure
B) Emission and production of pollutants	EPAT1	308	1) Undifferentiated urban waste collected (Urban waste: total and by type of collection)	Pordata	2016	Tons
	EPAT2	308	2) Differentiated urban waste collected (Urban waste: total and by type of collection)			
General indicator: 3.2) Circular economy						
A) Recycling and reuse	RR1	308	1) Income from waste management	INE	2016	M.€
	RR2	308	2) Expenditure on waste management			
	RR3	308	3) Urban waste sent to energy recovery	Pordata		Tons
	RR4	308	4) Urban waste sent to organic recovery			
	RR5	308	5) Urban waste sent to recycling			
	RR6	308	6) Urban waste sent to landfill			
General indicator:3.3) Environmental protection in urban areas						
A) Territory	TER1	308	1) Income from biodiversity and landscape protection	INE	2016	M.€
	TER2	308	2) Expenditure on biodiversity and landscape protection			
	TER3	308	3) actions of environmental improvement and territorial development	redemunicipiossaudaveis.com	2018	Number
	TER4	308	4) Expenditure on air and climate protection, Protection and recuperation of soil, underground and surface water, protection against noise and vibrations, protection against radiation, R&D and other activities of environmental protection.	INE	2016	M.€
	TER5	308	5) Income from air and climate protection, protection and recuperation of soil, underground and surface water, protection against noise and vibrations, protection against radiation, R&D and other activities to protect the environment.			

Source: Own elaboration

Appendix 2 –Exploratory Factor Analysis of creativity dimension

Table A – Sub-dimension Culture

Variable	h^2	Results of Exploratory Factor Analysis							Squared factor loading (scaled to unit sum[26]						
		Factor							Factor						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
LIC1	0,795					0,775							0,448		
MA1	0,722						0,828							0,591	
MA2	0,587						0,747							0,481	
MA3	0,579						0,600							0,310	
CIN1	0,908			0,893							0,290				
CIN2	0,849			0,904							0,297				
CE1	0,584							0,681							0,407
CE2	0,713					0,719							0,386		
TEA1	0,402		0,593							0,104					
RAL1	0,552	0,625							0,085						
RAL2	0,945	0,970							0,205						
RAL3	0,741	0,723							0,114						
DORT1	0,913	0,943							0,194						
DORT2	0,485	0,393							0,034						
DORT3	0,920	0,950							0,197						
VISM1	0,899				0,935							0,382			
VISM 2	0,882				0,921							0,370			
ATENC 1	0,891		0,859							0,218					
ATENC2	0,885		0,873							0,225					
DCE1	0,553							0,659							0,381
DCE2	0,567		0,612							0,111					
OCC1	0,664					0,785							0,460		
DM1	0,606						0,528							0,240	
Eigenvalue		4,59	3,38	2,75	2,29	1,34	1,16	1,14							
% Explained variance		17,21	11,53	9,87	9,39	9,32	9,01	6,03							
Total explained variance		72,35	Varimax rotation; N = 308; KMO = 0,711; Bartlett Sphericity Test = 2335,137; gl = 253; p < 0,000						0,276[27]	0,203	0,165	0,138	0,080	0,070	0,068

[26] Example of calculation for RAL1: o,625^2/4,59 = 0,085

[27] Example of calculation for: 4,59/∑ 4,59+3,38+2,75+2,29+1,34+1,16+1,14 = 0,276

Table B -Sub-dimension Creative economy

Results of Exploratory Factor Analysis							Squared factor loading (scaled to unit sum)				
Variable	**h²**	**Factor**					**Factor**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
EC1	0,964		0,797					0,241			
ICPIB1	0,960		0,938					0,333			
ICPIB2	0,971				0,977					0,697	
ICPIB3	0,930		0,889					0,299			
ICPIB7	0,806		0,866					0,284			
ATIC1	0,705		0,710					0,191			
ATIC2	0,979				0,981					0,702	
ATIC5	0,956					0,958					0,987
ID1	0,639			0,791					0,297		
ID2	0,905			0,937					0,416		
ID3	0,774			0,792					0,297		
TC1	0,887	0,877					0,117				
TC3	0,615	0,721					0,079				
TC4	0,945	0,917					0,128				
PP1	0,809	0,867					0,114				
PP2	0,795	0,889					0,120				
Eigenvalue		6,59	2,64	2,11	1,37	0,93					
% Explained variance		25,42	25,12	14,49	13,69	6,52					
Total explained variance		85,25					0,483	0,194	0,155	0,100	0,068

Varimax rotation; N = 308; KMO = 0,723; Bartlett Sphericity Test = 6244,488; gl = 120; p < 0,000

Table C -Subdimension Favourable Environment

		Results of Exploratory Factor Analysis					Squared factor loading (scaled to unit sum)				
Variable	**h²**	**Factor**					**Factor**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CC1	0,832	0,907					0,115				
CC2	0,821	0,901					0,113				
CC3	0,866	0,924					0,119				
CC4	0,802	0,890					0,110				
CC5	0,934	0,961					0,129				
CC6	0,947	0,967					0,130				
CC7	0,638	0,778					0,084				
CC8	0,562	0,529					0,039				
PR1	0,546	0,702					0,069				
TOL1	0,714				0,842					0,496	
TOL2	0,802		0,877					0,306			
TOL3	0,619		0,759					0,230			
TOL4	0,695				0,805					0,453	
LI1	0,560			0,690					0,222		
LI2	0,618					0,565					0,285
LL1	0,794					0,861					0,662
FE1	0,925			0,950					0,422		
FE2	0,859			0,910					0,387		
FE3	0,836		0,896					0,320			
Eigenvalue		7,18	2,51	2,14	1,43	1,12					
% Explained variance		35,93	12,37	12,01	9,08	6,25					
Total explained variance		75,64					0,499	0,175	0,149	0,099	0,078

Varimax rotation; N = 308; KMO = 0,750; Bartlett Sphericity Test = 6577,490; gl = 171; p < 0,000

Appendix 3 –Exploratory Factor Analysis of intelligence dimension

Table A-Sub-dimension Governance

Variable	h^2	Results of Exploratory Factor Analysis								*Squared factor loading (scaled to unit sum)*							
		Factor								Factor							
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
EGOV1	0,540				0,352								0,085				
EGOV2	0,805				0,887								0,543				
EGOV3	0.486							0,485								0,224	
FIN1	0,993			0,989								0,520					
FIN2	0,846				0,693								0,331				
FIN3	0,993			0,989								0,520					
RED1	0,666						0,709								0,445		
RED2	0,736						0,776								0,533		
PEL1	0,971	0,964								0,208							
PEL2	0,988	0,982								0,216							
PEL3	0,818	0,748		0,989						0,125							
PEL4	0,955	0,951								0,202							
VIND1	0,785		0,837	0,989							0,223						
VIND2	0,694				0,466								0,150				
VIND3	0,581					0,738								0,462			
VIND4	0,880		0,868								0,240						
VIND5	0,897		0,817								0,213						
VPUB1	0,852							0,913								0,794	
VPUB2	0,793								0,878								0,779
Eigenvalue		4,47	3,14	1,88	1,45	1,18	1,13	1,05	0,99								
% Explained Variance		23,53	16,51	9,92	7,64	6,18	5,94	5,52	5,19								
Total explained variance		80,42								0,292	0,205	0,123	0,095	0,077	0,074	0,069	0,065

Varimax Rotation); N = 308; KMO = 0,697; Bartlett Sphericity Test:= 6471,587; gl = 171; p < 0,000

Table B – Sub-dimension ICT

Variable	Results of Exploratory Factor Analysis					*Squared factor loading (scaled to unit sum)*			
	h^2	Factor				Factor			
		1	2	3	4	1	2	3	4
TEL1	0,945	0,961				0,225			
TEL2	0,940	0,966				0,228			
AMB1	0,935		0,923				0,361		
AMB2	0,806		0,877				0,326		
AMB3	0,798			0,863				0,683	
AMB4	0,970				0,953				1,032
ACES1	0,727			0,679				0,423	
ACES2	0,890	0,859				0,180			
PUB1	0,781		0,868				0,319		
IND1	0,648	0,598				0,087			
Eigenvalue		4,10	2,36	1,09	0,88				
% Explained Variance		40,98	23,65	10,94	8,850				
Total explained variance		84,41				0,486[28]	0,280	0,129	0,104

(varimax Rotation); N = 308; KMO = 0,741; Bartlett Sphericity Test:= 2378,938; gl = 45; p < 0,000

[28] Example of calculation for TEL1: 4,10/∑ 4,10+2,36+1,09+0,88 = 0,486

Appendix 4 –Exploratory Factor Analysis of urban sustainability dimension

Table A– Sub-dimension Economic sustainability

Results of Exploratory Factor Analysis									*Squared factor loading (scaled to unit sum)*						
Variable	**h^2**	**Factor**							**Factor**						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
CREC1	0,811		0,665							0,151					
CREC2	0,541	0,399							0,025						
CREC3	0,728	0,813							0,104						
CREC4	0,740		0,411							0,058					
CREC5	0,702				0,454							0,135			
NEG1	0,803		0,858							0,252					
NEG2	0,664		0,776							0,206					
NEG3	0,716					0,697							0,395		
NEG4	0,788			0,758							0,296				
NEG5	0,791		0,745							0,190					
NEG6	0,916	0,759							0,090						
NEG7	0,841	0,870							0,119						
NEG8	0,829	0,836							0,110						
NEG9	0,815			0,443							0,101				
NEG10	0,679				0,738							0,356			
EMP1	0,781						0,780							0,569	
EMP2	0,751				0,651							0,277			
EMP3	0,812			0,704							0,255				
EMP4	0,866			0,838							0,362				
EMP5	0,680					0,767							0,478		
EMP6	0,803							0,883							0,780
Eigenvalue		6,37	2,92	1,94	1,53	1,23	1,07	1,00							
% Explained Variance		30,35	13,88	9,26	7,31	5,84	5,08	4,75							
Total explained variance		76,46							0,397	0,182	0,121	0,095	0,077	0,067	0,062

Varimax Rotation); N = 308; KMO = 0,779; Bartlett Sphericity Test:= 4305,614; gl = 210; p < 0,000

Table B– Sub-dimension Social sustainability

Results of Exploratory Factor Analysis										*Squared factor loading (scaled to unit sum)*							
Variable	**h²**	**Factor**								**Factor**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
AD1	0,934	0,954								0,114							
AD2	0,891	0,929								0,109							
AD3	0,540	0,642								0,052							
AD4	0,902	0,944								0,112							
AD5	0,744	0,757								0,072							
AD6	0,500								0,678								0,430
AD7	0,763	0,613								0,047							
ICH1	0,828					0,903								0,582			
ICH2	0,656								0,796								0,592
ICH3	0,834					0,887								0,562			
ICOM1	0,893			0,932								0,400					
ICOM2	0,860	0,777								0,076							
ICOM3	0,800	0,767								0,074							
ICOM4	0,860	0,777								0,076							
ICOM5	0,799	0,846								0,090							
PD1	0,703							0,802								0,579	
PD2	0,564						0,576								0,263		
PD3	0,888				0,938								0,483				
DSA1	0,777		0,855								0,318						
DSA2	0,492	0,506								0,032							
DSA3	0,518							0,550								0,273	
DSA4	0,762		0,865								0,325						
DSA5	0,899				0,885								0,430				
DSE1	0,784						0,847								0,569		
DSE2	0,883			0,886								0,362					
Eigenvalue		7,95	2,30	2,17	1,82	1,40	1,26	1,11	1,07								
% Explained Variance		31,82	9,21	8,67	7,30	5,58	5,03	4,42	4,26								
Total explained variance		76,29								0,417	0,121	0,114	0,095	0,073	0,066	0,058	0,056

Varimax Rotation); N = 308; KMO = 0,802; Bartlett Sphericity Test = 9623,441; gl = 300; p < 0,000

Table C – Sub-dimension Environmental sustainability

Results of Exploratory Factor Analysis									*Squared factor loading (scaled to unit sum)*						
Variable	**h^2**	**Factor**							**Factor**						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
EGA1	0,888		0,925							0,468					
EGA2	0,898		0,945							0,488					
EGA3	0,763	0,792							0,160						
EPAT1	0,740	0,802							0,165						
EPAT2	0,778	0,845							0,183						
RR1	0,619	0,665							0,113						
RR2	0,696	0,652							0,109						
RR3	0,838			0,877							0,466				
RR4	0,956						0,965							0,870	
RR5	0,613	0,682							0,119						
RR6	0,913	0,638							0,104						
TER1	0,716				0,842							0,521			
TER2	0,675				0,803							0,474			
TER3	0,581							0,730							0,555
TER4	0,668					0,776							0,478		
TER5	0,700					0,809							0,519		
Eigenvalue		3,91	1,83	1,65	1,36	1,26	1,07	0,96							
% Explained Variance		24,46	11,42	10,30	8,51	7,87	6,68	6,03							
Total explained variance		75,27							0,325 [29]	0,152	0,137	0,113	0,105	0,089	0,080

Varimax Rotation); N = 308; KMO = 0,558; Bartlett Sphericity Test = 1792,370; gl = 120; p < 0,000

[29] Example of calculation: 3,91/∑ 3,91+1,83+1,65+1,36+1,26+1,07+0,96 = 0,325

Appendix 5 – Calculation of the weightings of each sub-dimension in the dimension

Table D - Exploratory Factor Analysis of the Creativity Dimension and Weights

Subdimensions	h^2	Factor – Creativity	Weights
		1	
Culture	0,446	0,668	0,220
Creative Economy	0,772	0,878	0,380
Favourable Environment	0,810	0,900	0,399
Eigenvalue		2,03	
% Explained variance		67,59	
Total explained variance		67,59	

Varimax rotation; N = 308; KMO = 0,607; Bartlett Sphericity Test = 299,642; gl = 3; p < 0,000; h^2 > 67%; *loadings*>40%

Table E - Exploratory Factor Analysis of the Intelligence Dimension and Weights

Subdimensions	h^2	Factor – Intelligence	Weights
		1	
Governance	0,566	0,752	0,500
ICT	0,566	0,752	0,500
Eigenvalue		1,13	
% Explained variance		56,55	
Total explained variance		56,55	

Varimax Rotation; N = 308; KMO = 0,500; Bartlett Sphericity Test = 5,290; gl = 1; p < 0,000; h^2 > 0,5 *loadings*>0.40

Table F - - Exploratory Factor Analysis of the Urban Sustainability Dimension and Weights

Subdimensions	h^2	Factor – Urban Sustainability	Weights[30]
		1	
Economic sustainability	0,621	0,788	0,386
Social sustainability	0,393	0,627	0,245
Environmental sustainability	0,593	0,770	0,369
Eigenvalue		1,61	
% Explained variance		53,60	
Total explained variance		53,60	

Varimax Rotation; N = 308; KMO = 0,598; Bartlett Sphericity Test = 83,775; gl = 3; p < 0,000; h^2 > or near 0,4 *loadings*>0.40

[30] Example of calculation for Economic sustainability: 0,788^2/1,61 = 0,386

CHAPTER 8

Appendix 1 - Cluster composition

Cluster	Towns
1	Arcos de Valdevez, Caminha, Melgaço, Monção, Paredes de Coura, Ponte da Barca, Mondim de Basto, Vieira do Minho, Boticas, Chaves, Montalegre, Ribeira de Pena, Valpaços, Vila Pouca de Aguiar, Armamar, Lamego, Mesão Frio, Moimenta da Beira, Murça, Penedono, Peso da Régua, Sabrosa, Santa Marta de Penaguião, São João da Pesqueira, Torre de Moncorvo, Macedo de Cavaleiros, Miranda do Douro, Mogadouro, Vimioso, Vinhais, Nazaré, Murtosa, Mira, Mortágua, Vila Nova de Poiares, Aguiar da Beira, Santa Comba Dão, Vila Nova de Paiva, Belmonte, Celorico da Beira, Fundão, Gouveia, Mêda, Pinhel, Sabugal, Seia, Trancoso, Calheta [R.A.M.], Ponta do Sol, Ribeira Brava, Santana, São Vicente.
2	Ponte de Lima, Vila Verde, Cabeceiras de Basto, Póvoa de Lanhoso, Paredes, Amarante, Baião, Castelo de Paiva, Celorico de Basto, Cinfães, Lousada, Marco de Canaveses, Paços de Ferreira, Penafiel, Resende, Sernancelhe, Tabuaço, Montemor-o-Velho, Penacova, Soure, Tábua, Carregal do Sal, Castro Daire, Penalva do Castelo, São Pedro do Sul, Sátão, Tondela, Vouzela, Câmara de Lobos.
3	Valença, Amares, Barcelos, Esposende, Terras de Bouro, Fafe, Guimarães, Vila Nova de Famalicão, Vizela, Arouca, Espinho, Gondomar, Oliveira de Azeméis, Póvoa de Varzim, Santa Maria da Feira, Santo Tirso, Vale de Cambra, Valongo, Vila do Conde, Vila Nova de Gaia, Felgueiras, Carrazeda de Ansiães, Tarouca, Alcobaça, Alenquer, Arruda dos Vinhos, Bombarral, Cadaval, Lourinhã, Sobral de Monte Agraço, Torres Vedras, Águeda, Albergaria-a-Velha, Anadia, Estarreja, Ílhavo, Ovar, Sever do Vouga, Vagos, Arganil, Cantanhede, Condeixa-a-Nova, Figueira da Foz, Lousã, Mealhada, Miranda do Corvo, Oliveira do Hospital, Penela, Ansião, Batalha, Figueiró dos Vinhos, Marinha Grande, Pombal, Porto de Mós, Mangualde, Nelas, Oliveira de Frades, Proença-a-Nova, Abrantes, Alcanena, Entroncamento, Ferreira do Zêzere, Ourém, Sertã, Torres Novas, Vila de Rei, Vila Nova da Barquinha, Almeida, Figueira de Castelo Rodrigo, Alcochete, Barreiro, Loures, Mafra, Moita, Montijo, Palmela, Seixal, Sesimbra, Sintra, Vila Franca de Xira, Alcácer do Sal, Odemira, Santiago do Cacém, Aljustrel, Almodôvar, Cuba, Ferreira do Alentejo, Mértola, Moura, Serpa, Vidigueira, Almeirim, Alpiarça, Azambuja, Benavente, Cartaxo, Chamusca, Coruche, Salvaterra de Magos, Avis, Ponte de Sor, Sousel, Arraiolos, Borba, Estremoz, Montemor-o-Novo, Portel, Redondo, Reguengos de Monsaraz, Vendas Novas, Viana do Alentejo, Vila Viçosa, Monchique, Olhão, Machico, Santa Cruz.
4	Viana do Castelo, Vila Nova de Cerveira, Alijó, Bragança, Mirandela, Caldas da Rainha, Peniche, Leiria, Pedrógão Grande, Viseu, Castelo Branco, Tomar, Guarda, Almada, Amadora, Setúbal, Beja, Rio Maior, Santarém, Elvas, Portalegre, São Brás de Alportel, Silves.
5	Braga, Vila Real, Covilhã, Évora, Faro, Corvo.
6	Maia, Trofa, Oliveira do Bairro, Fornos de Algodres, Oeiras, Campo Maior.
7	Matosinhos, São João da Madeira, Óbidos, Vila Velha de Ródão, Constância, Cascais, Sines, Castro Verde, Alcoutim, Aljezur, Castro Marim, Lagoa, Lagos, Loulé, Tavira, Funchal.
8	Porto, Aveiro, Coimbra.
9	Freixo de Espada à Cinta, Vila Nova de Foz Côa, Alfândega da Fé, Vila Flor, Góis, Pampilhosa da Serra, Alvaiázere, Castanheira de Pera, Idanha-a-Nova, Oleiros, Penamacor, Mação, Sardoal, Manteigas, Grândola, Alvito, Barrancos, Ourique, Golegã, Alter do Chão, Arronches, Crato, Fronteira, Gavião, Marvão, Monforte, Nisa, Alandroal, Mora, Mourão, Portimão, Vila Real de Santo António, Porto Moniz.
10	Lisboa
11	Odivelas, Vila do Porto, Lagoa [R.A.A.], Nordeste, Ponta Delgada, Povoação, Ribeira Grande, Vila Franca do Campo, Angra do Heroísmo, Vila da Praia da Vitória, Santa Cruz da Graciosa, Calheta [R.A.A.], Velas, Lajes do Pico, Madalena, São Roque do Pico, Horta, Lajes das Flores, Santa Cruz das Flores.
12	Castelo de Vide, Albufeira, Vila do Bispo, Porto Santo
Total	**Portugal**