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Reviewing the State-of-the-Art of Smart Cities in Portugal: Evidence Based on Content Analysis of a Portuguese Magazine

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Abstract: The lack of examples of smart-city initiatives and the sharing of best practices in Portugal confirm the gap in the transference of empirical knowledge to the scientific literature in this area. The smart-city concept has passed through three stages. However, its evolution has not been noted equally throughout countries and their territories. The literature only provides information about specific projects implemented in a few cities. Therefore, the aim of this paper was to study the state-of-the-art of smart cities in Portugal by analyzing 25 editions of the most relevant national-wide smart-cities magazine. First, the objective of analyzing the magazine was to study each Portuguese city in terms of the subject areas and types of existing initiatives in order, ultimately, to frame cities within their respective smart-city phases, as per the literature. Second, the aim of the paper was also to provide information about the evolution of the concept through analyses of embedded experts' quotes. The results of the first are complemented with the analysis of interviews with policymakers to provide information about the existing challenges to implementing a smart city and to understand the role of government therein. Qualitative and quantitative analyses were performed on the case study. The findings suggest that the three smart-city phases are perceived in slightly different ways in Portugal and heterogeneity within the country can be noted from the lack of strategies and a standard framework.

Keywords: smart city; empirical evidence; state-of-the-art; Portugal

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1. Introduction

There is little evidence in the literature to help understand the state-of-the-art of smart cities in certain countries. Often, the practices and implemented initiatives are not found in the scientific literature but rather in empirical sources. This is the case for Portugal, for which a quick search for the terms "Smart Cit*" and "Portugal" only returned 84 results in Scopus and 66 on the Web of Science. Moreover, it represents a lack of significant practical contributions to support new theoretical directions and future studies [1,2]. This is mainly the case for topics whose actors are not directly linked to the scientific field. Therefore, their contributions generally occur in informal data sources. Nevertheless, empirical knowledge should not be neglected, because it often means a comprehensive collection of information focused on a specific topic of interest.

With the lack of existing scientific knowledge, also explained by the novelty of the topic, it is vital to consider empirical sources of information to provide academia with the premises for further developments. Therefore, the aim of this paper is to detail the state-of-the-art of smart cities in Portugal by studying the existing initiatives and players. Serving this purpose, content analysis of the most important Portuguese magazine dedicated

to the field of smart cities, with reported practical implementations and contributions from experts, is performed [3]. The case study was addressed by editorial choice and dissemination needs.

First, a narrative review of the literature is conducted to detail the evolution of the smart-cities concept within the Portuguese context that served as a starting point to conceive the objectives of the analysis of the magazine. Second, a methodology to answer the research and sub-research questions is further detailed. The results are reflected in the third section. Quantitative and qualitative analysis are performed to give an overview about Portugal, the area and type of existing initiatives, the roles, and entities of the experts, and summarize the evolution of the understanding of smart cities based on interviews and opinion articles in the magazine. Furthermore, to complement the analysis regarding the understanding of the challenges of implementing a smart city, as well as the role of the government in the process, the results of the interviews performed with Portuguese policymakers and a secretary of state are also detailed. Finally, the discussion section portrays the state-of-the-art of smart cities in Portugal, by positioning each city within the respective smart city stage and comparing the obtained results with the literature.

2. Literature Review

Smart cities emerged in the 1990s and have passed through three different stages [4]: (i) Smart City 1.0—technology companies led and encouraged the adoption and implementation of new solutions; (ii) Smart City 2.0—local administrations used technological solutions as a way to improve sustainability and citizens' lives; and (iii) Smart City 3.0—co-creation models and collaborative approaches have emerged, wherein policymakers and citizens work together to find the best strategy for and solutions towards a common vision.

The first technological perspective led cities to become dependent on proprietary solutions. Over time, it created vertical silos that did not allow for the interoperability of cities or the integration of third parties. In addition, it left less space for citizens' participation. Moreover, the lack of city context and Hollands' [5] critics made policymakers acknowledge the need to promote open and interoperable standards. Therefore, the concept focused on human and social capital [6]. Today, citizens have been empowered by cities' willingness to co-create. Their inclusion and participation have become highly relevant to the success of smart-city strategies [7]. Therefore, today, the smart city is in the third stage, where citizens have an active and collaborative role [8,9].

Russo et al. [10] recall the definition of the smart city and evolution of guidelines at the EU level. The Europe 2020 strategy was focused on three priorities [11]: sustainable growth (low-carbon economy), smart growth (education, research, and innovation), and inclusive growth (jobs and wealth). The International Organization for Standardization (ISO) and International Telecommunication Union (ITU) have played leading roles in establishing tools with key performance indicators that try to align the sustainability of the city with information and communication technologies (ICT) [12]. Several smart city frameworks can be found in the literature [13–18]. However, there is a lack of a practical and accepted standard framework to guide and monitor the city's progress [19].

Furthermore, two stakeholder advisory platforms emerged: European Technology Platforms (ETPs) and European Innovation Platforms (EIPs). The latter aimed to bring public and private stakeholders together to accelerate research and innovation. Moreover, through EIP for Smart Cities and Communities (EIP-SCC), the smart city assumed a relevant role [20]. The two governance bodies of EIP-SCC, the High-Level Group (HLG) and Smart Cities Stakeholder Platform (SCSP) were responsible for defining rules and guidelines for the development of smart cities. These can be found in the Strategic Implementation Plan (SIP) [21], and the Operational Implementation Plan (OIP) [22].

The guidelines cross (i) three specific vertical areas: sustainable urban mobility, sustainable districts and built environment, and integrated infrastructures and processes across energy, ICT, and transport, with (ii) eight horizontal themes aggregated into three classes: decisions (citizen focus, policy and regulation, and integrated planning and man-

agement), insight (knowledge sharing, metrics, and indicators, open data and standards) and funds (business models, procurement and funding). The intersection of vertical areas and horizontal themes constitutes 24 focus areas to guide strategic planning [20].

Nevertheless, the strategic planning of smart cities raises the challenge of matching plans with the policy strategies followed by local decision-makers [23]. Furthermore, in the breakdown of strategic plans, local decision-makers are challenged to transfer macro guideline scales to micro realities. The challenges of implementing smart city initiatives also differ depending on the context of each territory and its socioeconomic needs [24].

Furthermore, Gil-Garcia and Pardo [25] reflected on the management and organization barriers to implementing a smart city. The lack of mindset and internal organization moved them to consider a gap in IT skills among the city's structure [26]. Chourabi et al. [27] brought to the discussion security and privacy issues, the need to promote integration and interoperability between solutions, and their associated operational costs. Later, from a raw dataset of 212 barriers of energy projects, Mosannenzadeh, Di Nucci, and Vettorato [28] ranked 35 final barriers, in nine categories, based on a quantitative approach. Moreover, insufficient funding and limited access to capital were highlighted, as well as social and legal matters. Recently, with similar dimensions, Rana et al. [29] and Tan and Taeihagh [30] have also reflected on this subject.

The evolution and implementation of the concept have not been noticed equally throughout countries and their territories, nor have their associated challenges.

In the case of Portugal, the first reference to a smart-city project present in the literature is made to the PlanIT Valley project in Paredes, a city in the north of Portugal. The vision was to create an environmentally friendly district where IT solutions could be developed, tested, and showcased. The Paredes municipality granted the project the exclusive rights to purchase 1670 hectares of land at a low price, which provoked political contestation from the community and impacted political support. Together with the difficulties of soliciting private funding and with delays in delivery, the project failed to move forward [31,32].

Porto was one of the first cities to address the topic. In 2014, the city was covered by 15 hotspots and carried a project to implement a vehicular network of over 400 buses to provide free wi-fi internet access [33]. In addition, the sensing platform, UrbanSense, of the Future Cities project was implemented to collect critical environmental data from multiple city points to provide third parties with real-time and historical information [34]. Their active participation in European projects (e.g., Synchronicity), the relationship with the FIWARE community, and the creation of Porto Digital Association to enhance ICT projects have helped the city to innovate [35].

Lisbon has also been active in the establishment of European partnerships on this matter. For example, in 2016, the Sharing Cities flag project granted Lisbon 24 million euros. The project joined three lighthouse cities (Lisbon, London, and Milan) and three other cities (Bordeaux, Burgas, and Warsaw) to create living labs to test ideas and technologies [36]. In addition, over the years, the municipality made several mobile applications available to address specific needs and two open data portals—Lisboa Interactiva and Lisboa Aberta [37].

Aveiro had the PASMO project, which aimed to provide vehicular communications, regular wi-fi access, and mobility services (parking, bikes, jams, weather). The plan was to install up to 175 parking sensors and four LoRa gateways to communicate with a dedicated platform and two environmental monitoring stations to measure multiple environmental parameters [38].

Vila Real piloted different public LED lighting solutions to assess and compare the savings level. These solutions could only work during specific periods of the night and when there was the presence of people, with embedded solar panels that charge the batteries of the luminaire during the day [39].

Évora was one of the cities of the project InSMART—Integrative Smart City Planning project—integrated planning framework for developing medium-term strategic sustainable energy plans (SEAPs) at the city level [40]. The city of Évora is also piloting the InovGrid

project towards a next-generation energy distribution system. An open platform is used for the integration of electrical vehicles (EV), micro generations, consumers, producers, demand-side management, public lighting, storage, multi-utility architectures, cyber-security, data privacy, distributed energy resources (DER), and renewable energy sources (RES) [41]. The REIVE project headed by INESC Porto aimed to develop a technological framework towards integrating EV in the Portuguese distribution grid, as an extension of InovGrid [42].

Costa, Machado, and Gonçalves [43] presented several initiatives that Guimarães has launched. The focus was on inclusive mobile and web applications to break isolation barriers, promote urban sustainability, and conserve the environment and the natural heritage.

Nevertheless, there is insufficient data to design a detailed portrait of the country regarding the state of each city within the smart-city concept and the challenges there faced. The literature only gives information about specific projects implemented in a few cities. Smaller cities are mostly forgotten.

3. Materials and Methods

First, the methodology followed in this work is based on the content analysis of a Portuguese magazine dedicated to smart cities. This national-wide recognized data source aggregates and analyzes multiple stakeholder contributions. Otherwise, it would be challenging to obtain data to characterize the state-of-the-art of smart cities in Portugal with detailed historical information. Traditional methods lack a temporal character, since data collection is performed at specific moments. This data source allows the study of the evolution of the subject based on the analysis of the direct contributions over the years. In addition, to complement the analysis and the understanding on the state-of-the-art of smart cities in Portugal, interviews with Portuguese policymakers were conducted. The main purpose was, on the one hand, to realize the existing challenges for the implementation of a smart city, and, on the other hand, to understand the role and support of a sovereign body; in this case, the government, to promote these initiatives, by means of an interview with a Portuguese secretary of state.

3.1. Research Questions and Design

To conduct this study related to the state-of-the-art of smart cities in Portugal, two main topics of analysis emerge: (1) the study of existing initiatives in Portuguese cities, and (2) the evolution of the understanding of the concept. Therefore, the main research question is: "What is the state-of-the-art of smart cities in Portugal?" The sub-questions associated with it are: "What are the existing smart-city initiatives in Portugal?" and "What was the evolution of the understanding of the concept?" Figure 1 shows the methodological processes followed to answer each of these questions.

3.2. Sample Characterization

The editions of the magazine (Appendix A) follow a standard structure, where first there is a keynote article and then several opinion articles and interviews.

The magazine is distributed free of charge to all Portuguese municipalities. It is the only journalistic source dedicated to the topic in Portugal. It is a reference publication on urban and territorial sustainability that bridges academia, public entities, and municipalities with companies that develop solutions to improve the management and sustainability of territories. In addition, the magazine aims to provide a channel to share best practices and empirical knowledge based on specialized journalistic work, to help policymakers and other professionals to understand and address urban challenges. Moreover, it is the main dissemination channel for knowledge of existing smart-city initiatives, reflections of critical players, and future perspectives in the area.

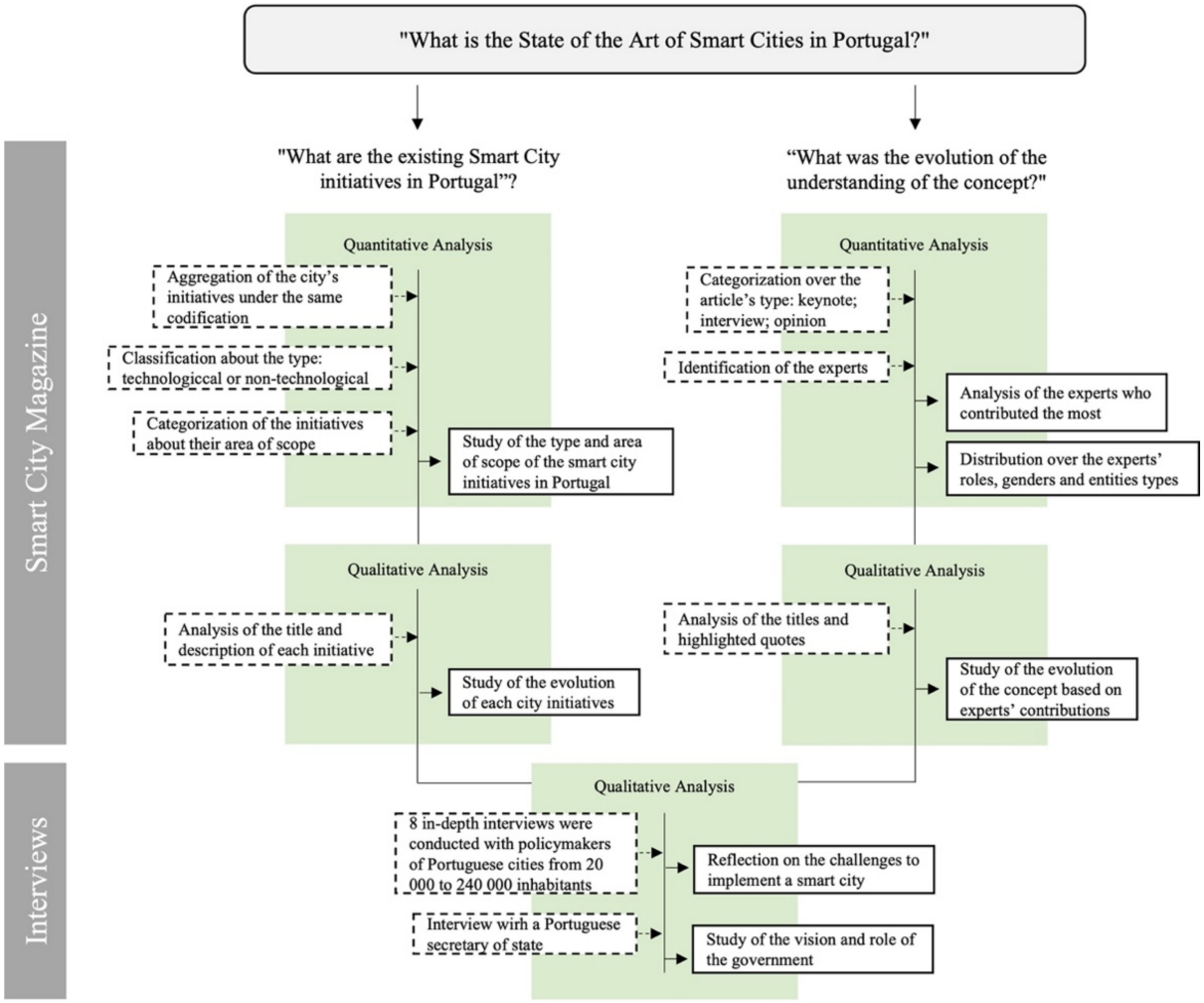

Figure 1. Methodology Framework.

The magazine's first issue was released in 2015, and it published six issues per year; in 2016, it changed to its current quarterly format. In total, 25 issues, released between 2015 and 2020, were analyzed. The first three issues were not considered in the present study because they were not available. The magazine is in Portuguese, hence it is also essential to transfer the empirical knowledge to the English language to allow the scientific community to proceed with further research. The editions of the magazine follow a standard structure, where first there is a keynote article followed by several opinion articles and interviews. Until the 14th edition, there had even been a glossary, with terms such as Sharing Economy, eHealth, FabLab, Big Data, Bottom-up, Crowdfunding, Bitcoins, RFID, Gamification, Standard, Hackathon, Elevator Pitch, Unicorn, Millennials, SEO, Influencers, Circular Economy, Hydric Footprint, Fog Computing, and Downcycling/Upcycling. These terms were largely unknown by policymakers at the time. Over the years, the robustness of the projects increased, and the articles about implementations of smart city initiatives began to dominate. As a result, the magazine moved from an informative and motivational perspective to a showcase for best practices.

In addition, eight in-depth interviews were conducted with policymakers from different Portuguese cities. This covered a range of cities from different regions of the Portuguese territory with different characteristics; the smallest one with around 20,000 people, and the largest one with around 240,000. The characterization of the policymakers' interviewed is given in Table 1.

Table 1. Policymakers and cities sample data.

City	Role	Gender	Area	Population	Location
1	Vice-Mayor	male	environment, mobility and tourism	45,000	south
2	Councilor	male	social policy, innovation and tourism	20,000	center
3	Vice-Mayor	male	innovation, environment and energy	240,000	north
4	Vice-Mayor	female	environment, social and energy	35,000	north
5	Councilor	male	mobility and urban planning	140,000	center
6	Vice-Mayor	male	urban plan ning and mobility	40,000	north
7	Vice-Mayor	male	urban planning, innovation and mobility	210,000	south
8	Councilor	male	mobility and urban planning	190,000	north

The interviewed Secretary of State is male, and his work is related to innovation. A detailed characterization is avoided for ethical and non-disclosive reasons. Furthermore, all the data was anonymized. Participants were made aware of the purpose of data collection. All the necessary steps were taken following General Data Protection Regulation (GDPR).

3.3. Data Analysis

A thematic analysis carefully attributed codes and themes to each edition of the magazine. On the one hand, any reference to an initiative of a city was classified under the same code. After that, each city initiative was cataloged according to their scope and area to finally compare the city-state with the stage of the smart-city concept. The resume of the information is detailed in Appendix B. Governmental initiatives, events, awards, and solutions were also coded. On the other hand, it was possible to structure the information about experts' reflections, either through opinion articles or interviews, to study the theoretical evolution of the concept and compare it with the literature. Also assisted by NVivo software (version 20.3.2), each quote was coded and associated with the expert case. The classification of each case allowed a further quantitative study of the roles and entities of the experts. The codification of each author's and interviewee's contributions allowed the prominent experts to be identified. In addition, quotes that had been highlighted, by the magazine, in each article and interview were also collected. This allowed us to build a matrix wherein the quotes were aggregated, according to theme, and by year. Furthermore, because the editions of the magazine were ordered chronologically, it was possible to summarize the chronological evolution of the smart-city concept according to the analysis of the quotes' content.

The interviews performed were also analyzed through content analysis. Data from the interviews was translated to English and analyzed. Furthermore, information about existing challenges was searched for and classified within policymaker feedback. In addition, the data collected from the interview with the secretary of state deserved an extended analysis and description to provide contextualized information and give readers the chance to acknowledge the positioning of the government about this subject.

Moreover, the content analysis of both approaches served as the basis for subsequent quantitative and qualitative studies to support the response to the research questions.

4. Results

This section aims to answer the two sub-questions: "What are the existing smart-city initiatives in Portugal?" and "What was the evolution of the understanding of the concept?" Therefore, first it gives an overview of Portugal through a qualitative analysis of the country's evolution, as noted in the magazine and complemented with empirical evidence, and provides the data, coded under governmental initiatives. After that, a quantitative analysis is performed for the area and type of initiatives present in Appendix B, followed by content analysis. Understanding the evolution of the of the smart-city concept is realized through the qualitative analysis of the embedded interviews and content of the opinion articles. Thus, it was possible to perform an empirical study of the evolution of the concept, which closely matches with the literature. Finally, the challenges that Portuguese

policymakers face when implementing a smart city are highlighted, as well as the role and vision of the Portuguese government therein.

4.1. Portugal Overview

After a difficult economic period in Portugal, with a low level of investment, the European Union's 2014–2020 program brought a new impetus to cities.

In 2009, RENER emerged, the first smart-cities network in Portugal. RENER was created under the "Mobi.E" program to prepare cities for electric mobility. The scope of RENER initially included 25 municipalities[1] (later 43). However, the interest in the topic of smart cities has only been consolidated since 2012, having gained momentum from the anticipation of existing funding opportunities on the European agenda. In 2013, the Smart Cities Portugal Cluster emerged to promote innovative integrated urban solutions and cooperation between companies, associations, universities, RandD centers, municipalities, public bodies, and civil society. In 2015, the government approved the Sustainable Cities 2020 Strategy. In addition, the smart cities section was created, with 136 municipalities, within the National Association of Portuguese Municipalities (ANMP), which replaces RENER, and aims to promote the discussion within five different areas: governance; energy, environment, and patrimony; mobility; society and quality of life; and economy and innovation.

In 2017, the Smart Cities Tour initiative was created to promote an annual roadshow with workshops in different regions of the country dedicated to relevant topics within the scope of smart cities, allowing the exchange of experiences and knowledge between participating municipalities. The end of the tour is marked by a formal event, entitled the Mayor's Summit. In addition, an initiative named "Living Laboratories for Decarbonization (LVpD)", an initiative of *Fundo Ambiental* was launched to allow cities to become real living labs and implement technologies, reducing carbon emissions. The projects were implemented in several Portuguese cities, i.e., Almada, Maia, Matosinhos, Águeda, Loulé, Alenquer, Seixal, Mafra, Braga and Évora. However, this was not the only policy to incentivize the development of smart cities. The government initiatives promoted to accelerate the adoption of solutions and implement new projects are shown in Table 2.

4.2. Smart City Initiatives in Portugal

Concerning the results obtained (Figure 2), it is possible to verify that smart city initiatives in Portugal are divided into the following areas: cultural (5.62%), economy (3.37%), energy (4.49%), environment (13.48%), governance (8.99%), mobility (23.6%), social (24.72%), strategy (7.87%), and urbanism (7.87%). Furthermore, regarding their type, 70.8% correspond to technological initiatives and 29.2% to non-technological ones.

For each of the areas, through data harmonization and aggregation, it is possible to understand, in qualitative terms, what the existing technological and non-technological initiatives are. Table 3 details the content analysis of the data collected in Appendix B. The initiatives were aggregated by area. For its technological types, the content of each area was sorted from the most technological to the least technological.

Table 2. Portuguese governmental funding initiatives.

Year	Initiative	Description
2015	Cidades Analíticas	One international conference, five regional workshops (sharing of best practices and funding opportunities), and one award of a €5000 prize to the best national project in this area.
	Cidades Sustentáveis 2020	Strategy-guiding document aligned with Portugal 2020 and with the territorial options on the strategic instruments of spatial planning policies; establishes a reference framework for sustainable urban development in Portugal.
2016	ClimAdapt.Local	1.5 million-euro budget for local strategies to combat climate change.
	2020 National Strategy for the Air	Creation of a 160 million-euro-per-year fund—Fundo Ambiental—to achieve fossil fuel independence by 2050. Living labs focused on combating climate change and was included in promoting a participated and discussed environmental culture.
2017	wi-fi in Historic Centers	1 million euros of funding available for wi-fi in Portuguese historical centers.
	U-Bike	5.3 million euros available to encourage the use of bicycles in universities.
2018	Social Innovation Portugal	150 million euros to finance innovation and social entrepreneurship initiatives.
	Living Laboratories for Decarbonization (LVpD)	12 projects received an average amount of 500 thousand euros from Fundo Ambiental to develop and experiment with technologies that improve citizens' quality of life and combat climate change.
	Participatory Budget Portugal	3 million euros is the yearly amount available for the national participatory budget.
2019	Cidades Circulares	1.5 million euros from the Fundo Ambiental is the total amount allocated for 2019–2021 to support and empower municipalities and their communities to transition to a circular economy. Establishment of partnerships between Portuguese municipalities called Redes Cidades Circulares (RC2) to submit joint applications. Cities and the community find a place to share and disseminate knowledge on these topics on the InC2 portal

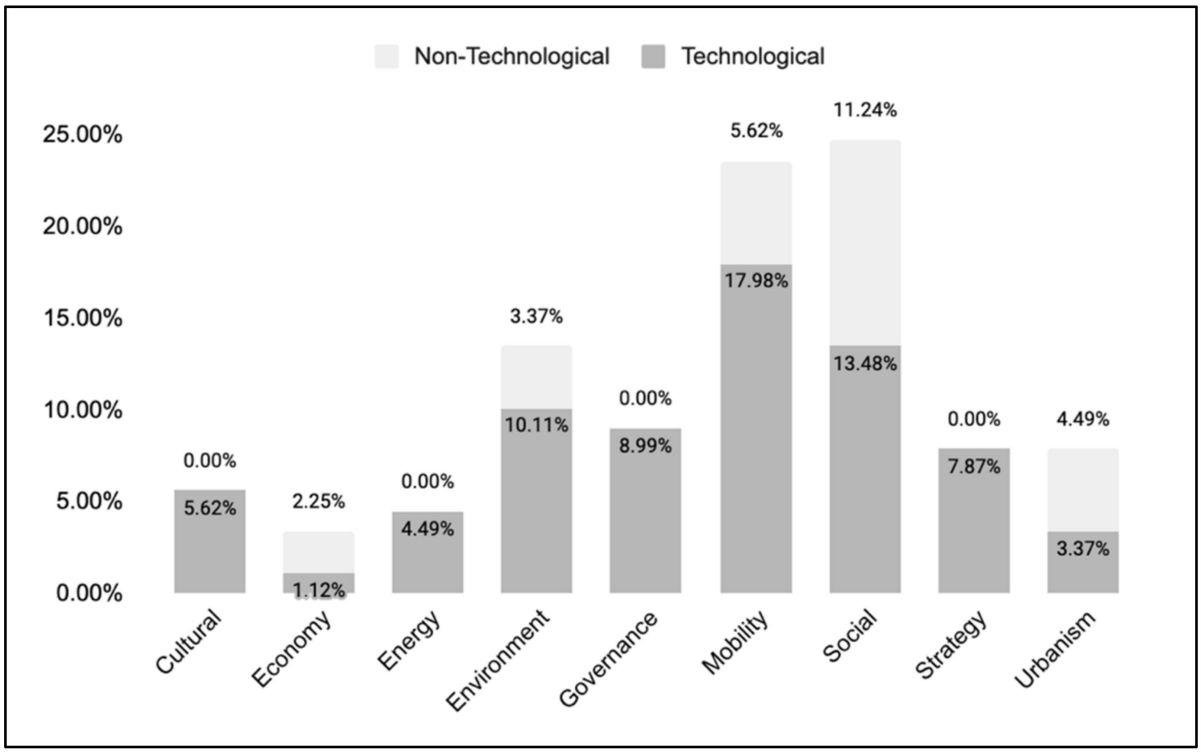

Figure 2. Area and type of the smart-city initiatives.

Table 3. Description of the smart-city initiatives according to their area and type.

Area	Description
Cultural	• Technological: The implementation of beacons to enable interaction with monuments and the development of mobile applications to guide and provide helpful information to citizens and tourists about the city's points of interest.
Economy	• Technological: A platform for the certification, promotion, sale, and distribution of regional products for local producers. • Non-Technological: Securing the private sector to create conditions for innovation and entrepreneurship and encouraging the creation and maintenance of local commerce through low rents.
Energy	• Technological: Public lighting management platform to collect consumers' consumption data to parameterize usage profiles and remotely control the luminaires (LED); the integration of electric vehicle charging stations.
Environment	• Technological: A latform for reporting environmental events or the need for waste collection. Waste management system with filling-level sensors or pa PAYT (pay-as-you-throw) system with access-card reading allows the weight of waste produced by each citizen to be recorded. Installation of onboard computers in collection trucks for route optimization; the placement of sensors in urban cleaning equipment to monitor the service in real-time; remote real-time management of irrigation in green spaces; the monitoring of air quality and CO2 consumption and emissions in water supply and wastewater sanitation systems. • Non-Technological: The creation of a natural lake, forests, and the promotion of natural regeneration to respond to climate change; the implementation of an observation space of best practices to involve the community; placing green roofs on city buildings for precipitation retention, increasing green areas, and improving thermal comfort and soundproofing, CO2 capture, and lifetime; the separation of domestic waste into waste bags provided by the city.
Governance	• Technological: An urban intelligence platform to support daily operations, public space management, and occurrences, based on the services and sensors installed in the city; an open-data portal; the sharing of information and knowledge with the dissemination of specific solutions in the field of urban intelligence; the dematerialization and streamlining of decision-making processes using a digital platform to enable submission and collaborative work on proposals, consulting the documentation, following up the decision-making process, and executing pending tasks.
Mobility	• Technological: Technological platform aggregating the city's urban transport network with various transport service operators, infrastructures, and equipment; a mobile application with transport schedule, location of docking stations, number of bicycles, and car parks; the integration of payments and user data collection to map urban travel, with the aim of co-building the city, matching mobility policies to actual needs; a multimodal pass for citizens; the implementation of bike-sharing systems (free of charge) with electric and regular bicycles; the acquisition of electric buses; and the implementation of signage with directional plates and charging stations for electric vehicles. • Non-Technological: Building and consolidate green spaces with walking lanes and cycling paths; promoting sustainable mobility by encouraging homework cycling; preventing the circulation of vehicles before 2000 in the city center, and all vehicles on Sundays.

Table 3. *Cont.*

Area	Description
Social	• Technological: Mobile application with direct communication channel between the citizen and the city that allows processes to be streamlined, integrated with the incident management system, ensuring more proximity, and encouraging the involvement in initiatives, events, and decisions of the city; the cemocratization of access to new technologies through the provision of equipment and specialized technical support to the community; creating physical spaces for experimentation and active cooperation provides an innovative and creative environment; an open data platform establishes a dialogue point for sharing ideas and collaboration between citizens, universities/schools, municipalities, and companies; a mobile application for direct communication with emergency bodies, that contemplate the clinical historical information, age, real-time GPS location of the citizen, and the details of an emergency contact; psychological evaluations, and motor rehabilitation sessions are promoted, provided through a dedicated platform and free of charge. • Non-Technological: Exercise citizen participation for collaborative diagnosis, presentation of proposals, and experimentation of the solutions by the community; placing technicians to perform exercises that allow the maintenance and development of motor skills in the elderly in the most isolated locations; intensive programming boot camps are paid for only by those who get a job later; facilities prepared and designed to accommodate sports for people with disabilities; the use of environmental education to connect citizens to the conservation initiatives of the natural heritage of the municipality; housing support programs seek to respond immediately to people who experience a sudden lack housing or live-in undignified housing conditions; offering land priced at one cent, with the licensing project fee and education fees paid by the municipality to retain young people.
Strategy	• Technological: The installation of air quality, noise, meteorological and ultraviolet sensors, street lighting technology, traffic measurements, urban waste management, and alarm management associated with civil protection services, as well as in other areas such as mobility, energy, culture, heritage, and urban rehabilitation to predict situations and respond preventively and proactively; a control center to manage data through an urban platform; the implementation of 5G infrastructures; challenges to the local community and creation of urban intervention spaces open (Fablab) to experimentation and co-creation, with the allocation of technology-based types of equipment (such as 3D printers).
Urbanism	• Technological: Dematerialization of submission processes and online consultation of documents, such as licensing of works and urban projects. • Non-Technological: Rehabilitation and standardization of buildings facades and improvement of their internal conditions.

4.3. Identification of the Magazine' Contributors

Figure 3 shows the distribution of the experts' roles and types of entities. Most are from private entities (41%), which allows a relevant empirical contribution to be obtained that is often scarce in the literature. Nevertheless, a heterogeneous group is represented in the sample. There are people from universities, associations, municipalities, public bodies and with governmental responsibilities. Figure 3 also mirrors their high-level and prestigious roles; 23.08% are managers, and 16.78% are C-level representatives, but there are also professors, researchers, mayors, secretaries of state, and European commissioners, among others.

Of the people who contributed the most to the magazine, we identify Paula Teles (five times), Miguel Castro Neto (four times), Ana Fragata (three times), Catarina Selada (three times), and José Gomes Mendes (three times). Although the gender relationship is well distributed among the top five contributors, this is not the case in the overall figure. About 73.4% of the interviewees or authors of opinion articles are men. This fact may reveal little gender equity on the topic. The sample only considered the keynote articles, interviews, and opinion articles. However, there are some individuals—such as Vítor Pereira and Jorge Máximo—deserve mention, as they have periodic columns in the magazine that reflect on current related issues.

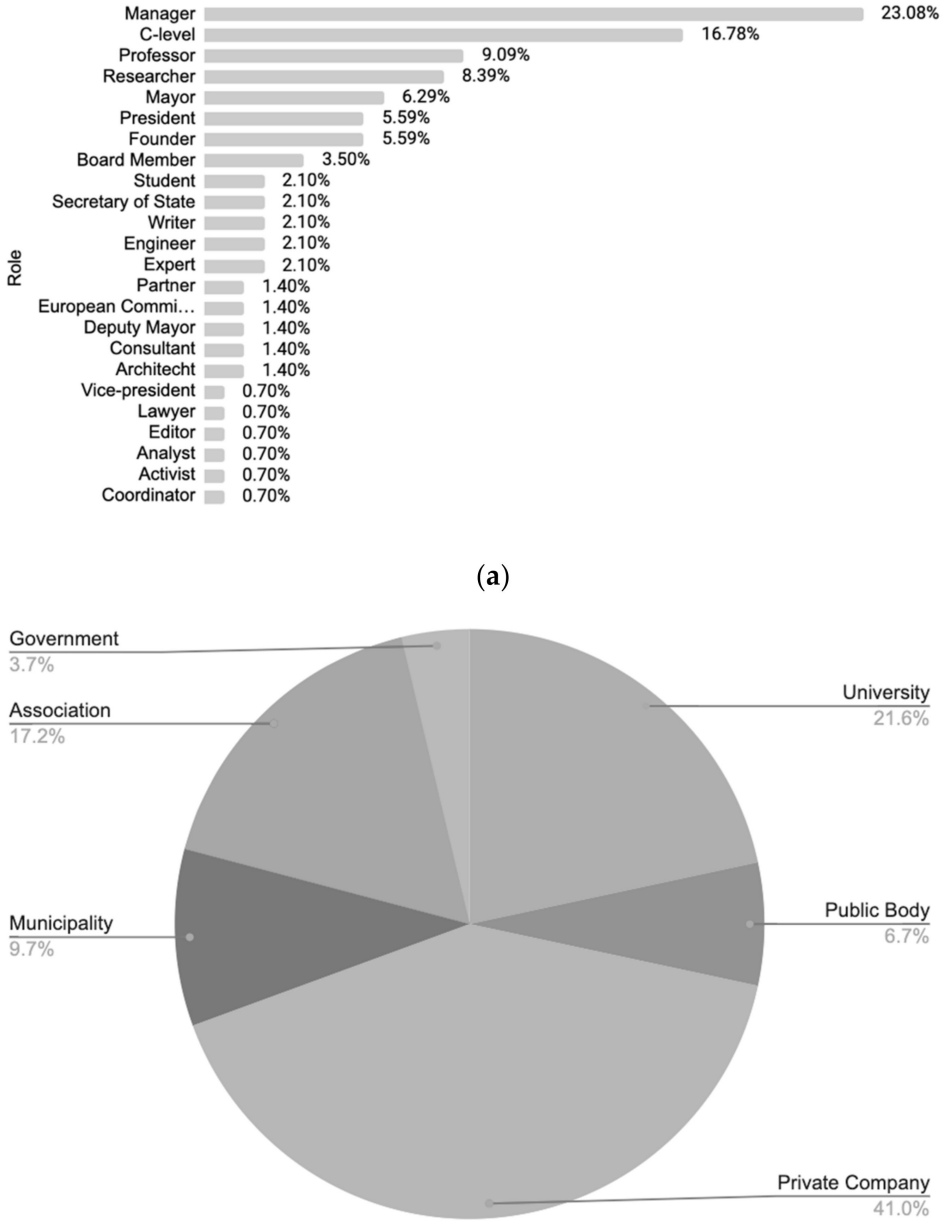

Figure 3. (**a**) Classification of the roles of the magazine's contributors; (**b**) distribution of the entity types of the magazine's contributors.

4.4. Evolution of the Concept

In 2015, Horizon 2020 and other dedicated research programs were seen as "essential to reduce differences between regions and ensuring growth across Europe" (European commissioner). Moreover, that Horizon 2020 promoted joint initiatives between entities from different European countries may have changed the decision-makers' mindsets. It enhanced the collaboration between stakeholders and promoted open data cultures for creating innovation hubs for the community and constituting "multidisciplinary teams and collaboration models based on open innovation" (university professor).

The collaborative models were already evident during the technological disruption phase (Smart City 1.0) through additive manufacturing. It was pointed out as the engine of evolution for the self-manufacturing paradigm through the ideology "Do-it-Yourself",

to democratize innovation (private company manager). On the other hand, social networks were still adjectivized as "a mobilizing force" (association president).

The evolution of the concept (Smart City 2.0) was noted by the refusal of "technological determinism" (private company manager), studies of the usage of urban services to help policymakers decide which were the "most appropriate technologies towards the defined goals" (university researcher), and a growing concern with the participation of citizens' and cities' sustainability, over the fact that citizens had to have an "environmentally sustainable behavior" (public body director), and the learning experience that when "the goal is a need manifested by the community, things happen" (secretary of state).

Mobility and energy took significant roles to "combat the aging of society and the cost of caring the elderly" (private company founder), and to conciliate the population growth with "policies that responded to a complex and social demanding organization" (university professor). Moreover, the need emerged to "integrate energy efficiency measures in urban rehabilitation processes" (mayor). At the same time "shared mobility was an unavoidable trend" (private company manager), and increasingly seen as a "service and not a product" (public body president), where "autonomous vehicles promised to have a huge impact on urban life" (researcher). At the same time, "equity and inclusion" were reflected upon, in terms of access to transport (writer). Nevertheless, references were also made to other areas, namely health, with regards to the need for the health system to "put people at the center of its activity" (private company C-level), and to simplify legislation (private company manager).

Over the years, several concerns were raised. Among them were data security (university professor); the lack of standards to promote the integration of solutions (private company manager); the fact that rural areas were forgotten (private company C-level); and the creation of non-child-friendly cities (researcher).

Furthermore, it was said that cities needed first to "create the market and not the other way around" (foundation C-level), not forgetting that "people express their happiness through votes" (public body vice-president).

Moreover, there was a growing discussion about citizens' involvement, raised primarily by international experts, namely the need to first "create the debate" (private company president) and to build the foundations of a smart-city strategy with a combination of bottom-up and top-down approaches (association founder). In addition, decision-makers needed to critically reflect on "who belongs, who plans and who makes the city" (sociology expert). Cities should not replace human input or risk being "equal to all other places" (association founder). Therefore, policymakers must not isolate themselves from the people's realities to "build the necessary confidence to lead them participating in the decisions" (mayor).

Participation remained a challenge for cities; citizens only "connected to the government when something was wrong, to understand what the government was doing and why" (private company manager). In the industry, "there are no moral values" (foundation C-level).

Co-creation and co-governance (Smart City 3.0) only became constants in 2019, when it was recognized that "it was necessary to build communities in which everyone participated" (neuroscience expert). Moreover, collaborative ecosystems would facilitate innovation by creating "connections between citizens, governments, companies and educational institutes" (association founder).

Urban and mobility planning (private company C-level) have recently taken an even more relevant dimension with the COVID-19 pandemic and the need for cities to be resilient in responding to urban challenges and citizens' basic needs. Therefore, a growing trend is to remove road space for traffic and "return it to the city, inviting people to walk" (secretary of state). Allied to this, the perspective of remote work accelerated digitization, raising the need to "create innovative models to overcome the distance" (secretary of state), which is closely related to the evolution of smart cities and the need to think about collaborative models and proximity dynamics.

4.5. Challenges and the Role of the Government

The main findings of the existing challenges obtained through the qualitative analysis of the interviews are shown in Table 4.

Table 4. Challenges of smart city implementation.

City	Challenges
1	Finding companies to meet the objectives. High level of bureaucracy in public procurement processes and project definition, which makes the implementation of solutions time-consuming.
2	Lack of knowledge, mindset, and expertise in the organization. Inability to think about and execute projects beyond the guidelines of the existing European funding opportunities.
3	There is a great challenge in the ability to use data, since they are owned by various public and private stakeholders. Moreover, the fact data are not in the public sphere and the fact that there is no concept of information management promoted by sovereign entities to leverage their integration challenges the implementation of smart cities.
4	The main challenge is financial; there are not enough internal resources, meaning that it is necessary to subcontract external services, which does not allow for the autonomous development of the projects and difficult access to funds.
5	The biggest challenge is the public procurement code because of the existing bureaucracy and the fact that there is no knowledge of methods for defining the requirements for solutions. Therefore, they are specified according to a specific party solution. Thus, it leads to mistrust of competitors and processes are embargoed for undefined periods, slowing down the strategies.
6	Essentially technological; on the one hand, the training of human resources to operate the new systems and, on the other hand, the high costs and the reliability/uncertain durability (the solutions are constantly being updated). Additionally, the delay in the solutions delivering delays advancement. Maintenance and monitoring are done only by few entities.
7	The greatest challenge is in data integration while respecting data privacy and integrity.
8	The main challenge is the administrative (bureaucratic) component of opening procedures. Susceptibility to litigation and conflict, many delays due to the objection and impugnation. Additionally, financial resources are scarce. Data integration and privacy also pose challenges.

From the interview with the secretary of state, it was understood that smart cities are a transversal topic across the various ministries (e.g., economy, digital transition, and environment), meaning there is no dedicated body. The government's main concern is to look holistically to the country rather than urban centers and find the best solutions for each specific case. Moreover, it is stated that the city's strategy is the competence of local authorities. The government is responsible for influencing and making the necessary financial resources available. The secretary of state gives the example of the implementation of bike lanes, "where the government did not support their construction in cities but force their agreement to connect them in inter-city projects".

Furthermore, the national smart-city strategy that is being drawn up for the coming years has the priorities of sustainability and inclusiveness, and is based on three axes: integrated planning (implementation of smart cities and efficiency of public spending); scalability (extension of pilot projects), and interoperability (common principles that are shared across borders). With this national approach, the goal is to consider existing projects as best practices and to disseminate them between municipalities. The principles of the strategy are determined within the structure of the ministries. However, it will not fail to reflect the priorities defined by the government. Nevertheless, citizens' participation is not formally contemplated nor is there a formally defined methodology to guide policymakers' actions within the city scope.

5. Discussion

The literature enunciates several barriers, from social participation to financial capacity. Furthermore, from the analysis of Table 4, a pattern is noted in terms of the existing challenges that Portuguese policymakers face. First of these barriers is the lack of knowledge and skillset within the organization; second, the bureaucracy in public procurement processes; third is the lack of data in the public sphere and capacity of data integration.

A final barrier is the scarcity of financial resources and the cost of solutions acquisition and maintenance.

Furthermore, and also noticed throughout the empirical study, were the inexistence of references to the proposals of EIP-SCC and the guidelines for the development of smart cities of the Strategic Implementation Plan (SIP) and Operational Implementation Plan (OIP). This reinforces the existing gap between the proposals of sovereign bodies identified in the literature and their translation to concrete local action plans to guide policymakers' decisions.

As noticed above, the interest in the smart-cities topic increased with the anticipation of existing funding opportunities in the European agenda. European cities have taken advantage of the financing instruments available for these matters. The promoted initiatives are based on partnerships with other European cities, private entities, and academia, contributing to the logic of collaboration and innovation that underlines the smart city concept. Nevertheless, two interesting instances of feedback were expressed: first, by Policymaker 2, about the inability to think and execute projects beyond the guidelines of the existing European funding opportunities, and, secondly, by Policymaker 3, about the lack of an information management standard approach promoted by sovereign entities. This means, on the one hand, that funds can act oppositely to their intended use if cities have to adjust their approaches to fit in specific demands and, on the other hand, the dependencies that territories feel concern them about concrete guidelines on this subject.

In recent years, Portuguese municipalities have had the possibility of using European funds from programs such as Horizon 2020, COSME, ERDF and ESF, LIFE+. Nevertheless, these resources are not directly related to smart-city projects. Although they focus on research and innovation in the areas of energy, transport, climate action, and resource efficiency, and support the development of skills and expansion of companies, they lack the promotion of initiatives focused on the development of holistic and sustained strategies. Despite the impetus of European Commission programs, two of the main tools for the development of the European smart city initiatives have been the creation of clusters and living laboratories [44]. In recent years, many cities, such as Barcelona and Vienna, have become the stages of pilot projects for new solutions, fostering innovation and collaboration between the public sector, companies, and academia. The same happened in Portugal. Twelve cities had 500 thousand euros to implement innovative solutions through the LVpD. Nevertheless, the questions that arose were about the continuity of the projects and the approaches, since neither the smart-cities section of the National Association of Portuguese Municipalities (ANMP) nor the Smart Cities Portugal cluster that join the remaining stakeholders promoted the design of standard holistic approaches rather than the promotion of the best practices of isolated projects.

In terms of the evolution of the smart-city concept, Horizon 2020 has also helped to adapt policymakers' mindset. Perhaps because the sample data was from 2015 onwards, it is possible to notice from the beginning of an evident concern of citizens, one aligned with the evolution of the concept noted in the literature. However, initially, this reflection was still very much associated with how citizens should behave and the potential of tools to sensitize their participation. The evolution that the concept underwent in the literature from Smart City 1.0 to Smart City 2.0, between 2008 and 2012, is noted in the magazine on Portuguese cities after 2016, where technology started to be employed to solve urban problems towards defined goals, and from which the concern for sustainability and the participation of citizens arose. Co-creation only became a constant in 2019, with the transition from Smart City 2.0 to Smart City 3.0 toward building collaborative ecosystems to enhance innovation and citizen participation.

Despite Figure 2 portraying a more significant percentage of technological initiatives, Table 5 indicates that there is no clear technological motivation without an association with the aspect of sustainability. At the same time, there seems to be a growing effort to promote civic participation. Moreover, although the literature mentions the existence of three phases of the concept, the first had a purely technical nature led by private entities. The second

was associated with promoting sustainability and quality of life and the third was focused on collaboration and co-creation of strategies. In Portugal, they can be perceived in slightly different ways.

Table 5. Portuguese Cities association over the smart city concept stage.

Stage	Summary	Description	Cities
Smart City 1.0	vertical projects	Isolated initiatives, pilots, and proofs of concepts.	Amadora, Bragança, Angra do Heroísmo, Beja, Caldas da Rainha, Coruche, Cuba, Elvas, Fundão, Leiria, Oliveira de Azeméis, Sintra, Setúbal, Santarém and Vila Franca de Xira
Smart City 2.0	integrated strategy	Integrated management supported by technology to promote the quality of life of citizens and city's sustainability.	Braga, Caldas de Rainha, Esposende, Évora, Lagoa, Loulé Matosinhos, Porto, Seixal, Torres Vedras and Viseu
Smart City 3.0	collaboration and co-creation	Promotion of collaborative dynamics and co-creation of strategies with citizens.	Abrantes, Aveiro, Águeda, Cascais, Guimarães, Lisboa, Maia, Oeiras and Vila Nova de Gaia

As Portuguese smart cities did not have initial projections, as in other countries, it is not clear that they experienced the classic Smart City 1.0 phase. That is justified by the lack of deep tech initiatives based on the development and implementation of disruptive technologies. As a result, very few initiatives are mirrored, in Appendix B, from the initial editions of the magazine.

Therefore, Smart City 1.0 is not assumed to have happened, in Portugal, by implementing technologically disruptive solutions but rather by isolated initiatives, largely pilots, without an apparent holistic strategy. While in smaller cities (such as Alcobaça, Alfândega da Fé, Azambuja, Castelo Branco, Lamego, Lousada, Melgaço, Odemira, Vimioso, and Vizela) they focus on implementing specific verticals to address existing gaps, larger cities, on the other hand, have associated a strategic vision for the territory (Smart City 2.0). More than implementing small projects or pilots, the cities are committed to urban digital transformation. On a higher level, the cities of Abrantes, Aveiro, Águeda, Braga, Cascais, Guimarães, Lagoa, Lisboa, Maia, Oeiras, Porto, and Vila Nova de Gaia promote collaboration and co-creation with citizens (Smart City 3.0), as summarized in Table 5.

The differences between cities, regarding their development phase, is noticeable. In smaller cities, the solutions are implemented in specific verticals to increase efficiency with a quick payback. Moreover, in recent years the focus has been given, for example, to changing street lighting to LED sources, and, in some cases, the preparation of the luminaires for the remote control and regulation of their intensity, and to the implementation of electronic systems for measuring the tension and flow of water pipes for anticipating ruptures and controlling leaks.

In larger cities, a concern for holistic and integrated views of the city is noted. Cities are committed to their digital transformations and have a data-driven decision-making logic, where they gather data via an integrated management platform to support policymakers' decisions. The information is processed and transmitted in real-time to this control center and urban observatory to concatenate sensor data in the territory and anticipate problems. In addition, there are already cities implementing gamification-based applications to award citizens whenever they have environment-friendly behaviors, and to promote participation through technological tools that allow instant interaction with citizens in order to receive their suggestions and concerns.

Smart cities are increasingly based on a holistic perspective. Moreover, the funding sources will cover the entire strategy rather than isolated projects for each of the verticals. The evaluation of grants should also be carried along the urban development strategy, wherein the evaluation committee would have a multidisciplinary team to ensure strategies have adequate orientation. The strategy could be divided into several stages with clearly

defined milestones. This would require the city to promote a collaborative co-creation process with citizens and respond to the heterogeneity of its territory.

Although there is a national smart-city strategy being designed, the goal is mentioned to keep with only high-level guidelines and the dissemination of the existing best practices in initiatives. The issue is the scarcity of holistic strategies in the territory—there are still foundations and standard guidelines that are still missing.

6. Conclusions

The present paper reviewed the state-of-the-art of smart cities in Portugal through content analysis of a Portuguese smart-cities magazine, supported, essentially, by empirical knowledge and by interviews conducted with policymakers and a secretary of state.

Our results showed that smart city initiatives, in Portugal, are mostly from the mobility and social areas, followed by the environment. In addition, 70.8% correspond to technological initiatives and 29.2% to non-technological ones. Nevertheless, there is no clear technological motivation without an association with the sustainability and efficiency aspects. Deep technology and breakthrough solutions are not mentioned. The articulated initiatives aim to promote urban regeneration and development towards meeting citizens' cultural expectations while improving quality of life. At the same time, there seems to be a growing effort to promote civic participation.

This paper also highlighted the contributors to the development of the smart-city topic in Portugal. Our results show that, although gender was well distributed among the top five contributors, the same was not true of the overall figure. About 73.4% of interviewees or authors of opinion articles are men. This fact may reveal poor gender equity within the topic.

By means of qualitative analysis of the content of the interviews and opinion articles, it can be observed that the evolution of the concept closely matched the literature. Indeed, the three stages of the concept can be observed in different cities of the territory. Moreover, the literature mentions the existence of three phases of the concept: the first is of a purely technical nature, led by private entities; the second is associated with promoting sustainability and quality of life; and the third is focused on collaboration and the co-creation of strategies. In Portugal, the three phases are perceived in slightly different ways. Due to the challenge of accessing funds, smaller cities have been only able to establish vertical and isolated projects to respond to pressing challenges (Smart City 1.0). On the other hand, the larger cities are divided into those with integrated projects (Smart City 2.0), and those that have followed the evolution of the concept and are focused on promoting citizen participation (Smart City 3.0). Ultimately, Portuguese cities are framed by their respective phase.

In summary, Portugal did not follow the three smart city phases; nevertheless, there is great heterogeneity within the country, probably motivated by the lack of funding and knowledge. The portrait of the country is detailed with respect to the positioning of Portuguese cities within the three phases of the concept.

Although the number of initiatives and funding are scarce, it is possible to notice their focus on promoting participation, collaboration, transparency, and, above all, the fight against climate change. However, these initiatives prove not to be inline and integrative, making it challenging to define a smart-city strategy. This may have led cities to adapt their strategies to meet the scope and requirements of each funding opportunity, thereby losing sight of the overall logic that was at their strategies' origins. Moreover, based on the careful reading and analysis of the magazine's content and the initiatives there enunciated, access to funds has been one of the main drivers of smart-city initiatives in Portugal. Cities with integrative projects have funding from national or European programs in common, concluding that cities are very dependent on financing opportunities to support these investments. It may also reveal the discrepancy between those cities with financial support and those without, which is directly associated with their dimension. This fact puts the continuity of projects at risk, which may be why there is a lack of medium and long-term strategies.

Furthermore, most of the government initiatives were promoted through *Fundo Ambiental*; however, it lacks a holistic approach to funding strategies in isolated initiatives and pilots. The LVpD initiated that vision, but several questions emerged, such as how to address each city's ability to define whatever strategy they wished, and about the follow-up of strategies implemented in living labs. The lack of methodologies and prospective funding can lead to being discredited within the population and to its disregard of future innovative approaches by policymakers. Future work should study the actual state of the projects funded under the European Commission scope and the reasons behind their successes or failures after the end of the projects. In addition, the reflection on the factors and KPIs that dictate and evaluate the success of an initiative may emerge.

However, the Portuguese government is aware of the subject and is willing to create a dedicated strategy. Yet it is expected to only give high-level guidelines of the focus areas for establishing projects. It lacks legislation and standard frameworks to help policymakers comprehend and implement smart-city strategies, while the discrepancy between territories is acknowledged and combated with specific policies. In addition, is necessary to promote the discussion of the role of sovereign bodies and legislators, and of how European guidelines can be translated into local actions.

As a limitation of the study, all existing city initiatives may not be portrayed in the magazine, and therefore in this paper. This study serves as a benchmarking effort for academic use of the information about the state-of-the-art of smart cities in Portugal in supporting further study. International experts were the first to raise the need to reflect on citizen-participatory methodologies. The COVID-19 pandemic accelerated the urban planning discussions aimed at finding proximity and collaborative models to respond to urban challenges and citizens' basic needs. These topics may also be considered in future work.

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Appendix A

Table A1. Smart City Magazine Data.

Nr	Date	Title	Subtitle	Keywords on the Cover	Foreword
4	Jan/Feb 2015	Barcelona	Gaudí, Las Ramblas, history, tapas, and football give soul to Europe's Innovation capital. Benvingut to Catalonia!	PlanIT Valley reborn; Do we have a Smart Government? Trends for 2015; Digital health in Europe	Smart Cities: Freedom and Inclusion
5	Mar/April 2015	Urban Art	The streets are colorful, touristic, and supportive. Embraced by cities, street art is revolutionizing public space. Meet the new urban galleries.	To Uber ride; Energy-Producing Citizens; Mobile: The Hyperconnected World; Fiware, APPs for all	Cities with Soul
6	May/June 2015	Do It Yourself	Fablabs are bringing the workshops back to the cities.	Budapest is changing; Is there strike? Lost Lisbon; Cities 2020	365
7	Jul/Aug 2015	Do you still use cash?	Payments via the smartphone will give vacation to your wallet. Discover the cashless world.	Internet of Things; Street Food; Technological Coruña; Is your cell phone broke?	The arrogance we lack
8	Sep/Oct 2015	There are tourists in the neighborhood	Millions arrive to get to know our cities. Lisbon and Porto are the world tourism center, but will it be possible to host, in the historical streets, the tradition, visitors, and residents?	Art in the City; New Orleans; Autonomous Cars; Tech Giants	What is, after all, a smart city? Does anyone know?
9	Nov/Dec 2015	Lisbon Hub for innovation	Lisbon is the scene of a creative explosion never seen before, which gives visibility to the city and Portugal worldwide. Irresistible to innovation, the portuguese capital is convincing.	Fragmented Brussels; Towards Barcelona; Survive the Climate; Amadora in cartoon	The constant that makes the wills move
10	Jan/Feb/Mar 2016	Do you trade with me?	From time banks to Airbnb, a new form of economics wants to change the world. However, what is this phenomenon of the Sharing Economy after all?	Around the World; Benita Matosfka; Thinking the light; Smart Homes	Zoom to ZOOM
11	Apr/May/Jun 2016	Vegetable gardens in the City, do you already have yours?	More and more people are dedicated to urban agriculture, and cities can only gain from it.	Portugal Summit; Sharing Cities; Goal: Decarbonization	Simplicity
12	Jul/Aug/Sept 2016	#Citizen	Collaborating and co-creating are the keywords of today's urban leaders. A new form of citizenship is gaining momentum, and they are all summoned!	Right to the city; Venice Biennial; Zoom Smart Cities; Saskia Sassen	Numb European Innovation

Table A1. *Cont.*

Nr	Date	Title	Subtitle	Keywords on the Cover	Foreword
13	Oct/Nov/Dec 2016	Cycling in the city	Bicycles are fashionable and exist for all tastes. The two wheels are conquering more fans, and cities are contributing to it.	Urban Identity; Smart Portugal; Industry 4.0	Architects and Smart Cities
14	Jan/Feb/Mar 2017	Change of life	When it comes to choosing a destination to live in, it is not just the big cities with the upper hand. In an intelligent approach, smaller territories are gaining prominence.	Economy 360; Songdo, U-city; DREAM; Smart@PT	2017, the "year zero" of smart cities in Portugal
15	Apr/May/Jun 2017	Old, like us	The aging of the population is one of the most significant challenges of our century. Cities have to adapt to the needs of older people and learn to take advantage of the much they have to offer.	Pedal deliveries; Digital democracy; Urban Melodies	Smart cities a dream that could become a nightmare
16	Jul/Aug/Sept 2017	Where do you train?	From private gyms to public spaces, there is more and more options to choose. Cities are committed to getting their citizens into training.	Bike Holidays; Happiness in the City; The Future of Water	From Matrix to the city you experience
17	Oct/Nov/Dec 2017	Welcome to the Electric Era	Cars, buses, scooters, etc. The era of electric mobility is coming. May this transformation help to return cities to people?	Best Practices; Varanasi, Light City; Klaus Bondam	No room for manoeuvre
18	Jan/Feb/Mar 2018	Cities under pressure	In Portugal, the drought of recent months has soared the bell: water is not a certainty. In our cities, water management goes far beyond saving on tap.	Lisbon Beer District; Chuck Wolfe; Moscow	What is a smart city?... Again!
19	Apr/May/Jun 2018	Ensemble Music, Art, Territory	More than music shows, festivals are a point of communion between economic development, arts, and territories' identity.	Bettina Tratz-Ryan; Ticketing; New Digital Agreement	Break barriers and abandon old habits
20	Jul/Aug/Sept 2018	Portugal Smart Destination	Smart tourism is a great opportunity, and cities are learning to take advantage of it. Learn how.	Parking; Architechture	Who got the highest card?
21	Oct/Nov/Dec 2018	People on the move	The latest mobility trends bring innovative and more sustainable modes to urban space, but their success always depends on planning.	Human Rights; Urban Mobility; Happiness	Commitment
22	Jan/Feb/Mar 2019	Brake on waste	The circular economy comes not only from the separation and recycling of waste but also from sharing and a new approach to consumption.	Hi-Tech Health; Central Madrid; Smart City Expo	Self-help for sustainability

Table A1. *Cont.*

Nr	Date	Title	Subtitle	Keywords on the Cover	Foreword
23	Apr/May/Jun 2019	The City that makes you happy	The secret to happiness is also in cities. Learn how to find it.	Authentic Urbanism; Transports; Charles Montgomery	Cities that generate happiness
24	Jul/Aug/Sept 2019	Electrical mobility connected to the mains	While we change fuel, cities prepare to be the stage of the great energy transition.	Special Mobility; Portugal Smart Cities Summit; Co-Project Farm	Act against the "normal"
25	Oct/Nov/Dec 2019	Green, city color	Green spaces bring ecological, economic, and social benefits to communities. Regain the link between man and the nature of urban areas can be crucial to surviving the climate crisis.	From mobility to planning; Urban art	Abandon what no longer serves
26	Jan/Feb/Mar 2020	Can we still inhabit the City?	Learn how real estate pressure and tourism are driving the Portuguese away from urban centers.	Karin Zauner-Lohmeyer; City Changers; Barcelona Fair	A new mission
27	Apr/May/Jun 2020	Post-pandemic: a new urban era?	With the streets empty, the confinement period proved to be an opportunity to rethink the urban space. The future could bring a disruption in the city life as we know it: more technologies, leveraged by the arrival of 5G, and urban planning that claims space to cars, to allow the physical distancing of pedestrians and cyclists.	Innovation to 5G hitchhiking; Urban Mobility; Buy Innovation	Decisions
28	Jul/Aug/Sept 2020	Innovation vs Covid-19	In the fight against the virus, co-creation in technological and social innovation has marked the response of the Portuguese.	Richard Florida; Environmental Justice; Place Healing	From pride to humility
29	Oct/Nov/Dec 2020	The health of our homes	Cold, humidity, lack of natural light, or exposure to outside noise are weaknesses that affect the homes of the Portuguese people. Energy rehabilitation is the key to more comfort and well-being within buildings, while contributing to urban sustainability.	Isabel Ferreira; Regional Innovation; Territorial Cohesion	The discomfort in our homes

Appendix B

Table A2. Smart City Initiatives of Each Portuguese City.

City	People	Area	Type	Initiative	Description	Edition
Abrantes	39,325	strategy	T	Smart City, Happy City	A strategy focused on efficiently managing existing resources and the citizens: energy and water consumption management; public lighting; waste management; interaction with the citizen; fair local commerce; irrigation management; video surveillance; transports, mobility, and centralized monitoring.	11
		economy	T	Prodfarmer	Through a free online channel, certification, promotion, sale, and distribution of regional quality products from local producers.	11
		social	T	I am a Citizen	Direct communication channel between the citizen and the municipality. It is integrated with the city's incident management system, thus ensuring greater proximity and encouraging their involvement in initiatives, events, and even decisions of the municipality.	11
Alcobaça	56,693	Environment	T	Praia.comigo	Communication of occurrences and suggestions for beaches preservation.	16
Alfândega da Fé	5104	social	T	Senior Smile	Through a digital platform, psychological evaluations and rehabilitation sessions are promoted (free of charge), allowing the senior population to maintain an active life, socialize and increase their solidarity.	12
		environment	NT	LIFE Adaptate	Creation of a natural lake and multi-purpose forests to promote natural regeneration and combat climate change.	22
Amadora	177,136	urbanism	NT	Rehabilitation and Urban Art	Strategy for the rehabilitation and standardization of building facades, and improvement of their internal conditions.	5
		environment	T	Smart Irrigation	Efficient irrigation management project. Installed in two urban parks of the city to monitor irrigation in real-time and interrupt it at any time, via mobile phone or computer.	11
		mobility	NT	-	Construction and consolidation of green spaces with walking lanes and cycling tracks.	21
Amarante	56,264	cultural	T	Digital Interaction	Implementation of a beacon network to provide useful information to citizens and visitors, whether related to events, history, or curiosities.	16
		urbanism	NT	RUA	Urban revitalization project with three fundamental axes: Public space, ground floor, and housing. It brings together local associations, inhabitants, and merchants in a rejuvenation process that unites political will with citizen participation.	20

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Angra do Heroísmo	35,402	social	T	Angra Smart City	City agenda (online platform with information of cultural, sports and social activities), MyAngra (virtual place to request documents and follow-up the requests), Visit Angra (APP for providing information on georeferenced points of interest) and Angra wi-fi (ten hotspots to provide free Internet access).	15
Aveiro	78,450	strategy	T	Aveiro Steam City, Aveiro Tech City	(1) Implementation of 5G infrastructure and technologies and creation of an urban data platform; (2) Implementation of Tech Labs in 37 educational institutions to provide schools with technology-based equipment (such as 3D printers); (3) Installation of electric charging stations for boats; (4) Aveiro challenges - challenges of the local community in areas such as mobility, environment, energy, social action, among others, for companies and research centers to propose solutions.	22
		social	NT	Civic Lab of Santiago	Exercise citizen participation in leading the community to identify common problems in a specific neighborhood and then solve them collaboratively. Examples of initiatives: Vivó Bairro, VivaCidade, and Aveiro Soup.	23
Azambuja	21,814	environment	NT	-	Regeneration of a river and creation of a local observation space with accessible information to the population.	27
Águeda	46,600	cultural	T	Walkinagueda	Mobile application designed to guide pedestrian visitors through the city's points of interest and inform the spent calories.	8
		mobility	NT	Águeda+B, BeÁgueda	An incentive to home-work travels by bike and restructuring the city's shared bike system increases the number of available bikes and creates more parks.	13
		energy	T	SInGeLu	The SinGeLu street lighting management platform allows collecting consumption data from different sensors, parameterizing usage profiles, and controlling the luminaires remotely.	14
		social	T	CityFy	Mobile application that gathers all the available applications in the city provides information and allows citizens to interact with decision-makers.	14
		social	T	Águeda Living Lab (ALL)	ALL aims to: (1) Be a place of experimentation and active cooperation, offering a physical space to the community (ALLficina-Robotics, 3D Modeling, and Electronics); (2) Establish a point of dialogue, sharing of ideas, and collaboration between Citizens, Universities/Schools, Municipality and Companies in an open innovation platform; (3) Democratize the access to new technologies by providing equipment and specialized technical support.	23
		urbanism	T	-	Dematerialization of processes. Submission and request of documents related to construction sites and urban operations, such as the licensing of works and urban projects.	28

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Beja	152,758	mobility	T	U-bike	Implementation of 80 electric and 120 regular bikes.	13
Braga	136,885	mobility	T	Smart Mobility	Creation of 76 km of cycling tracks and implementation of a bike-sharing system. Acquisition of electric buses. The goal is to reach 18,000 regular bike users by 2025.	14
		governance	T	Control Center	Platform to manage all information obtained through the sensors installed in the city.	15
		cultural	T	Braga Explorer (Braga Green Guide)	Mobile application helps discover Braga's historical heritage, with audio-guided routes of the city's main monuments and points of interest. It also includes the green spaces and gardens as well as the principal trees of the municipality.	25
Bragança	35,341	mobility	T	Sustainable Mobility Plan	20 free electric bicycles (Xispas) spread over three parking spaces in the city. Extension and creation of new bike paths. Acquisition of 2 electric buses.	13
		social	NT	Senior sport in rural areas	Displacement of technicians in the most isolated locations to perform physical exercises for the elderly.	16
		mobility	NT	Moveletur	Promote sustainable mobility in natural and cultural heritage areas, in close connection to preserving the nature and identity of those territories.	20
Caldas da Rainha	51,729	mobility	T	City Guide	A technological platform that integrates different mobile applications, and the city's urban transport network.	6
Cascais	210,889	governance	T	Executive's Portal	A digital platform allows submitting and working collaboratively on proposals, consult the documentation, follow up the decision-making process, and execute pending tasks.	10
		environment	T	PAYT	A technological system that allows the record of the produced waste by each citizen. Participants in the pilot can access the historical information of their waste production via web or smartphone app. The initiative is part of the European Waste4Think project.	10
		environment	T	-	Placement of volumetric sensors to monitor the filling level of waste containers. On-board computers accompany the vehicles' circuits, while containers collection is recorded automatically by reading their RFID.	11
		mobility	T	MobiCascais	Mobility system that integrates transport service operators, infrastructures, and vehicles (buses, bicycles, and scooters). A free multimodal pass gives access to the use of buses and shared bicycles of the county. The associated mobile application gives the transport schedule, docks location, bicycles, and car parks available.	12
		environment	T	-	Sensors in urban cleaning equipment to collect data about the waste collection service. Creation of standards considering the various variables associated, such as wind, rain, and other extreme phenomena, as well as the study of the behavior of human resources.	17

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Castelo Branco	56,109	economy	NT	CEI	The Center for Innovative Companies aims to welcome and create conditions of innovation and entrepreneurship for the private sector to settle their operations in the region.	15
Coruche	19,944	mobility	T	-	Displacement of electric and regular bicycles supported by a dedicated Mobile Application.	19
Cuba	4878	social	T	Cuba Alert	Mobile application to inform the municipality of potholes on the roads, water supply failures, public space maintenance problems, garbage collection, and street lighting.	14
Elvas	23,078	cultural	T	Interactive Forte da Graça	Through the installation of beacons, citizens and tourists will have the possibility to interact with the monument.	16
Esposende	33,947	strategy	T	Esposende Smart City	Connection to the arts and culture through technology. Installation of sensors to monitor air quality, noise and ultraviolet index, and other areas such as mobility, energy, culture, heritage, and urban rehabilitation to predict situations and respond preventively. Centralized management in a control center.	25
Évora	56,596	energy	T	POCITYF	Implementation of energy-positive buildings and districts (use of renewable energy, implementation of energy efficiency measures on buildings renovation); energy management and storage systems (reusage of batteries from electrical mobility for mobile or stationary applications); social innovation for the citizen (gamification); mobility and mobility-as-a-service (one-way and two-way electric charging, and implementation of Smart Lampposts).	24
Fundão	29,213	social	NT	Code Academies	The initiative, designed in the short-term form, with intensive programming boot camps, and in the long term, giving foundations for first cycle students, is based on a sustainable financial model based on the obtained results. After these courses, young people who do not get a job do not pay for training, while those who get a job return 2500 euros.	12
		mobility	T	MUV	Mobile application that puts citizens, merchants, and local authorities collecting data and urban mapping ravel, co-building the city by matching mobility policies to the real needs of people.	21
Guimarães	158,124	Energy	T	-	Project to modernize public lighting networks using a remote management platform.	7
		strategy	T	DREAM	European consortium where Guimarães is the leader and intends to demonstrate innovative ICTs pre-commercial solutions for infrastructure optimization, mobility, and energy efficiency on a real scale. Combination of three elements—the living lab methodology, the challenges (or transformative projects), and the urban intervention space (i.e., where the pilots will be implemented)—with open space to experimentation and co-creation.	14

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Lagoa (Algarve)	22,975	governance	T	Smart City Operations Center	All information generated and collected in real-time by the sensors is transmitted securely through the LoRa network to the Smart City Lagoa Operations Room, where qualified technicians manage the city's various systems through different applications.	20
Lamego	26,691	energy	T		Installation of LED lighting technology in the luminaires.	4
Leiria	126,897	mobility	T	U-bike	Displacement of 220 electric bikes.	13
		social	NT	Inclusive Pavilion	Equipment prepared and designed to host sports for people with disabilities.	18
		urbanism	NT	Jardim da Almuinha Grande	Amphitheater in an outdoor park.	25
Lisboa	504,718	governance	T	Lisboa Aberta	Georeferenced open data portal.	10
		mobility	T	Gira	Expansion and construction of bicycle paths. Provision of a bike-sharing system through a mobile application.	13
		mobility	T	Sharing Cities	A project that contemplates electric mobility, energy requalification of buildings, implementation of smart lampposts, air quality and noise sensors, sustainable energy management systems, and data-sharing platform.	14
		social	T	Lisboa Participa	Web portal to simplify and facilitate citizens involvement by bringing together, in a dedicated space, the various instruments of participation of the city, such as participatory budgeting and the applications "Na Minha Rua", "Lisboa Aberta", "Lisboa em Debate" and "LisBoaIdeia".	15
		governance	T	COI	City operational center that integrates data from 40 services, such as firefighters, civil protection, municipal police, utilities, public transport, ports, environment, etc...	16
		environment	T		Placement of waste sensors in containers and implementation of a PAYT system with dedicated access cards.	22
		mobility	NT	Green Capital 2020	Preventing the circulation of vehicles before 2000 in the city center and all vehicles on Sundays.	26
		social	T	Lisboa.24	Real-time information about the city (traffic, occurrences, events, parking and transport).	27

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Loulé	70,622	environment	T		Monitoring, measurement, and assessment of energy consumption and its costs, as well as CO2 emissions in water supply and residual waters sanitation systems	11
		governance	T	Smart Governance	Digitization with the dematerialization and streamlining of decision-making ecosystems.	11
		mobility	T	Loulé Adapta	Bike sharing, electric charging, construction, and extension of bike paths.	13
		mobility	T	LoulÉmobilidade	Mobile application to access real-time information of urban transport schedules and facilitate the parking payment.	18
		social	NT	HealthyCities	Project to deepen the relationship between health and the urban environment, developing policies focused on improving the population's health status and assessing their impact.	26
Lousada	47,387	social	NT		Use of environmental education to connect the citizens to the conservation natural heritage initiatives of the municipality.	26
Maia	135,678	strategy	T	Baze_Living Lab	Urban space (Fablab) for testing, demonstrating, and experimenting with integrated technological solutions in a real context. It intends to be a low-carbon environment, resilient, accessible, participated and connected, developing an Urban Management Platform.	23
Matosinhos	175,478	social	T	The Online Citizen Store	Through a platform, citizens can download and submit requirements, make suggestions, complaints, or clarify all their doubts about the city's activity.	4
Melgaço	9213	economy	NT	Melgaço Pop-up	An incentive to the creation and maintenance of local commerce. In the first three months, the rent is free and, in the following three, the due monthly payment is a symbolic amount of 1 euro per square meter to the owner.	28
Odemira	22,536	urbanism	NT		Rehabilitation of urban space. New water networks and more efficient luminaires.	19
Oeiras	173,149	governance	T	Smart Cities Platform	A platform for sharing information and knowledge, with the dissemination of specific solutions in the field of urban intelligence.	12
		social	T	OeirasEu.pt	Citizenship web app aims to go beyond simple communication and data analytics to plan and help solve urban challenges. It allows citizens to communicate, in real-time, an occurrence to decision-makers, where a dedicated team in a "command center" does the screening and forwards the occurrence to the responsible stakeholder.	15
		strategy	T	-	Implementation of 5G to increase sensorization and data collection to help city's management. Install meteorological and street lighting sensors, traffic measurements, urban waste management, environmental monitoring, and alarm management associated with civil protection.	27

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Oliveira de Azeméis	69,127	mobility	T	BiclAz	Construction of bicycle paths. Acquisition and displacement of electric bicycles.	13
Porto	214,349	environment	T		Buses with wi-fi coverage and air quality sensors to monitor environmental parameters.	4
		environment	NT	Green Roofs	The pilot project is to place green roofs in city buildings for precipitation retention, increase green areas, thermal comfort, soundproofing, CO2 capture, and the roof's lifetime.	15
		social	NT	Entrance Door and 1st Right	Housing programs to immediately support people who suddenly have deprived themselves of housing and help people who live in undignified conditions.	27
Santarém	61,752	social	T		Mobile application with an audio format guide in different languages allows access to local information and news, communicates occurrences, sends suggestions, requests meetings to municipal services, locates points of the territory, and learns more about historical monuments.	10
		mobility	T	Bikes	Bike-sharing with real-time information.	13
Seixal	158,269	strategy	T	Seixal Smart City (LVpD)	Strategy with 17 projects, focusing on improving the quality of life and boosting the riverside area of Seixal and neighboring communities. 1. Intelligent street lighting; 2. Smart water meters; 3. Electric train and renewable energy; 4. Individual electric mobility equipment; 5. Smart parking for electric vehicles; 6. Electric charging points; 7. Photovoltaic sun hats; 8. Mini wind power stations; 9. Energy storage; 10. Smart network; 11. Eco-restaurant; 12. Solar kitchen; 13. Zero-emission room (Ecosystem Monitoring and Information Center); 14. Smart container; 15. Live innovation exhibition for decarbonization technology; 16. Ecosystem database and information system; 17. Ecosystem portal.	19
Setúbal	116,330	social	T	Setúbal SOS	Mobile application for direct connection with the emergency services based on GPS real-time location. Includes clinical historical information, age, and the contact person to be contacted in case of emergency.	13
		urbanism	T	USO	Simplification and streamline of administrative processes through an online geoportal that integrates geo-referenced information and content of different urban areas.	22
Sintra	381,728	cultural	T	Talking Heritage	Mobile application with information about city's points of interest. Images, texts, videos, or augmented reality technology along the routes.	4
		environment	NT		Separation of domestic waste using waste bags provided by the city.	29

Table A2. *Cont.*

City	People	Area	Type	Initiative	Description	Edition
Torres Vedras	79,465	mobility	T	Eco Urbe	Implement directional signs, 18 lampposts, a shadow structure with a solar photovoltaic system, a bicycle support infrastructure, a passenger shelter with two seats, two conventional Mupis, and a dynamic information totem. Implementation of a smart lamppost that uses the sun and wind as energy sources and serves as a telecommunications network station with the capacity to charge devices or electric vehicles and has IP cameras. Acquisition of electric vehicles and bicycles, an extension of bike paths, and implementation of traffic control sensors.	26
Vila Franca de Xira	136,886	mobility	NT	Ribeirinho Park	Urban requalification and construction of a bike path.	20
Vila Nova de Famalicão	133,832	governance	T	Smart Center Famalicão	Urban intelligence platform to support daily city operations and the management of public space and occurrences.	23
Vila Nova de Gaia	301,496	urbanism	T	Nopaper	Digitization and streamlining of urban processes in a dedicated platform.	6
		social	NT		Collaborative methodology to diagnose, present proposals, and experiment with the solutions by the community.	28
Vimioso	4669	social	NT		Lands at one cent, with the offer of the project, the licensing fee, and education fees paid by the city to retain young citizens.	20
Viseu	99,274	mobility	T	MUV	Mobility application allows buying tickets or electronic passes, validating trips, and knowing bus schedules in real-time or parking availability. Construction of bicycle paths. New urban transport network, shared bicycles (electric and regular), on-demand transport service, and a parking system with three new parks with sensors. Displacement of two electric buses and one unmanned electric vehicle.	13
Vizela	23,736	social	NT	CittaSlow	Philosophy of slowness to (re)find the idea of well-living and the awareness of the value of life in the local community, emphasize territorial rooting, and preserve the territory's identity.	12

Legend: T—Technological; NT—Non-Technological. Although briefly mentioned in the magazine, the municipalities of Barreiro, Faro, Funchal, Guarda, Lagoa (Azores), Madeira, Mafra, Oliveira do Bairro, Paredes, Peniche, Ponta Delgada, Portimão, Sátão, São Brás de Alportel, Vila do Bispo, among others, did not contain enough information to be considered in the previous table.

Notes

[1] Viana do Castelo, Braga, Guimarães, Porto, Vila Nova de Gaia, Aveiro, Coimbra, Leiria, Santarém, Torres Vedras, Loures, Sintra, Cascais, Lisbon, Almada, Setúbal, Faro, Beja, Évora, Portalegre, Castelo Branco, Guarda, Viseu, Vila Real, Bragança.

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