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Digital Technologies for Urban Greening Public Policies

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Abstract

Digital technologies and public policies are fundamental for cities to define their urban greening strategies, and the main goal of this research is to identify in the literature and official documents the applied digital technologies and the public policies dimensions implemented at the national level by the member states to promote urban greening. The methodology used is a Systematic Literature Review (based on international studies), a Delphi study with experts, and a Policy Analysis, to understand how the Portuguese government has implemented policies and which are the main applied technologies to urban greening. The main findings are regarding (i) the focus on the interaction of actors in policymaking. (ii) Interpretive approaches examine the application of technologies in urban greening problems; and (iii) how policies reflect the social construction of 'problems'. The research will focus on how policy analysis provides a powerful tool to understand the technologies, the actions, interests, and political contexts underpinning policy decisions.

JEL Classification: O32; O38; Q55

Keywords: Technologies, Urban Greening Strategies, Policy Analysis, Public Policy

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1. Introduction

Urban greening public policies have an essential role in influencing the sustainability of the cities. The concept 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 (Thompson, 2002). Urban green spaces are an important component of the complex urban ecosystem. Parks, forests, and farmlands are three main types of urban greenspace, which have significant ecological, social, and economic functions (Bradley, 1995; Shafer, 1999; Tyrvainen, 2001; Lutz and Bastian, 2002). Other common urban greenspaces 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. and for the sustainability of urban greening of the cities (Jim, 2001); and vertical greening is a strategy for high-density development and limited land, and it includes roof gardens, wall greening, balcony greening, and windowsill greening. Vertical greening can augment the greenspace of the cities to enhance the ecological goals, and increasing green space (Xu et al., 1999).

Moreover, the green parks is an effort to create a natural forest structure, including trees, shrubs, and herbs, to improve the greening condition of the cities (Flores et al., 1998)

An important indicator of urban greening is the greenspace coverage (the percentage of green land area on a spot), however, it does not reflect the quality of the green structure, nor does it represent the variety of ecosystem services of greenspace. In addition, the indicator of the green plot ratio can provide an effective method to assess the quality of greening in urban planning (Ong, 2003). Both indicators can help the urban planning policies for more sustainable development (Diamantini and Zanon, 2000). The urban greening policies can reduce the complexity of introducing in the city ecosystem models of management of urban green spaces (Shafer, 1999; Landelma et al., 2000; Pauleit and Duhme, 2000).

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

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

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

The main innovation of the article was mapping the articles published about urban greening public policies and the main actions taken in the different countries. This can contribute to other countries to replicate some of these actions and help them to define the urban greening strategies for the cities. It specifically discusses what is known about green urban policies, from a social perspective, with the participation of 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 practices and innovative technologies.

In sum, this article's main goal is to make a global overview of the public policies oriented to programs that incentives urban greening and the sustainability of the cities with emerging technologies applications. It begins with a systematic literature review, followed by a Delphi Study and then a policy analysis, finishing with recommendations for policymakers.

2. Methodology

Based on the unique nature of urban green studies and the need for them to intersect with public policies and technology, this research conducted a systematic review of the literature using the terms "urban green*", and "technology*," and "polic*" using b-On scientific engine search. The usage of the Boolean operator "and" was motivated by the need to find policies and technologies that might be used for urban greening. Given the large scope of the word "polic*", we chose to search in the title to avoid the occurrence of irrelevant results. Searching by title rather than topic field is a trend demonstrated in several studies (e.g. Álvarez-García et al. (2018); Amin et al. (2019); Coetzer et al. (2017); Huang et al. (2020); Leong et al. (2020); Peng et al. (2018).

The period chosen was until 2015 up to the moment of the survey (June 2021), 89 studies were retrieved. Based on this, a network analysis was created using Vosviewer software and a content analysis of official documents of public policies and technologies applied to urban greening was accomplished using a Model of 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; 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.

Step 1 - Keyword co-occurrence analysis

For the keyword occurrences, the themes were verified through network analysis, using Vosviewer software to do a Scientometrics study for mapping knowledge domains. VOSviewer allows mapping the knowledge domains in images which shows the development process and structural relationship on the scientific knowledge. It shows complex relationships including network, structure, interaction, intersection, evolution, or derivative among knowledge units of knowledge clusters. The mapping knowledge domains include 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 the statistics of how many times two documents are cited by one or more papers at the same time, to conduct a network analysis for 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 a pair of keywords is mentioned in the same document is used to do network and cluster analysis for 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 over time in a specific research field, which may be used to investigate a topic's development pattern. Although each keyword may be used significantly less frequently than in the burst detection analysis based on threshold values, the burst keywords can be detected based on the change in keyword frequencies over time, and so the latest research trend can be predicted through such keywords.

Step 2 – Delphi Study to validate the technologies applied to urban greening

This is an exploratory quantitative study using a questionnaire as the primary source of data collection, applied to 34 academics and experts. The questionnaire was based on the Systematic Literature Review, to validate the technologies applied to urban greening, as discussed above in the literature review. The questionnaire is a scale of seven choices for the evaluation of all statements, ranging from ‟disagree completely″ (1) to ‟agree″ (7). The respondents represent 34 academics and experts in the field of technologies applied to urban greening.

Step 3 - Public policy analysis

We analyzed, through inductive content analysis (Bardin, 1977), 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, public policies as a tool to understand values and interests and sustain political decisions. In an operational procedure, it was used the Berg (1989) approach to content analysis technique "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 was used for that purpose, which is designated as MAXQDA. More specifically the criteria used for the categories/dimensions defined was the following (suggested by Bardin, 1977): - 1st criterion: categories need to be valid, relevant, or appropriate; - 2nd criterion (of completeness or inclusivity): the categories must have the possibility 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, it was followed Eden et al.'s (1977) policy analysis methodology helped to identify potential recommendations to policymakers as a methodology suggested by (El-Jardali et al., 2014). To clarify the sources, it is important to refer that the policy analysis was made based on available official documents from EC and National entities.

3. Systematic Literature Review

The methods for this systematic review follow the guidelines detailed by the PRISMA methodology as an evidence-based set of items for reporting in systematic reviews and meta-analyses. This research follows the main phases of PRISMA methodology including the background of the study, the primary goals, the data sources and the eligibility criteria, the methods, the results, and then 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*", and "technolog*," and "polic*".

The criteria for this study's selection were the following: a) studies which involved technologies in urban greening; b) there were also restrictions on language (only English). Moreover, the papers need to c) have full-text available and d) be published after 2015.

Table 1 Number of Articles Found Per Query

Keywords "urban green*", and "technolog*," and "polic*"
Number of Scientific papers 2, 376
Number of Scientific papers in Science Direct since 2015, (2015–2021) 172
Peers reviewed journals 99
Language English 87

3.2. Results of the papers search

The number of papers found with these queries is 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 2, 376 to 172 (Table 1). The final methodologic decision was to consider only peer-review papers (99 papers), and with the English language. This resulted in 87 papers (n = 87) for the current research.

The systematic literature review helped to respond to the research questions: Rq1: "Which are the main Public Policies 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 presents also the applied technologies, and the authors of the papers considered in the literature review.

Table 2 Dimensions of Urban Greening Policies, and Technologies by Authors

Dimensions	Technologies	Authors
Urban innovation	Virtual reality and Augmented Reality	(Affolderbach et al., 2018; 2019) (Aldy, 2016) (Altenburg et al., 2016) (Barbose et al., n.d.) (Basberg, n.d.) (Bergquist & S uc0 u246{}derholm, n.d.) (Birch & Calvert, 2015) (Brudermann & Sangkakool, 2017) (Bryson et al., 2016) (Cavdar & Aydin, n.d.) (Chiu, 2017) (R. Cohen & Bordass, 2015) (S. Cohen, 2015) (Commission, n.d.) (Cooper, n.d.) (Cowley et al., n.d.) (Dal Borgo et al., n.d.) (de Boer et al., 2018) (Dey, n.d.) (Di Stefano et al., n.d.) (Dror, n.d.) (Drummond & Ekins, 2016) (Duhamel & Santi, n.d.) (Dvarioniene et al., 2015)
	Artificial Intelligence, Robotics, and Drones	
	Green technologies, green energy	
	Digital platforms, green digital products	
Digital technologies	Artificial Intelligence, Internet of Things, Big Data Analytics	
	Intelligent Systems, Digital platforms, green digital products, Big Data Analytics	
Urban environment	Internet of Things, Blockchain Technology, Smart cities Management Technologies	
	Internet of Things, Water Intelligent Systems Management, Big Data Analytics	
	Waste Management Systems, Internet of things, Blockchain	
Urban-rural integration	Internet of Things, Intelligent Systems for Smart Agriculture, Green	

Dimensions	Technologies	Authors
	energy, Drones and Robotics	(Dyckman, 2016) (Ferrara, 2015) (Geth et al., 2015) (Giezen et al., 2018) (Griliches, n.d.) (Grupp & Schubert, n.d.) (Hammond & O uc0 u8217{}Grady, n.d.) (Hannon et al., 2015) (Hittmar et al., n.d.) (Hodgson et al., 2016) (Holley, 2016) (Irga et al., 2017) (Jaffe et al., n.d.) (Kanniah & Siong, 2017) (Karvonen & K uc0 u228{}ssi, n.d.) (Kelly-Detwiler, 2015) (M. H. Kim & Han, 2015) (S.-K. Kim, n.d.) (Kulkarni et al., 2017) (Lazarevi uc0 u263{}, n.d.) (Li et al., 2017) (Lindman & S uc0 u246{}derholm, 2016) (Littlechild, 2016) (Makkonen & Have, n.d.) (Manders et al., 2016) (Merig uc0 u243{} et al., n.d.) (Muscio et al., 2015) (Newbery, 2016) (Padmore et al., n.d.) (Pettigrew & Fenton, n.d.) (Peyravi, n.d.) (PEYRAVI, 2015)
	Internet of Things, Drones, and Robotics	
	Internet of Things, Drones, and Robots, Intelligent transports	
	Artificial Intelligence, Water Intelligent Systems Management, Drones and Robotics.	
	Intelligent Technology for heritage monitoring and management. Big Data Analytics.	

Dimensions	Technologies	Authors
		(Pitk uc0 u228{}nen et al., 2016) (Pittens et al., 2015) (Portney et al., n.d.) (Rainville, 2017) (Raja & Wei, n.d.) (Raunbak et al., 2017) (Rocha et al., n.d.) (Roper & Hewitt-Dundas, n.d.) (Rubashkina et al., 2015) (Ruby, 2015) (Scarpellini et al., 2016) (Schmitz & Altenburg, 2016) (Schweber et al., 2015) (Seeberger et al., 2016) (Sgobbi et al., 2016) (Shane, n.d.) (Strachan et al., 2015) (Therrien & Mohnen, n.d.) (Thoma, n.d.) (Tohidi & Jabbari, n.d.) (Trajtenberg, n.d.) (Triguero et al., n.d.) (Van Den Ende & Dolfsma, n.d.) (Verhees et al., 2015) (Vermunt et al., 2018) (Von Hippel, n.d.) (Wentworth, 2017) (Wright et al., 2016) (Y-S. et al., n.d.) (Yu et al., 2017) (Zhou et al., n.d.)

The main dimensions of urban greening policies are urban innovation, information and communication technologies, 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, water intelligent systems 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 authors will be presented and analyzed in the following topics.

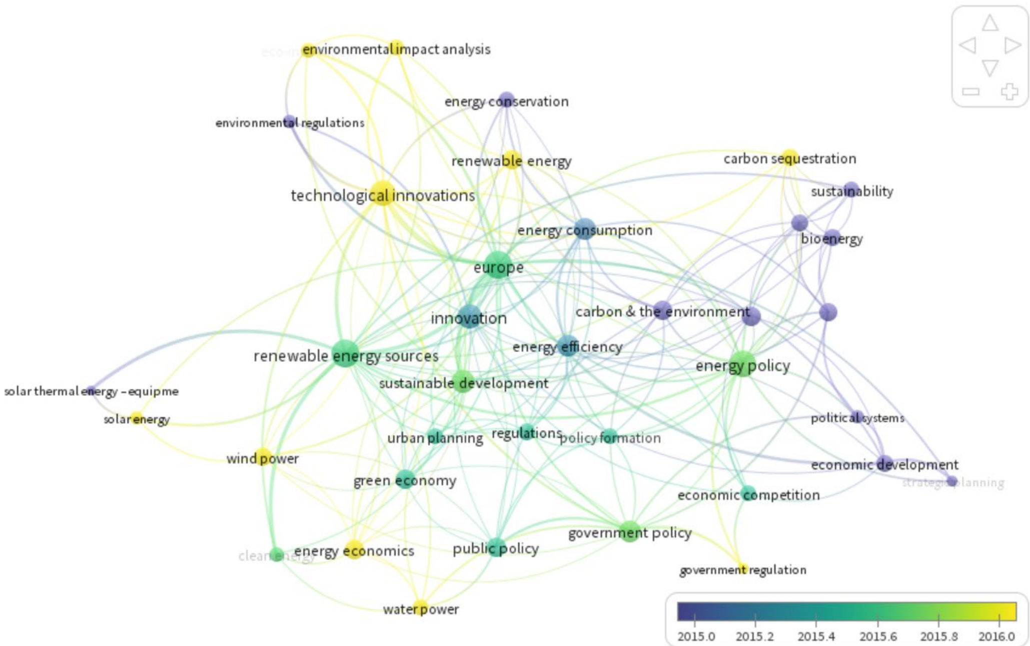
3.3. Data network and discussion

All the papers were analyzed with Mendeley (Elsevier), and the final 87 papers constituted the final database that was saved in .ris format to be uploaded by the VOSviewer, to analyze the co-authorship and the occurrence of the keyword.

3.3.1. Keywords Occurrence

Vosviewer is a program for creating networks and analyzing the strength of associations between variables.

Figure 1- Keywords Occurrence Network



As a result, the strongest link strength between the keywords, based on equal distance, is significant. The main keywords are:

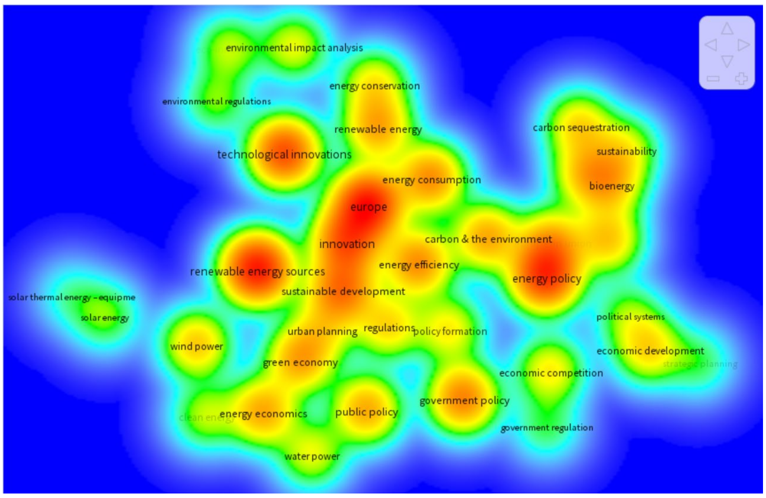
Table 3 – Keywords Occurences and Links Strenght

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 & 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. Keywords Occurrence Intensity

Regarding the keywords occurrence intensity, it is defined by the number of occurrences of the keywords. The red, orange and yellow colors represent the keywords with a high level of occurrences:

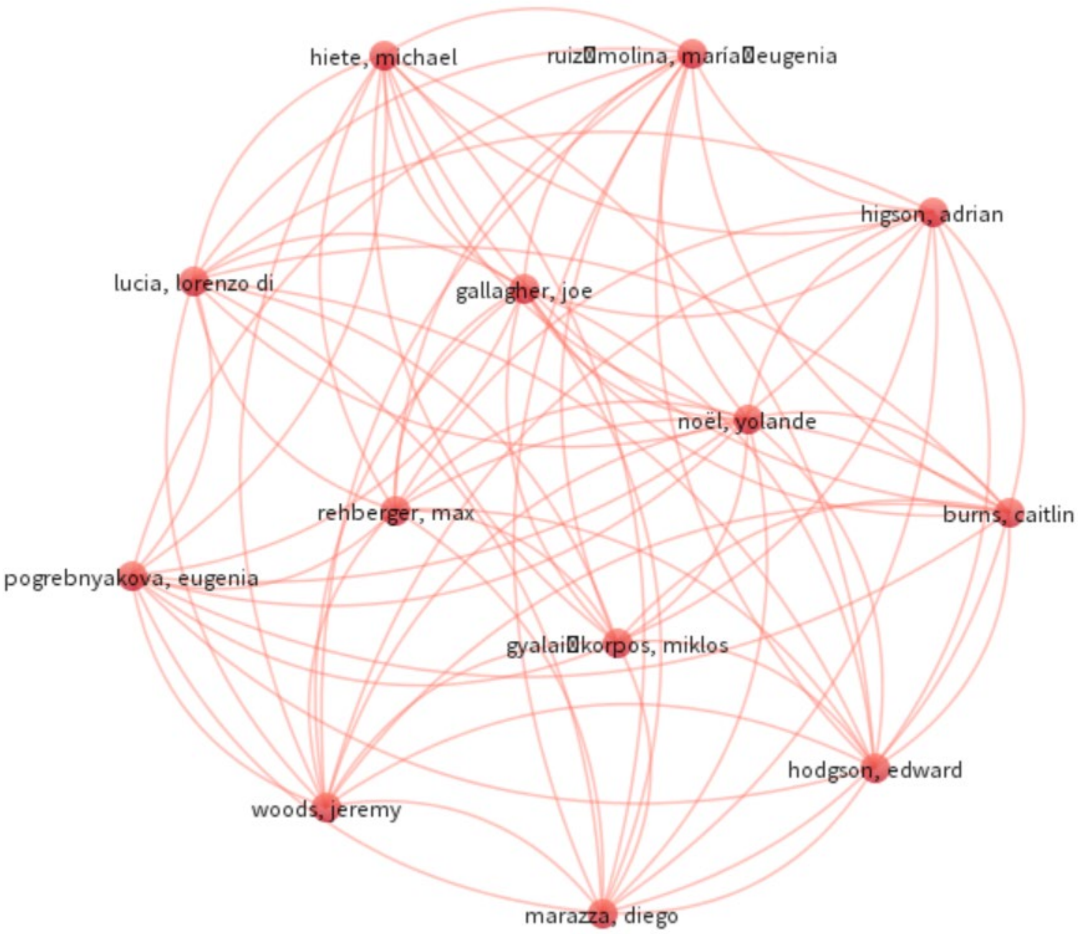
Figure 2 - Keywords Occurrence Intensity



3.3.3. Co-Authorship Network

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

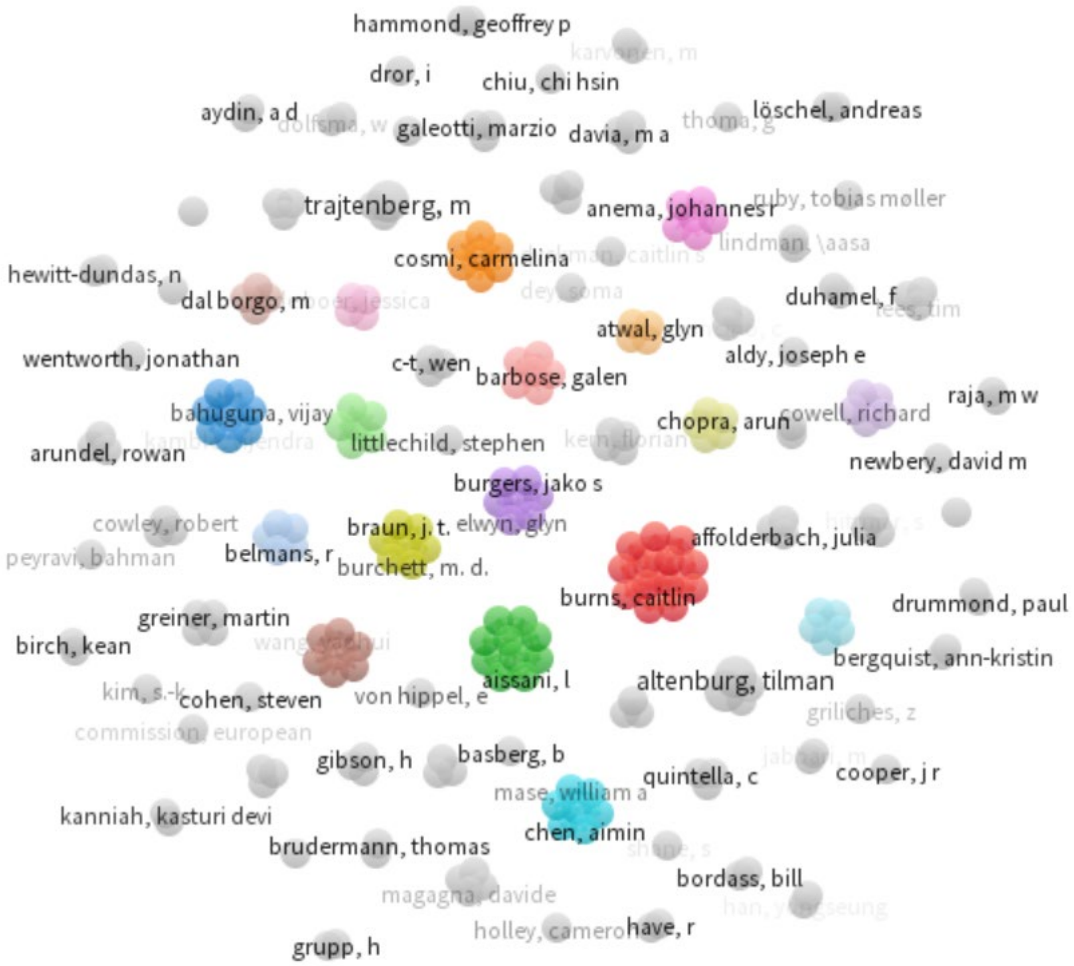
Figure 3 - Co-Authorship Network



3.3.4. Co-Authorship Analysis

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

Figure 3 - Co-Authorship Analysis



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

4.1. Data Analysis and Results

The experts that participated in data collection for 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 on Technologies Applied to Urban Greening

To analyses, the research trends on technologies applied to urban greening calculations were made with the Means and Standard Deviation among the responses of the participants. The Mean calculation is based on the following formula to measure the average of the numbers:

$$\bar{X} = \Sigma x N$$

where:

Σ represents the summation

X represents scores

N represents a number of scores.

The Standard Deviation calculation is based on the following formula to measures the spread of the data about the mean value:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

where:

σ = standard deviation

Xi = each value of dataset

μ = the arithmetic mean of the data

N = the total number of data points

$\sum (X_i - \bar{x})^2$= The sum of $(X_i - \bar{x})^2$ for all datapoints

Table 6 studies the different Technologies Applied to Urban Greening.

Table 6. 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 systems management	6.39	0.78
Intelligent transports	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 systems management, Intelligent transports, Waste management systems, Big data analytics, Robotics and drones, 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 7), beginning with the definition of a problem, normally, associated with different stakeholders (citizens, public administration, companies, and others), the identification of potential solutions to analyze the problem, the definition of policies to solve the problem, policies implementation, and the evaluation of the policies considering the impacts. In the last years, Public policies regarding urban greening have evolved as the countries in European Union are focused on the sustainability of the cities. Public Policies play an important role by promoting programs that contribute to improving the way countries, municipalities and organizations invest in promoting urban greening.

Table 7 – Policy Analysis of Public Policies Applied to Urban Greening

Public Policies Actions	Description
Policy 1st Action Problem identification regarding the Stakeholders	Citizens
	Public Administration
	Companies
	Society
Policy 2nd Action Mapping the Dimensions of Policies for Urban Greening and the Technologies	Mapp the Dimensions of Policies for Urban Greening
	Identify Technological challenges and solutions
Policy 3rd Action Implementation of the Policies	Identify Resources needed – funding programs
	Facilitators
	Obstacles
Policy 4th Action Evaluation of the Impacts on Stakeholders	Positive impacts
	Negative Impacts

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 are regarding 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; also, the problems regarding the Public Administration, namely, the municipalities, and also the companies, and other originations.

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

Identify the most important technologies for urban greening (table 8) according to the dimensions of Public Policies identified in the literature review and through a) written documents as official reports, other documents, and discussion groups. b) visual: using models, illustrations, or data visualization tools; c) spoken word: recordings, and person-to-person interaction; d) video/ observation: video database, and videoconferences; e) combination of all of the above.

Table 8 – Technologies Applied to Urban Greening
Confrontation 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 link between cities and their seafronts and riverine and fishing centers, contributing to the blue economy of coastal urban areas, on several sides, of which blue energy, aquaculture, sport, and blue recreation, and coastal maritime tourism and cruises stand out.	Artificial Intelligence, Robotics, and Drones
	Bet on the green economy as a way of operationalizing sustainable development and on the role that public procurement has in this context, encouraging the adoption, by companies and institutions based in the city, of low carbon strategies, environmental protection, and efficiency in the use of resources, and	Green technologies, green energy

Dimensions	Public Policy goals	Technologies
	enhancing innovation, research and development of business models, production processes and more sustainable products.	
	Encourage the adoption of innovative urban solutions applied to urban space, of a social and technological nature, promoting, in partnership with civil society, the provision of goods and services better adjusted to local demand.	Digital platforms, green digital products
Digital technologies	Design and implement intelligent systems for 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 at 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 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 free of recreation, leisure, sociability, culture, and sport, enhancing their role in the	Internet of Things, Blockchain Technology, Smart cities Management Technologies

Dimensions	Public Policy goals	Technologies
	micro climatological balance, ecosystems, biogeochemical cycles, biodiversity and landscape, and contributing to green infrastructure;	
	Limit urban pressure on water resources, promoting the improvement of urban water balance, water stress management, rationalization of public, domestic, and industrial consumption, reuse of grey and rainwater, and environmental requalification of industrial effluents;	Internet of Things, Water Intelligent Systems Management, Big Data Analytics
	Increase the efficiency of urban metabolism, assuming the priority of reducing and valuing waste as a resource, expanding the framework of solutions for reuse, recycling and 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 articulation 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 proximity relationship, improving transport and logistics 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 building in rustic soils, especially for housing, preventing urban economies, and promote the allocation of these soils to	Internet of Things, Drones, and Robotics

Dimensions	Public Policy goals	Technologies
	productive activities, namely agricultural and forestry, demotivating their abandonment and helping to neutralize adventitious searches and interests;	
	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 to natural values;	Internet of Things, Drones, and Robots, Intelligent transports
	Promote investment in urban green infrastructure and urban-rural and 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 related economic activities;	Artificial Intelligence, Water Intelligent Systems Management, Drones and Robotics.
	Boost the economic and social valorization of natural heritage, protected areas and classified for nature conservation, promoting in an urban environment 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 8 also shows the technologies that support urban greening applications. Technologies are designed to improve the performance investments in the energy of buildings and equipment existing public spaces; it supports the creation of networks of urban thermal energy; promotion of energy efficiency investments with the possible adoption of renewable sources in cities and for self-consumption.

They help on the recovery, and monitoring of ecological urban systems and green infrastructure; public space qualification; monitoring the air quality and noise to implement measures for its reduction. And they are applied to equipment to increase efficiency (for example lighting, windows, insulation, green heat, and energy management systems in buildings of services).

Technologies as virtual reality and augmented reality help to create prototypes, and analyze the best context for the implementation of the public policies; artificial intelligence, robotics, and drones help in so 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 to reduce the pollution in the cities and to improve the quality of life of the citizens; digital platforms and digital products help to reduce the carbon emissions, as they help to reduce traffic and push 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, like blockchain technology, and internet of things used in the waste management systems and the water management systems, and in the optimization of the cities energy and urban greening sites.

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

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

The implementation of Policies can potentiate the economies, and the organizations and effective implementation are made 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 selects as priorities, including the promotion of a low-carbon economy, environmental protection and resource efficiency, risk management and prevention and adaptation to climate change, competitiveness and innovation, urban regeneration, and social inclusion. The ESI Funds included 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 this fund 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, Sustainability, and Efficiency in the Use of Resources - POSEUR) and regional OPs. ESIF funding sources are complemented with or behind investment solutions managed at the European level, such as Horizon 2020, INTERREG (Europe, MED, SUDOE, POC - TEP), Atlantic Area, COSME, LIFE, and URBACT III, among others, and the European Fund for Strategic Investments.

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

Policies regarding urban greening impact several stakeholders in many different positive and also negative ways. Nevertheless, the outcome of the policies is very important for the sustainability of the cities. Companies design projects to access funding under the Public Policies and invest in innovation and research regarding urban greening. For citizens, it is important to the qualification and modernization of spaces, equipment, and urban environment, including green spaces and urban furniture; 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 active inclusion and aging, involving subregional social networks; Local Contracts for Social development; Mediators Project Municipal and Intercultural Mediators in Public services.

6. Recommendations to Policy

Decurrent from the literature review and the policy analysis it was possible to identify some recommendations for urban greening policymakers:

- Increase public and private investment including R&D and digital infrastructure to promote urban greening.
- Support Public-Private Partnerships as successful models for the forced financing of urban greening.
- Strengthen collaborative research and innovation projects to facilitate the process of conceiving new ideas, technologies, processes to make cities more sustainable and green.
- Support the development of new collaborative strategic projects between countries, to improve the knowledge and learning process about urban greening techniques and processes.
- Implement a strategy for taking advantage of emerging technologies, for a better qualify of life in the cities.
- Promoting the competitiveness of companies concerned with urban greening principles.
- Facilitate innovation in start-ups regarding urban greening projects to transform cities.
- Promote the use of artificial intelligence technology, Big Data, and real-time data to conceive, implement, and monitor urban greening projects.
- Flexible the regulatory systems regarding urban greening processes and projects.

The transformation of cities based on a greener strategy needs to be combined with the population needs and aligned with the strategic vision of governments for the countries.

7. Final Considerations

The ultimate goal of public policies leading to sustainable development is to actively contribute to improving 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 emphasis on national, but also integrated territorial approaches.

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

The main conclusions are that urban greening can benefit urban centers with the non-urban environment under their functional influence, namely as agricultural areas of the hinterland, the forest spaces surrounding the cities, and the rural and rural interfaces. Urban greening policies try to strengthen territorial cooperation, enhancing complementarities and adaptability, and productive and favoring access to the main international territories and markets. Moreover, they promote the integration and enhancement of the set of urban physical support (built park, infrastructure, environmental and landscape conditions) and promotion of functional, cultural, social, and economic development of urban areas, achieving strategic compromise solutions and operational 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 improved the capacity to respond to risks and impacts, namely the related to climate change.

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