


Article

Digital Technologies and Public Policies Applied to Green Cities

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Abstract: Digital technologies and public policies are fundamental for cities in defining their urban greening strategies, and the main goal of this research is to identify the applied digital technologies and the public policy dimensions implemented at the national level by the member states to promote urban greening in the literature and official documents. The methodology used is a systematic literature review (based on international studies), a Delphi study with experts, and a policy analysis, aiming to understand how the Portuguese government has implemented policies and identify the main technologies applied to urban greening. The main findings regard (i) the focus on the interaction between actors in policymaking; (ii) interpretive approaches used to examine the application of technologies in urban greening problems; and (iii) how policies reflect the social construction of ‘problems’. The research focuses on how policy analysis provides a powerful tool that can be used to understand the technologies, actions, interests, and political contexts underpinning policy decisions. The main lessons learned from this research are that urban greening can benefit urban centers together with the non-urban environment on which they have a functional impact, such as agricultural hinterland areas, forest spaces around the cities, and the rural–urban interfaces. Initiatives for urban greening are designed to enhance cross-border coordination, complementarities, flexibility, productivity, and access to the main international markets and territories.

Keywords: technologies; urban greening strategies; policy analysis; public policy



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1. Introduction

Urban greening public policies play an essential role in influencing the sustainability of cities. The major objective of this study is to discover the public policy components that the member states have undertaken at the national level to support green cities and urban greening strategies in the literature and official documents.

The concept of urban greening can be translated as the urban environment that contributes to public health and increases the quality of life of urban citizens, helping to create new lifestyles, values, and attitudes to nature and sustainability [1]. Urban green spaces are an important component of the complex urban ecosystem. Parks, forests, and farmlands are three main types of urban green space, which have significant ecological, social, and economic functions [2–5]. Other common urban green spaces are roadside trees that separate the roads and the residential zones and reduce noise. The road greenway can act as an important corridor for people. In regard to the sustainability of urban greening of the cities [6], vertical greening is a strategy for cases of high-density development and limited land, and it includes roof gardens, wall greening, balcony greening, and windowsill greening. Vertical greening can augment the green space of cities to enhance their ecological goals and increase green space [7]. Moreover, a green park requires effort so as to create a natural forest structure, including trees, shrubs, and herbs, to improve the greening condition of the city [8].

A relevant result of the rise of global urbanization is that more than half of the world's population live in cities. Urban housing and inequality are two pressing issues that the "urban commons" [9] concept seeks to address. Urban commons represent the idea that urban communities should have access to and be able to use public spaces, urban land, and infrastructure to produce and support a variety of commodities and services essential for the sustainability of those populations, particularly the most vulnerable populations. However, the dismantling of infrastructure systems, which may be in line with current neoliberal urban regeneration trends, has consequences for society's wellbeing [10]. Another dimension that should be addressed is gentrification [11]. In the context of greening, gentrification takes on socio-cultural as well as physical manifestations, causing new types of social erasure and suffering for vulnerable individuals. Students, academics, and researchers can disprove the frequently depoliticized branding and selling of green cities due to their diversity and breadth, and they can also reintroduce fundamental fairness and justice concerns into green city development.

Cities, then, play a crucial role in worldwide development but also in the management of climate change, as a vital component of the post-Paris global climate system [12]. A large number of individuals are optimistic that cities will play a key role in the creation of a successful bottom-up global response, in part due to their jurisdictional authority, shared commitment to action, and disdain for negotiations.

Urban planners are starting to realize that, when creating a city, they must consider the welfare of the inhabitants. It will be crucial for designers to consider how their work affects everyone, despite their differences, in the future. Better planning, greater inclusion, and a far better ability to simulate the impact of changes are all made possible by the data collecting and visualization tools of today focused on a better livability [13].

An important indicator of urban greening is green space coverage (the percentage of green land on a site). However, it does not reflect the quality of the green structure, nor does it represent the variety of ecosystem services of the green space. In addition, the indicator of the green plot ratio can provide an effective method so as to assess the quality of greening in urban planning [14]. Both indicators can help urban planning policies to achieve more sustainable development [15]. Urban greening policies can reduce the complexity involved in introducing the city ecosystem models of management of urban green spaces [3,16,17].

In this context, the research questions of this study emerges, including Rq1: "Which are the main Public Policy dimensions for promoting urban greening?"; and Rq2: "Which are the main technologies applied to urban greening?"

In this sense, the main goal is to identify and understand the main existing public policies and how they can influence the urban greening strategies of the cities. This relationship depends on an integrated vision between the human dimension and the other multiple dimensions, such as infrastructures, technological innovations, energy, and forestry.

In the EU (European Union), widely known green strategies have been promoted by various innovation support programs in the last decade. In this context, public policies have played an important role by promoting programs that contribute to the improvement of the way in which cities invest in their capacity for innovation in regard to technologies for urban greening.

The main innovation of the article is that it maps the articles published on urban greening public policies and the main actions taken in the different countries. This could contribute to other countries' efforts to replicate some of these actions and help them to define urban greening strategies for the cities. It specifically discusses what is known about green urban policies from a social perspective, together with the participation of the interested parties. The article also systematizes dispersed information about policies, which can assist researchers and policymakers in the development of green urban policies with a focus on good practice and innovative technologies.

In this context, the study examines the idea of urban greening and the technologies connected to urban strategies, as well as public policies. It draws on a variety of critical and interdisciplinary viewpoints and raises concerns about current green city issues, such as planning, the application of technology to the various aspects of city management, and the public policies that support the creation, growth, and preservation of green cities. An innovation of this study is that it is framed by interdisciplinarity and based on the vision of the experts who participated in the study and helped to develop a typology for the analysis of green cities.

In sum, this article's main goal and merit are to provide a global overview of the public policies oriented towards programs that incentivize urban greening and the sustainability of cities with the application of emerging technologies. The main limitations are the scope of the analysis of the public policies, which are focused on Portugal, and the number of experts who participated in the Delphi Study. In future research, the enlargement of public policies will be a major goal.

Finally, the structure of the article is as follows. It begins with a systematic literature review, followed by a Delphi Study and a policy analysis, finishing with recommendations for policymakers.

2. Methodology

Based on the unique nature of urban green studies and their need to intersect with public policies and technology, in this research, we conducted a systematic review of the literature using the terms "urban green*", "technology*", and "polic*" using the b-On scientific search engine. The usage of the Boolean operator "and" was motivated by the need to identify policies and technologies that might be used for urban greening. Given the large scope of the word "polic*", we chose to search for it in the title to avoid the occurrence of irrelevant results. Searching by title rather than topic field is a trend that can be observed in several studies [18–22].

The period chosen was from 2015 up to the time of the survey (June 2021), and 89 studies were retrieved. Based on this, a network analysis was created using VOSviewer software, and a content analysis of the official documents relating to public policies and technologies applied to urban greening was accomplished using a model with four dimensions: 1st dimension—problem identification regarding the stakeholders; 2nd dimension—mapping the dimensions of policies for urban greening and the technologies; 3rd dimension—implementation of the policies; and 4th dimension—evaluation of the impacts on stakeholders. For the validation of the model, a Delphi study was performed.

The data analysis procedures are reported below.

2.1. Step 1—Keyword Co-Occurrence Analysis

For the keyword occurrences, the themes were verified through network analysis, using VOSviewer software to perform a scientometric study for the mapping of knowledge domains. VOSviewer enabled the mapping of the knowledge domains in images, which shows the development process and structural relationships of scientific knowledge. It shows complex relationships, including networks, structures, interactions, intersections, evolution, or the derivative knowledge units of knowledge clusters. The mapping of knowledge domains includes co-citation analysis, co-occurrence analysis, and burst detection analysis, as follows:

Document co-citation analysis: According to scientometrics, the document co-citation analysis is based on statistics regarding the number of times in which two documents are cited in one or more paper(s) at the same time so as to conduct a network analysis of the cited documents and thus examine the knowledge created by that research.

Keywords co-occurrence analysis: Keywords are an important bibliometric indication in academic publications, since they convey the document's thematic aspects. The number of times in which a pair of keywords are mentioned in the same document is used to perform a network and cluster analysis of these terms and reveal the knowledge structure.

Burst detection analysis: Burst detection analysis considers changes in keyword frequencies and detects keywords with burst growth characteristics in a specific research field over time, which may be used to investigate a topic's development pattern. Although each keyword may be used far less frequently than the burst detection analysis would indicate based on threshold values, the burst keywords can be detected based on the changes in keyword frequencies over time. Thus, the latest research trends can be predicted through such keywords.

2.2. Step 2—Delphi Study to Validate the Technologies Applied to Urban Greening

This is an exploratory quantitative study based on the use of a questionnaire as the primary source of the data collection, which was applied to 34 academics and experts. The questionnaire was based on the systematic literature review, aiming to validate the technologies applied to urban greening, as discussed above in the literature review. The questionnaire includes a scale of seven choices for the evaluation of all the statements, ranging from “disagree completely” (1) to “agree” (7). The respondents represented 34 academics and experts in the field of the technologies applied to urban greening.

2.3. Step 3—Public Policy Analysis

Through inductive content analysis [23], we analyzed the role of governments in the implementation of policies; stakeholders involved; applications of green technologies in urban afforestation problems; social participation in green urban problems; and, finally, the status of public policies as a tool for understanding values and interests and sustaining political decisions. In an operational procedure, we used the [24] approach to content analysis, based on the technique of “making inferences by systematically and objectively identifying special characteristics of messages” present in policy reports. After identifying the characteristics, they were translated into categories and then analyzed as dimensions of the urban greening public policies. The software that we used for this purpose is designated as MAXQDA. More specifically, the criteria used for the categories/dimensions defined were the following (suggested by [23]: 1st criterion—the categories need to be valid, relevant, or appropriate; 2nd criterion (of completeness or inclusivity)—the categories must have the capacity to frame the entire content; 3rd criterion (of homogeneity)—the whole set must be structured in a single dimension of analysis; 4th criterion (exclusivity or mutual exclusion)—each element can be classified into only one category; 5th criterion—objectivity, consistency, or reliability.

After the definition of the categories and their analysis [23] policy analysis methodology was applied to help us to identify potential recommendations for policymakers, in line with the methodology suggested by [25]. To clarify the sources, it was important to ensure that the policy analysis was based on the available official documents of the EC and national entities.

3. Systematic Literature Review

The methods used for this systematic review follow the guidelines detailed by the PRISMA methodology, an evidence-based set of items for reports based on systematic reviews and meta-analyses. This research followed the main phases of the PRISMA methodology, including the background of the study, the primary goals, the data sources and the eligibility criteria, the methods, and the results, followed by the limitations, conclusions, and implications of the findings.

3.1. Eligibility Criteria—Inclusion and Exclusion Criteria

A systematic search of online scientific databases using b-On, a scientific information research tool, was conducted at the end of March 2018. The search was made using several queries, containing the terms “urban green*”, “technolog*”, and “polic*”.

The criteria for this study's selection were the following: (a) studies that involved technologies in urban greening; (b) restrictions on language (English only); papers must (c) have the full text available; and (d) papers must have been published after 2015.

3.2. Results of the Paper Search

The numbers of papers found through these queries are presented in Table 1. It is interesting to note that, after introducing the time criteria and the decision to use only the Science Direct database, the number of papers retrieved decreased significantly from 2376 to 172 (Table 1). The final methodologic decision was to consider only peer-reviewed papers (99 papers) and those in the English language. This resulted in 60 papers (n = 60) for the current research.

Table 1. Number of Articles Found Per Query.

<i>Keywords "urban green*", "technolog*", and "polic*"</i>
Number of Scientific papers 2,376
Number of Scientific papers in Science Direct since 2015 (2015–2021) 172
Peer-reviewed journals 99
Language English 60

The systematic literature review helped us to respond to the research questions, including Rq1: "Which are the main Public Policy dimensions for promoting urban greening?"; and Rq2: "Which are the main technologies applied to urban greening?".

The main dimensions identified in the literature review regarding urban greening policies are represented in the following Table 2, which also presents the applied technologies and the authors of the papers considered in the literature review.

The main dimensions of urban greening policies are urban innovation, information and communication technologies, the urban environment, and urban–rural integration.

The main technologies are virtual reality and augmented reality, artificial intelligence, robotics and drones, green technologies, green energy, digital platforms, green digital products, internet of things, intelligent systems, blockchain technology, smart cities, management technologies, intelligent water system management, waste management systems, blockchain, intelligent systems for smart agriculture, intelligent transports, intelligent technology for heritage monitoring and management, and big data analytics.

The network of the authors will be presented and analyzed in the following sections.

3.3. Data Network and Discussion

All the papers were analyzed using Mendeley (Elsevier), and the final 60 papers constituted the final database, which was saved in RIS format so as to be uploaded by VOSviewer to analyze the co-authorship and the occurrence of the keywords.

3.3.1. Keywords' Occurrence

VOSviewer is a program for creating networks and analyzing the strength of the associations between variables (Figure 1).

As a result, the strongest link between the keywords, based on their equal distance, is significant. The main keywords are as follows (Table 3):

Table 2. Dimensions of Urban Greening Policies and Technologies Applied by the Authors.

Dimensions	Technologies	Authors
Urban innovation	Virtual Reality and Augmented Reality	[26] (Affolderbach et al., 2018; 2019) [27] (Aldy, 2016)
	Artificial Intelligence, Robotics, and Drones	[28] (Altenburg et al., 2016) [29] (Barbose et al., 2015) [30] (Bergquist et al., 2015) [31] (Birch & Calvert, 2015)
	Green Technologies, Green Energy	[32] (Brudermann & Sangkakool, 2017) [33] (Bryson et al., 2016) [34] (Cavdar & Aydin, 2015) [35] (Chiu, 2017)
	Digital Platforms, Green Digital Products	[36] (Cohen & Bordass, 2015) [37] (Commission, 2001) [38] (Cooper, 1998)
	Artificial Intelligence, Internet of Things, Big Data Analytics	[39] (Cowley et al., 2018) [40] (Dal Borgo et al., 2013) [41] (de Boer et al., 2018) [42] (Dey, 2016)
Digital technologies	Intelligent Systems, Digital Platforms, Green Digital Products, Big Data Analytics	[43] (Di Stefano et al., 2012) [44] (Drummond & Ekins, 2016) [45] (Dvarioniene et al., 2015) [46] (Dyckman, 2016) [47] (Ferrara, 2015)
	Internet of Things, Blockchain Technology, Smart City Management Technologies	[48] (Geth et al., 2015) [49] (Giezen et al., 2018) [50] (Hammond et al., 2017) [51] (Hannon et al., 2015) [52] (Hittmar et al., 2015) [53] (Hodgson et al., 2016) [54] (Holley, 2016) [55] (Irga et al., 2017)
Urban environment	Internet of Things, Intelligent Water System Management, Big Data Analytics	[56] (Kanniah & Siang, 2017) [57] (Kelly-Detwiler, 2015) [58] (Kim & Han, 2015) [59] (Kulkarni et al., 2017) [60] (Lindman et al., 2016) [61] (Littlechild, 2016) [62] (Manders et al., 2016) [63] (Muscio et al., 2015) [64] (Newbery, 2016) [65] (Peyravi, 2015)
	Waste Management Systems, Internet of Things, Blockchain	[66] (Pitkanen et al., 2016) [67] (Pittens et al., 2015) [68] (Portney et al., n.d.) [69] (Rainville, 2017) [70] (Raja & Wei, n.d.) [71] (Raunbak et al., 2017)
Urban–rural integration	Internet of Things, Intelligent Systems for Smart Agriculture, Green Energy, Drones, and Robotics	[72] (Roper & Hewitt-Dundas, 2015) [73] (Rubashkina et al., 2015) [74] (Ruby, 2015) [75] (Scarpellini et al., 2016) [76] (Schmitz & Altenburg, 2016) [77] (Schweber et al., 2015) [78] (Seeberger et al., 2016) [79] (Sgobbi et al., 2016) [80] (Strachan et al., 2015) [81] (Verhees et al., 2015) [82] (Vermunt et al., 2018) [83] (Wentworth, 2017) [84] (Wright et al., 2016) [85] (Yu et al., 2017)
	Internet of Things, Drones, and Robotics	
	Internet of Things, Drones, Robots, Intelligent Transport	
	Artificial Intelligence, Intelligent Water System Management, Drones and Robotics.	
	Intelligent Technology for Heritage Monitoring and Management. Big Data Analytics.	

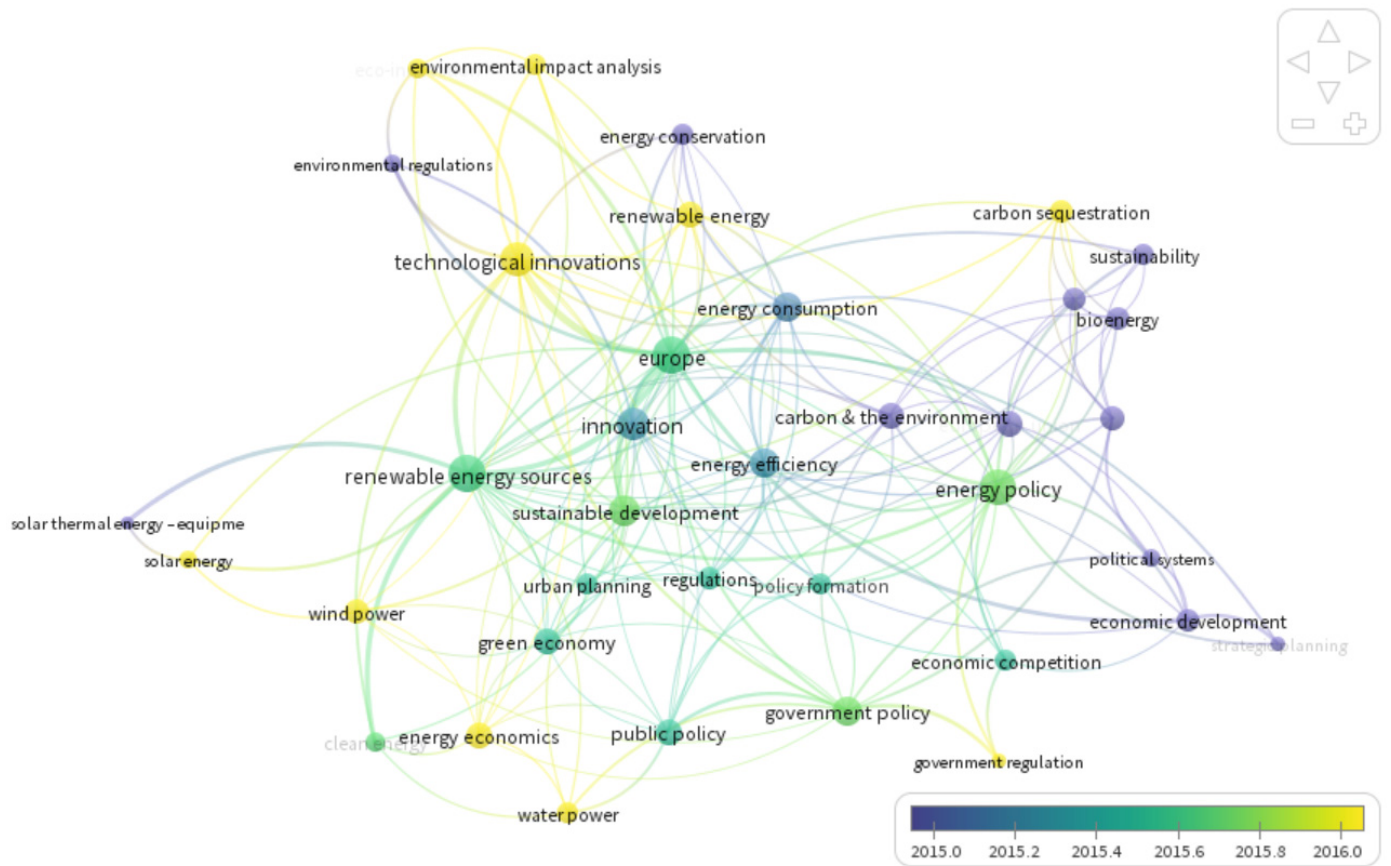


Figure 1. Keyword Occurrence Network.

Table 3. Keyword Occurrences and Link Strength.

Keyword	Occurrences	Total Link Strength
Renewable energy sources	14	35
Technological innovations	13	34
Energy policy	9	25
Government policy	9	18
Sustainable development	7	18
Energy consumption	6	22
Innovation	4	16
Energy efficiency	4	15
Economic development	4	9
Renewable energy	3	14
Carbon and the environment	3	11
Public policy	3	10
Clean energy	3	8
Electric power production	3	8
Eco-innovation	3	7
Environmental regulations	3	7
Stakeholders	3	7

3.3.2. Keyword Occurrence Intensity

Regarding the keyword occurrence intensity, this is defined by the number of occurrences of the keywords. The red, orange, and yellow colors represent the keywords with a high level of occurrence (Figure 2):

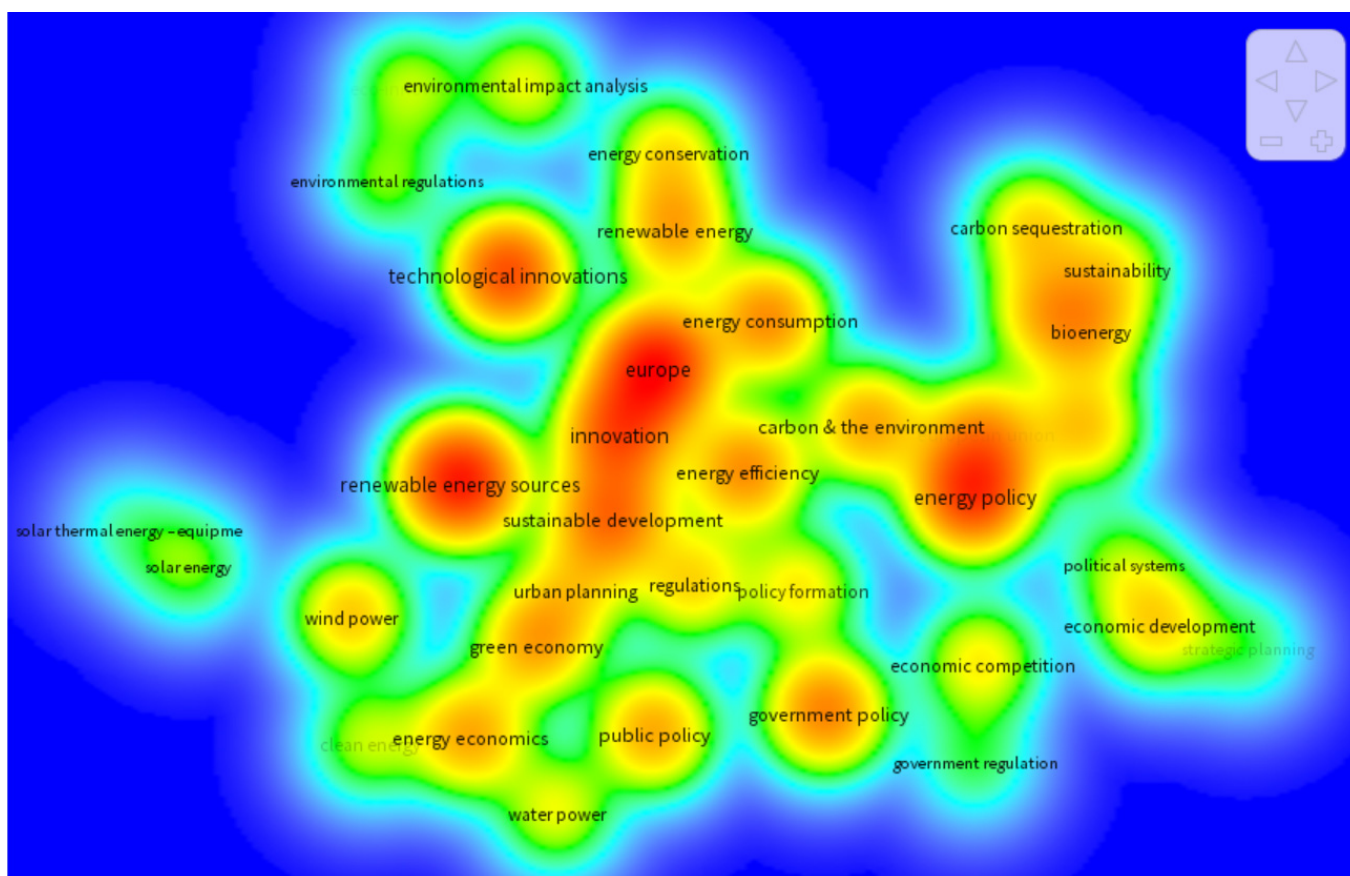


Figure 2. Keyword Occurrence Intensity.

3.3.3. Co-Authorship Network

Because of the highly interdisciplinary nature of the studies, the researchers come from different domains, such as engineering, planning, computer science, urban fields, architecture, and others, where complementary advantages can be achieved through cooperation. The creation and analysis of the knowledge maps of the co-authorship network of productive authors can provide valuable information for research organizations to develop cooperation groups and for individual researchers to seek cooperation.

3.3.4. Co-Authorship Analysis

In VOSviewer, co-authorship analysis (Figure 3) is conducted using nodes representing the authors. The node sizes indicate the number of published articles. The link connecting two nodes represents the cooperative relationship between two authors, and the thickness of the link represents the intensity of this cooperation. Overall, the cooperation between the productive authors is not close. However, there are several co-authorship groups. The co-authoring of publications has critical significance in promoting research innovation and knowledge sharing, as well as improving the research quality. However, according to the results of the analysis of the main research groups, the most productive authors are independent authors (grey nodes in Figure 4), and the scale of such cooperation is nevertheless small and unstable, lacking effective international exchange and cooperation.

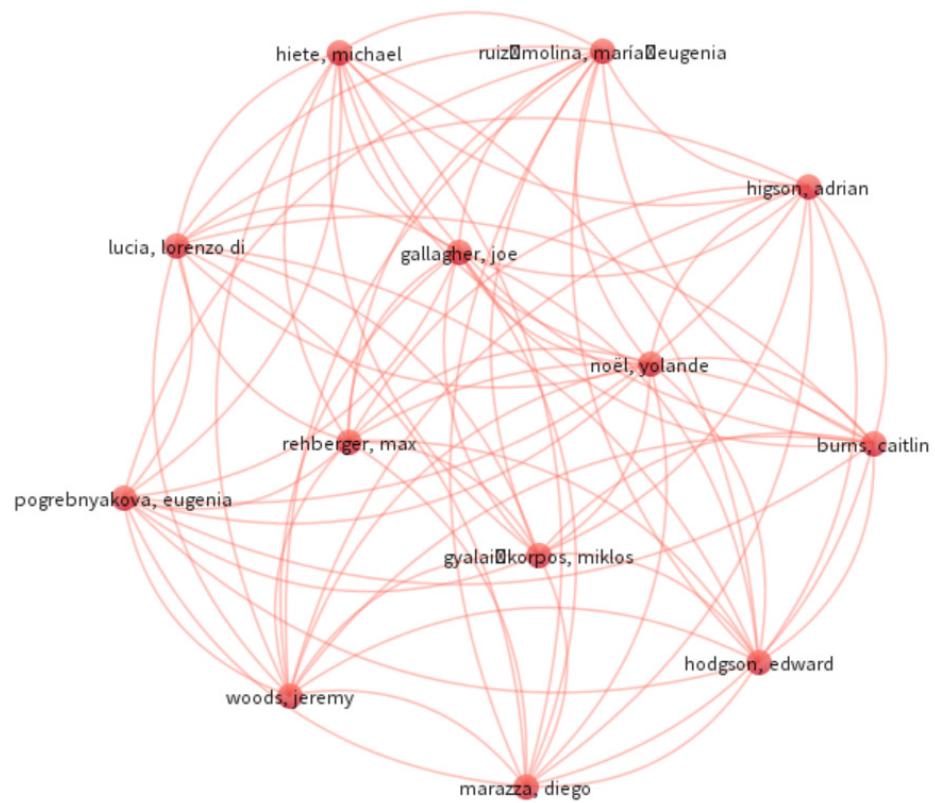


Figure 3. Co-Authorship Network.

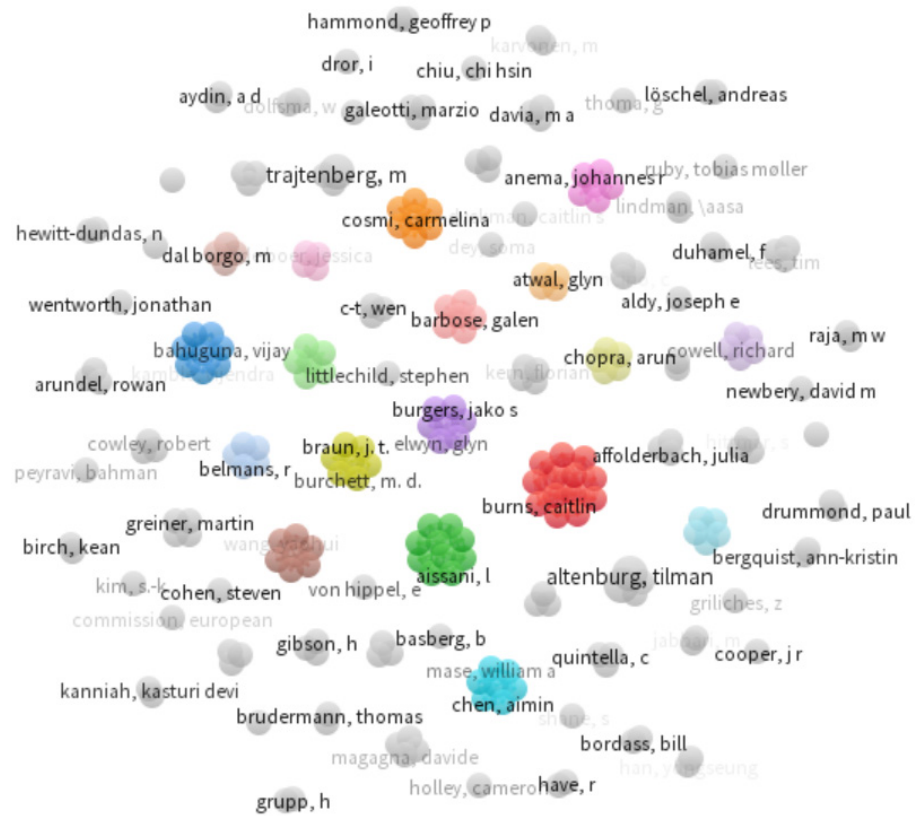


Figure 4. Co-Authorship Analysis.

4. Delphi Study of the Research Trends That Emerged from the Systematic Literature Review

4.1. Data Analysis and Results

The experts that participated in the data collection for the research trends that emerged from the systematic literature review are distributed as follows in Table 4:

Table 4. Background information on the experts.

Type of Expert	N	%
Academics	14	41%
Practitioners	9	26%
Researchers	7	21%
Policy Makers	4	12%
Total	34	100%

4.2. Data Analysis of the Research Trends in the Technologies Applied to Urban Greening

To analyze the research trends in the technologies applied to urban greening, calculations were performed using the means and standard deviation based on the responses of the participants. Table 5 shows the different technologies applied to urban greening.

Table 5. Technologies Applied to Urban Greening.

Technology	Mean	S.D.
Artificial intelligence	6.86	0.79
Green technologies	6.65	1.04
Blockchain technology	6.54	0.98
Internet of things	6.46	0.95
Water intelligent system management	6.39	0.78
Intelligent transport	6.39	0.44
Waste management systems	6.11	0.93
Big data analytics	6.11	0.67
Robotics and drones	6.10	0.95
Intelligent systems	5.78	1.20
Virtual reality and augmented reality	5.43	0.96
Intelligent systems for smart agriculture	5.14	1.03
Intelligent technology for heritage	5.14	0.95
Green energy	5.11	0.77
Green digital products	4.89	0.78
Digital platforms	3.74	0.98

The data analysis shows that the main technologies (Top 10) considered by the experts as fundamental for urban greening are artificial intelligence, green technologies, blockchain technology, internet of things, water intelligent system management, intelligent transport, waste management systems, big data analytics, robotics and drones, and intelligent systems.

These technologies will be confirmed by the policy analysis presented in the next section of the article.

5. Policy Analysis of Urban Greening

The analysis of public policies can be structured, along with several actions (Table 6), beginning with the definition of the problem, which is normally associated with different stakeholders (citizens, public administration, companies, and others), the identification of potential solutions so as to analyze the problem, the definition of policies that can be used to solve the problem, the policies' implementation, and the evaluation of the policies by considering their impacts. In recent years, public policies regarding urban greening have evolved as the countries in the European Union have focused on the sustainability of the cities. Public policies play an important role in promoting programs that contribute to the

improvement of the ways in which countries, municipalities, and organizations invest in the promotion of urban greening.

Table 6. Policy Analysis of Public Policies Applied to Urban Greening.

Public Policies Actions	Description
<i>Policy 1st Action</i> Problem Identification regarding the Stakeholders	Citizens Public Administration Companies Society
<i>Policy 2nd Action</i> Mapping the Dimensions of Policies for Urban Greening and the Technologies	Map the Dimensions of Policies for Urban Greening Identify Technological Challenges and Solutions
<i>Policy 3rd Action</i> Implementation of the Policies	Identify Resources Needed, e.g., Funding Programs Facilitators Obstacles
<i>Policy 4th Action</i> Evaluation of the Impacts on Stakeholders	Positive Impacts Negative Impacts

5.1. Policy Analysis 1st Action: Problem Identification regarding the Stakeholders

The policy cycle begins with the definition of a problem, and in this specific case, the problems regard the urban greening strategies of the cities. Policies try to eliminate or minimize the existing problems in society regarding the citizens’ lifestyles, health, and quality of life. Moreover, the problems regard the public administration, namely, the municipalities, as well as the companies and other organizations.

5.2. Policy Analysis 2nd Action: Mapping the Dimensions of Policies for Urban Greening and the Technologies

In the analysis, we identify the most important technologies for urban greening (Table 7) according to the dimensions of the public policies identified in the literature review and through (a) written documents, such as official reports, other documents, and discussion groups; (b) visual tools, using models, illustrations, or data visualization tools; (c) the spoken word, such as recordings and person-to-person interactions; (d) video/observation, using video databases and videoconferences; and (e) the combination of all of the above.

Table 7. Technologies Applied to Urban Greening. **Description of Technologies from the Literature Review and the Policy Analysis.**

Dimensions	Public Policy Goals	Technologies
Urban innovation	Promote and support the establishment of networks and niches of entrepreneurship and urban innovation at the local level, boosting pilot test and demonstration territories, urban living laboratories, business incubators, and business nests, and promoting the urban integration of business and technological parks.	Virtual Reality and Augmented Reality
	Strengthen the links between cities and their seafronts and riverine and fishing centers, contributing to the blue economy of coastal urban areas in several dimensions, of which blue energy, aquaculture, sport, blue recreation, and coastal maritime tourism and cruises stand out.	Artificial Intelligence, Robotics, and Drones
	Invest in the green economy as a way of operationalizing sustainable development and focus on the role that public procurement plays in this context, encouraging the adoption of low-carbon strategies by companies and institutions based in the city, environmental protection, and efficiency in the use of resources, and enhancing the innovation, research, and development of business models, production processes, and more sustainable products.	Green Technologies, Green Energy

Table 7. Cont.

Dimensions	Public Policy Goals	Technologies
Digital technologies	Encourage the adoption of innovative urban solutions of a social and technological nature that can be applied to urban spaces, promoting, in partnership with civil society, the provision of goods and services better adjusted to local demands.	Digital Platforms, Green Digital Products
	Design and implement intelligent systems for the monitoring and integrated management of urban subsystems that enhance gains in equity, efficiency, and reliability.	Artificial Intelligence, Internet of Things, Big Data Analytics
	Develop electronic solutions aimed toward the better governance and performance of urban functions, including information and access platforms for public services, citizen participation and collaboration between urban actors, and new models of employment and commercial relations, ensuring their alignment with the specific needs and capacities of the various sections of the population.	Intelligent Systems, Digital Platforms, Green Digital Products, Big Data Analytics
Urban environment	Fostering the creation, qualification, integration, accessibility, and readability of urban outdoor spaces, constituting systems of collective spaces, including squares, wooded sidewalks, pedestrian areas, traffic calm zones, vegetable gardens, gardens, farms, and parks, valuing their functions as areas for recreation, leisure, sociability, culture, and sport, enhancing their role in the micro-climatological balance, ecosystems, biogeochemical cycles, biodiversity and landscape, and contributing to green infrastructure.	Internet of Things, Blockchain Technology, Smart City Management Technologies
	Limit urban pressure on water resources, promoting the improvement of urban water balance, water stress management, the rationalization of public, domestic, and industrial consumption, reuse of grey- and rainwater, and the environmental requalification of industrial effluents.	Internet of Things, Water Intelligent System Management, Big Data Analytics
	Increase the efficiency of the urban metabolism, assuming the priorities of reducing and valuing waste as a resource, expanding the framework of solutions for the reuse and recycling of energy and organic recovery of waste, and promoting the consumption of local products and the fight against waste.	Waste Management Systems, Internet of Things, Blockchain
Urban–rural integration	Stimulate the interaction between cities and their rustic surroundings, including agricultural and forestry areas of the hinterland and urban–rural interfaces, exploring the economic, social, and cultural complementarities that result from this proximal relationship, improving transport and logistic conditions, and promoting the supply of regional production, particularly in the fruit and vegetable sector.	Internet of Things, Intelligent Systems for Smart Agriculture, Green energy, Drones, and Robotics
	To prevent the indiscriminate proliferation of dispersed buildings in rustic soils, especially housing, preventing urban economies, and promote the allocation of these soils to productive activities, namely agriculture and forestry, demotivating their abandonment and helping to neutralize adventitious searches and interests.	Internet of Things, Drones, and Robotics
	Enhance metropolitan wild spaces, creating or requalifying recreational and leisure parks, multi-use forest parks, and route networks in the areas of influence of cities, increasing the awareness of the urban population in regard to natural values.	Internet of Things, Drones, Robots, Intelligent transport
	Promote investment in urban green infrastructure and urban–rural and urban–urban interfaces based on natural capital and social, economic, and environmental services provided by ecosystems, and promote urban integration, valuing river, lagoon, and marine ecosystems and the related economic activities.	Artificial Intelligence, Intelligent Water System Management, Drones and Robotics
	Boost the economic and social valorization of natural heritage, protected areas, and areas classified for nature conservation, promoting in an urban environment and the products and services associated with these areas, and reinforcing their fundamental role in the defense of biodiversity and the affirmation of the city region.	Intelligent Technology for Heritage Monitoring and Management, Big Data Analytics

Table 7 also shows the technologies that support urban greening applications. Technologies are designed to improve the performance of investments in the energy used for

buildings and equipment in existing public spaces. This supports the creation of networks of urban thermal energy and the promotion of energy efficiency investments, together with the possible adoption of renewable sources in cities for the purpose of self-consumption.

These technologies aid in the recovery and monitoring of ecological urban systems and green infrastructure; public space qualification; and the monitoring of the air quality and noise so as to implement measures for its reduction. Additionally, they are applied to equipment so as to increase its efficiency (for example, lighting, windows, insulation, green heat, and energy management systems in service buildings).

Technologies such as virtual reality and augmented reality help to create prototypes and analyze the best contexts for the implementation of public policies. Artificial intelligence, robotics, and drones help to perform many activities that are difficult for human beings and related to the implementation of vertical urban greening, monitoring of the blue ocean economy, and the water systems. Green technologies and green energy are important for reducing the pollution in the cities and improving the quality of life of the citizens. Digital platforms and digital products help to reduce carbon emissions, as they help to reduce traffic and promote the creation of new technologies and new models of work and management. Big data analytics and intelligent systems help to introduce better systems for the management of the cities, such as blockchain technology and the internet of things, which can be used in waste management systems and the water management systems and in the optimization of the cities' energy and urban greening sites.

Public policies present several challenges to organizations and citizens regarding the need for technologies for urban greening. Public policies promote the transfer of technology and knowledge, social innovation, applications of public interest, networks, clusters, and open innovation through intelligent specialization in cities and other urban areas.

5.3. Policy Analysis 3rd Action: Implementation of Public Policies for Urban Greening

The implementation of policies can potentiate the economies, and their organization and effective implementation are realized through the available funds to promote the sustainability of cities and urban systems. There are several areas associated with sustainable urban development that the European Commission has selected as priorities, including the promotion of a low-carbon economy; environmental protection and resource efficiency; risk management and prevention of, as well as adaptation to, climate change; competitiveness and innovation; urban regeneration; and social inclusion. The ESI funds include the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund (CF), and the logic of multi-fund financing. Given the importance of the ERDF in this area, it has been established that at least 5% of these funds, across the framework, will have to be applied to sustainable urban development actions, thereby raising the need for a common reference framework certifying investments in this typology. The ESIF finances the operational programs (OP) covering, inter alia, four thematic OPs (competitiveness and internationalization—POCI, social inclusion and employment—POISE, human capital—POCH, and sustainability and efficiency in the Use of resources—POSEUR) and regional OPs. ESIF funding sources are complemented with or form part of investment solutions managed on the European level, such as Horizon 2020, INTERREG (Europe, MED, SUDOE, POC—TEP), Atlantic Area, COSME, LIFE, and URBACT III, and the European Fund for Strategic Investments, among others.

5.4. Policy Analysis 4th Action: Evaluation of the Impacts on Stakeholders

Policies regarding urban greening impact several stakeholders in many different positive and negative ways. Nevertheless, the outcome of the policies is very important for the sustainability of the cities. Companies design projects to access funding through public policies and invest in innovation and research regarding urban greening. For citizens, it is important to qualify and modernize spaces, equipment, and the urban environment, including green spaces and urban furniture, as well as the recovery, expansion, and valorization of urban ecological systems and structures and green infrastructure. The impacts

are also important, as policies integrate innovation programs focused on citizens and based on social experimentation and territorial animation for the purposes of active inclusion and aging, involving subregional social networks, local contracts for social development, and project municipal and intercultural mediators in public services.

6. Recommendations to Policy

From the literature review and the policy analysis, it was possible to identify some recommendations for urban greening policymakers, as follows:

- (a) Increase public and private investment, including R&D and digital infrastructure, to promote urban greening.
- (b) Support public–private partnerships as successful models for the forced financing of urban greening.
- (c) Strengthen collaborative research and innovation projects to facilitate the process of conceiving new ideas, technologies, and processes to render cities more sustainable and greener.
- (d) Support the development of new collaborative strategic projects between countries to improve the knowledge and learning process in regard to urban greening techniques and processes.
- (e) Implement a strategy to take advantage of emerging technologies for a better quality of life in the cities.
- (f) Promote the competitiveness of companies concerned with urban greening principles.
- (g) Facilitate innovation in start-ups regarding urban greening projects to transform cities.
- (h) Promote the use of artificial intelligence technology, big data, and real-time data to conceive, implement, and monitor urban greening projects.
- (i) Flexible regulatory systems regarding urban greening processes and projects.
- (j) The transformation of cities based on a greener strategy must be in line with the population needs and aligned with the strategic vision of governments for their countries.

7. Final Considerations

The ultimate goal of public policies leading to sustainable development is to actively contribute to the improvement of the quality of life of populations. Thus, for the effective implementation of urban greening policies, it is essential to establish useful tools for their implementation and monitoring. Important factors for the definition and implementation of public policies are the programs defined and the funding for urban greening development, with an emphasis on national and integrated territorial approaches.

The promotion of networks and platforms of knowledge of urban greening, as well as the dissemination of good practices, are fundamental for the evolution of knowledge, and this was what this article accomplishes, namely, the possibility of systematizing the existing bases of research on public policies for urban greening and the systematization of the main public policies axes on the European level.

The main conclusions are that urban greening can benefit urban centers, together with the non-urban environment, through their functional influence, namely the agricultural areas of the hinterland, the forest spaces surrounding the cities, and the rural and rural interfaces. Urban greening policies aim to strengthen territorial cooperation and enhance complementarities and adaptability, as well as productive and favorable access to the main international territories and markets. Moreover, they promote the integration and enhancement of the set of urban physical supports (built parks, infrastructure, environmental and landscape conditions) and promotion of the functional, cultural, social, and economic development of urban areas, achieving strategic solutions based on compromise and operational interactions between the various territorial agents (public, private, and associative). They also are focused on strengthening the sustainability of the urban development model, enhancing the base of endogenous resources, promoting the efficiency of subsystems (energy, mobility, water, and waste), and improving the capacity to respond to risks and impacts, namely those related to climate change.

Moreover, from the research results, it was possible to conclude that technologies support the development of urban thermal energy networks, the promotion of energy efficiency investments, and the potential adoption of renewable sources in cities for the purpose of self-consumption. The technologies are designed to increase the performance of investments in the energy used for buildings and equip existing public spaces. They support the restoration, monitoring, and implementation of noise reduction strategies, as well as the certification of public spaces, ecological urban systems, and green infrastructure. Additionally, they are applied to machinery to boost its efficiency (for example, lighting, windows, insulation, green heat, and energy management systems in service buildings).

Artificial intelligence, robotics, and drones assist in many tasks that are difficult for humans to complete, such as monitoring the blue ocean economy and water systems, creating prototypes, and analyzing the best contexts for the implementation of public policies. Green technologies and green energy are crucial for reducing pollution in cities.

The quality of life in green cities is enhanced by the use of technology, such as digital platforms and goods, which also lessen traffic and promote the development of new technologies and management and work models, thus also contributing to a reduction in carbon emissions. Blockchain technology, the internet of things, and other systems utilized in waste and water management, as well as in the optimization of city energy and urban greening sites, all contribute to the introduction of improved methods for the management of cities. The demand for technologies for urban greening is a challenge that public policies provide to organizations and citizens. Public policies promote social innovation, applications, and the transfer of knowledge and technology.

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