# Analyzing citizen participation and engagement in European smart cities

*María E. Cortés-Cediel, Iván Cantador and Manuel Pedro Rodríguez Bolívar*

**Abstract**

With the advent of smart cities, governance has been placed at the core of the debate on how to create public value and achieve a high quality of life in urban environments. In particular, given that public value is rooted in democratic theory and new technologies that promote networking spaces have emerged, citizen participation represents one of the principal instruments to make government open and close to the citizenry needs. Participation in urban governance has undergone a great development: from the first postmodernist ideals of countering expert dominance to today's focus on learning and social innovation, where citizen participation is conceptualized as co-creation and co-production. Despite this development, there is a lack of research to know how this new governance context is taking place in the smart city arena. Addressing this situation, in this paper we present an exhaustive survey of the research literature and a deep overview of the experience in participative initiatives followed by smart cities in Europe. Through an analysis of 149 smart city initiatives from 76 European cities, we provide interesting insights about how participatory models have been introduced in the different areas or dimensions of the cities, how citizen engagement is promoted in smart city initiatives, and whether the so-called creative smart cities are those with a higher number of projects governed in a participatory way.

**Keywords**

## Introduction

Proponents and opponents of smart cities (SCs) have offered several arguments to promote or to reject the idea of these cities. While some of them indicate that "*making cities smarter can help*

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*optimize resource and infrastructure utilization toward increased sustainability*" (Santana et al., 2018), others point out that SCs have provoked bad consequences in the city concept mainly based on a technological determinism of the city (Calzada & Cobo, 2015). In any case, the rise of the information and communication technologies (ICTs) has contributed to the proliferation and development of new ways of understanding public management (Stoker, 2006; Anttiroiko, 2016). Specifically, they have encouraged the emergence of concepts such as e-government, which has not only allowed governments to provide more efficient and effective services to citizens (Singh 2015; Meijer , 2016), but also have contributed to the transparency and accountability of the administration (Bonsón et al., 2012; Simonofski et al., 2017).

Moreover, authors such as Lawson-Body et al. (2014) have highlighted the fact that e-government has a close relationship with e-participation and e-democracy, since citizens are transformed from passive subjects in decision making to active actors that influence in the government decisions, and demand more participatory, transparent and accountable processes (Pratchett, 1999; Stoker, 2006; Dimitriu, 2008; Bonsón et al., 2012). As stated by Stoker (2006), this has not only had implications on the understanding of the nature of public services, but also on the democratic theory. Opening the management of resources to the participation of different stakeholders makes the decision making an exchange process between governing and governed actors, which really considers the experience and real interests of all involved actors. Government thus goes from being the only actor exercising public competencies to being a coordinator among numerous actors (Bovaird, 2007, Andrés & Bonivento, 2009).

On the other hand, the SC models, characterized by human and technological infrastructures (Nam & Pardo, 2011, Oliveira & Campolargo, 2014, William et al., 2018), have not only been optimal for the implementation of e-services and e-government strategies (Dameri and Benevolo, 2016), but also for the promotion of new and innovative forms of governance based on the concept of network governance (Rodríguez Bolívar, 2015a),), and increasing the democratic participation of people in city

government to obtain higher consensus and a better quality of life in a social sense (Dameri, 2014). In fact, civic participation is the principal way of transforming government to make it open and close to the citizenry needs, and is one of the main objectives to reach within the context of the SC movement (Rodríguez Bolívar, 2016).

To achieve this aim, new technologies are required to give citizens an opportunity to actively participate in public decisions (Linders, 2012; Rodríguez Bolívar, 2018a, 2018b). It has made local governments to become key actors in the use of those technologies for creating an interactive-, participatory- and information-based urban environment with the ultimate aim at producing increasing wealth and public value, achieving a higher quality of life for citizens (Castelnovo et al., 2015).

Thus, as cities become fertile grounds for embedded new technologies and services, the concept of participation in urban governance has suffered a great development: from the early postmodernist ideals of countering expert dominance to today's focus on learning and social innovation, in which participation is conceptualized as co-creation and co-production (Bovaird, 2007; Lund, 2018). This way, public value creation can be pictured in terms of an open system in which inputs are converted, through activities and processes, into outputs and outcomes, with the active help of co-producers and partner organizations (Bennington, 2011).

Nonetheless, although the main challenge in SCs lies in citizen engagement on public decisions (Hemment & Townsend, 2013; Boukhris et al., 2016), the increase in the use of algorithms that drive networked technologies and the no ambition of considering citizens' input (Kingston, 2002), among other reasons, are limiting the role of e-participation, and are moderating its implication in the democratic process of SCs (Yan et al., 2013).

In addition, in order to participate effectively, citizens need those city governments to put available platforms, applications and tools not only to promote an informed citizenry (Zheng et al., 2014), but also to improve citizen participation by offering debate and discussion on important issues of public concern, implement public policies, and provide public sector services (Giffinger et al., 2007).

Despite the previous issues, there is a lack of research to know how this new governance context is being included in the SCs framework. Thus, in this paper we aim to present insights into how participative models of governance are taking place in the smart city arena. This way, we undertake not only a profound literature search, but also a deep overview of the experience in participation models followed by SCs that are members of the EUROCITIES network with the aim of having a great picture of how these participative models (if any) have been introduced in different areas or dimensions of the cities.

The EUROCITIES network is composed of the elected local and municipal governments of major European cities, and aims to provide a strong operational framework for building creative citizenship (EUROCITIES, 2016). It is expected that EUROCITIES SCs with more emphasis on embracing and widening citizens' participation with innovative methods into the city management are those with more citizen participation practices. This way, our paper also explores whether the so-called "creative SCs" have higher number of smart projects governed in a participatory way.

The remainder of this paper is organized as follows. The next section deals with the topic of citizen participation in SCs, and motivates and supports our research questions. Then, an empirical research is performed in prior literature on SCs and on SC initiatives included in the EUROCITIES network (especially in its working group of "creative citizenship"), seeking to collect information about stories of SCs regarding the introduction of participative models of governance in smart projects (prior research), and to know the experiences of member cities of EUROCITIES network (and in the SCs included in the "creative citizenship" working group) about the use of participative governance models in city management. Then, conclusions and discussions bring the paper to an end.


## Citizen Participation in Smart Cities. Research questions

The SCs have put ICTs to the forefront emphasizing not only the technology itself, but also its role in human and social capital (Barsi, 2018). It redefines the concept of creation of public value in these

urban environments as a strategic approach to public management based on the promotion of networked governance with the aim at improving the quality of life of the city's residents (Rodríguez Bolívar, 2019a). Under this framework, solving societal problems is a managerial question of organizing strong collaborations between government and other stakeholders (Torfing, 2012); therefore, it revolves around processes of deliberation and ongoing dialogue between institutions and the public that they serve (Albert & Passmore, 2008).

This way, based on the post-material position combined with a technocratic perspective on good governance, instances of new governance models have been a particular focus of scholarly attention into this new urban environment, since public values in SCs are produced through innovative collaboration (Meijer & Rodríguez Bolívar, 2016). This situates public organizations in a wider network of stakeholders who have to be involved in the public value creation (Williams & Shearer, 2011; Moore, 2013), in which the use of smart solutions becomes the main goal for improving the quality of life (Bătăgan, 2011).

As a result, new forms of city management relied on sophisticated ICTs have taken place with the aim at working with civil societies in order to co-create solutions to local challenges (European Parliament, 2014; Centre for Cities, 2014). Within the broad range of such 'democratic innovations,' participatory governance has been defined as processes and structures of public decision-making that involve actors who are not normally charged with decision-making (Newig et al., 2017) and, according to SC practitioners, should complement, but not replace, traditional institutions of democracy (Rodríguez Bolívar, 2019b).

Nonetheless, in order to create public value in SCs, local governments should advance to a higher transformative level of governance that has been called smart urban collaboration (Meijer & Rodríguez Bolívar, 2016) and puts emphasis on the organizational process, not on the outcomes to be achieved. This involves the introduction of governance models that enable citizens to be fully involved in the public sector management, and the need to plug stakeholders in by setting up a new,

complex, multi-stakeholder, city urbanity as a way to transit towards real smartness in cities (Calzada, 2016). In fact, a SC by nature requires people's participation and engagement in city management and governance (Chourabi et al., 2012). Therefore, the first research question of this paper is:

*RQ1: How, if any, has citizen participation been conducted in smart city initiatives?*

The scientific debate on citizen participation in SCs has been focused on moving from the technocratic determinism of the smart city towards the involvement of citizens into governance models (Rodríguez Bolívar, 2018c), transforming SCs into "*cognitive cities*" (Wilke & Portmann, 2016). These urban environments, characterized by high information connectivity and high social connectivity furthering collaborative and increased democratic participation, have been defined as complex due to the no optimal solution to govern the city, since a satisficing solution will need to be explicitly or implicitly negotiated among stakeholders (Mostashari & Sussman, 2009).

In recent years, citizens are therefore changing their role in SCs from data-providers to decision-makers (Calzada, 2018), and are often resisting technocratic determinism of the SCs, taking up the challenge of understanding and mastering low cost, community-driven and local innovative efforts (Calzada & Cobo, 2015). However, with the proliferation of networked sensing and digital infrastructures into urban life, there are concerns that urban citizenship in SCs will be subject to inequalities in terms of access, representation, participation, and ownership (Heitlinger & Comber, 2018).

Indeed, when e-participation exists in SCs, it is usually not very robust and tends to focus on service delivery rather than public consultation and policy making (Cropf & Benton, 2019). This way, to encourage municipalities to foster e-participation, it is necessary to provide citizens with the ability to contribute detailed information efficiently using a wide range of interoperable devices and protocols (Patsakis et al., 2015).

Also, recent research has put emphasis on the difficulty to evaluate e-participation (Primus et al., 2018), because there is little understanding of what works and what does not (Smith, Macintosh, &

Millard, 2011). Citizen satisfaction with the use of e-participation and e-government systems has been proven to improve the trust in government (Bélanguer & Carter, 2008), and to have a direct influence on the citizens' adoption and use of the systems (Zolotov et al., 2018).

In addition, what has been neglected until now is the functioning and evaluation of citizen participation in SCs, the criteria by which the democratic quality of various instances of participatory governance can be assessed (Newton & Geissel, 2012), and, its contribution to the quality of life into the urban environment. Therefore, the second research question of this paper is derived:

*RQ2: To what extent citizen engagement is promoted and evaluated in smart city initiatives?*

Based on citizen involvement in SCs, individuals are enabled to engage and to act, alone or with others, in new and creative endeavors made possible and enhanced through technological innovation. This is considered more important than obtaining specific innovation results (Gascó, 2017), and allow citizens to generate public value by co-creating public services and increasing quality of life (Rodríguez Bolívar, 2018b).

Under this context, the concept of creative citizenship arises as a way of dealing imaginatively and collectively with complex issues in the urban environment using technological innovation and communal interaction (Lee, 2015). Creative citizenship in SCs is focused on participation in decision making in all aspects of life, and is therefore intimately associated with inter-action, co-creation and is inherently relational, having the capacity to build and support community (Lee, 2015). Nonetheless, citizens will only be willing to get involved in implementing new insights and solutions if their voices have been heard during the development stage (Kresin, 2017). Therefore, our third research question is:

*RQ3: Are the creative cities those that most promote citizen participation and engagement?*

## Empirical research

*Sample selection*

To achieve the aim of this paper, we have used two collection methods. On the one hand, we have performed a deep literature review to capture all the published research literature on participative SCs initiatives in Europe. On the other hand, we have analyzed the e-participation experiences reported in the EUROCITIES network. Both methods have allowed us to provide a general overview of the topic, and have data for undertaking a comparison between the issues addressed by researchers and those implemented by local governments. Next, we describe such methods; a brief scheme of them is shown in Figure 1.

[Figure 1]

*Citizen participation in the smart city research literature*

To collect the surveyed research papers, we first launched a formal query to the ISI Web of Knowledge [https://www.webofknowledge.com] (WOK) and Elsevier Scopus [https://www.scopus.com] (SCO) digital libraries, which index publications of major journals and conferences in many academic disciplines. For both cases, the query was defined as the intersection (i.e., the AND Boolean operation) between two specific queries: retrieving published papers about citizen participation, and retrieving published papers about smart cities.

More specifically, the first query was defined to retrieve those papers whose titles or abstracts contain any of the keywords shown in Table 1, enumerated by means of the OR Boolean operator. In the keywords, the asterisk `*` refers to the regular expression symbol that can be replaced by none or any combination of characters; hence, for example, `citizen*` would include terms such as `citizen`, `citizens`, `citizen's`, `citizens'` and `citizenship`. The keywords with a hyphen were also considered without it, e.g., `co-participation` and `coparticipation`.

[Table 1]

The second query, much simpler, was defined to retrieve those papers whose titles or abstracts contain the keyword `smart cit*`.

The selection of the above keywords was done carefully after reading leading papers in citizen

participation and observing key terms with which retrieving the maximum number of relevant papers and the minimum number of non-relevant papers. For instance, using the keyword `participation` alone was discarded since it is associated to a very large number of papers describing participation phenomena in a variety of smart city contexts, such as communication protocols between technological systems and collaboration models for government and business actors.

In addition to the WOK and SCO digital libraries, we also considered the version 14.5 of the Digital Government Reference Library (DGRL) database, created by the University of Washington (headed by Prof. Hans Jochen Scholl), which is composed of 11,211 bibliographic entries of papers published from 1981 to 2018. In this case, we executed the formal query explained above by means of a computer program for literature search designed by the authors, which automatically searched for the considered keywords in the title and abstract fields of the database entries.

Executing the queries at the end of December 2018, and considering only papers written in English, the number of initially retrieved documents were 208, 272 and 53 from WOK, SCO and DGRL repositories, respectively. Merging the three lists of results, we obtained a final set of 430 unique papers, dating from 1981 to 2018 (there were no papers about smart city and citizen participation previous to 2011).

Afterwards, by means of a thorough inspection of the abstracts of such papers, we selected a subset of the papers for potential investigation according to our research goals. In particular, we considered those papers mentioning participation processes followed in SC initiatives of European cities. Finally, after reviewing the contents of the selected papers and, if needed, accessing external information about the participation conducted in the initiatives, we only found 34 papers valid for our analysis. These papers present 56 initiatives implemented in 29 cities from 16 countries, resulting in a total of 65 analysis cases.

*Citizen participation in the case studies of EUROCITIES network*

The EUROCITIES network was founded in 1986 aimed to put the economic, political and social

development of cities onto the European agenda. As far of December 2018, the network is formed by over 140 members, among them 115 are cities with populations of at least 250,000 inhabitants. Its website [http://www.eurocities.eu] provides detailed information about a variety of issues in the member cities, such as projects, events, news, publications and case studies, associated to working groups in 8 forums: cooperation, culture, economy, environment, knowledge society, mobility, social affairs, and urban governance.

From all the available information, we focused on the reported case studies. In particular, we used another computer program for empirical cases, especially designed by the authors to automatically download and process all their corresponding web pages. Hence, for each case study, we captured its name, description, publication date, forums and related issues.

Then, as done with the DGRL database, we used the computer program for literature search to run the query presented in the previous subsection, and select the case studies whose names or descriptions contained the keywords of the query presented in the previous subsection. From a total of 285 case studies, 86 satisfied the query. Finally, according to our research questions and goals, 64 were selected for our analysis. Addressing 93 initiatives, such studies resulted in a total of 112 analysis cases implemented in 62 cities from 20 countries.

*Considered cities*

Our sample selection involves a total of 76 European cities; 14 of these cities have initiatives only reported in the research literature, other 47 cities have initiatives disclosed directly in the EUROCITIES network website, and the remainder 15 cities have initiatives reported in both the literature and EUROCITIES network website. Figure 2 visualizes all these cities in a map. Details about the initiatives are given in the Appendices of this paper.

[Figure 2]

*Methodology of research*

Conducting a thoroughly survey of the research literature and EUROCITIES network sample selected

for investigation, we finally identified a total of 149 SC initiatives for which enough information was publicly available to address our research questions (see Figure 1). We note that a significant amount of the surveyed research papers and EUROCITIES network web pages referred to several initiatives, and in many cases, we had to access the initiatives websites and reports to acquire the needed information.

More specifically, we established five variables to analyze, and collected their particular values for each of the initiatives; we discarded those initiatives for which we could not find the variables values. The first variable is the time context, specifically the initiatives year. This variable has a different meaning depending on whether the target initiative was presented in a research paper or was described in EUROCITIES network. For the research literature cases, the variable is associated to the implementation year of an initiative if it is given in the paper, or to the publication year of the paper, otherwise, understanding it presents an initiative that is ongoing at the time of publication. For the EUROCITIES network cases, in contrast, the variable refers to the year the initiative started.

The second variable of our study is the dimension from those of the six dimension model defined by Giffinger et al. (2007). The dimensions characterize SCs and are related to traditional and neoclassical theories of urban growth and development: *Smart economy*, *Smart environment*, *Smart mobility*, *Smart governance*, *Smart living*, and *Smart people*. Smart economy (ECO) entails all the actions that can be performed in a city under an economic innovation and productivity perspective. Smart environment (ENV) refers to actions to enable a sustainable management of natural resources in a city. The Smart mobility (MOB) dimension involves actions aimed to achieve a sustainable management of traffic and transport in a city, as well as to increase the accessibility to public spaces. Smart governance (GOV) includes all the actions related to the governance models followed between the city actors. Smart living (LIV) gathers all the actions targeted to citizen needs, such as health, security, education, culture and leisure. Finally, the Smart people (PEO) dimension refers to actions addressing social issues, such as building an inclusive and participative society.

For the third variable, we considered the model proposed by the OECD (2001) on different levels of interaction between citizens and government to develop our own participatory model. In that model, participation is understood as a participatory spectrum in which the role played by citizens regarding a city issue or initiative may range from just recipients of information (*information level*) to decision makers (*collaboration or participation level*), going through an intermediate level in which citizens are consulted but final decisions are taken by the government (*discussion level*) or they formally express interests and requests (*petition level*).

The fourth variable deals with the way stakeholders –mainly citizens– access, take part, and contribute to the initiatives. Specifically, we consider that an initiative can have an *open* or a *selected* (restricted) participation, according to whether participation in the initiatives is open to all citizens, or if, on the contrary, it is restricted to certain (selected) stakeholders for which the initiative is targeted (Fung, 2006).

Finally, the fifth variable is the tools of participation, that is, the mechanisms and instruments used in the participation processes of the analyzed SC initiatives. The tools can be of different forms, varying from traditional participation mechanisms, such as public hearings, community and neighborhood meetings, working groups, and cultural events, to digital tools, such as ad hoc e-participation platforms, social media, living labs, and Open Data.

In Appendices A and B, we present tables that show the values of the analyzed variables in this study for all the initiatives. In the next section, we analyze the data of such tables, crossing information inferred from the variables.

## Analysis of results

*RQ1: How, if any, has citizen participation been conducted in smart city initiatives?*

To address this question, we first analyze whether there is a trend on considering citizen participation in SC initiatives or, in contrast, it is an issue that had certain popularity and is progressively losing interest. Figure 3 shows the cumulative distribution in time of the SC initiatives surveyed from the

research literature and EUROCITIES network, respectively. For each year, the figure shows the number of initiatives addressing each of the 6 considered SC dimensions. For clarity and comparison purposes, we only consider the initiatives dated in the last 7 years, from 2012 to 2018. The figure covers all the analyzed research papers, but does not include 30 EUROCITIES network case studies dated before 2012.

In both the research literature and EUROCITIES network, we can observe that there is an increasing interest for SC projects involving some kind of citizen participation. We can also see that addressing citizen participation in SCs has started to be investigated quite late with respect the implementation of SC initiatives in Europe; as shown in Figure 3, it is in 2015 when the number of research papers per year begins to be relatively significant and is increasing meaningfully every year. Hence, it seems that citizen participation is a recent research topic of interest, and is expected to gain momentum in the near future.

The figure also shows the SC dimensions in which citizen participation has received more/less attention. As can be seen, *Smart governance* is the most frequent dimension addressed by the initiatives. This was expected since, as explained above, the initiatives were obtained from bibliographic libraries and EUROCITIES network by means of keyword-based queries related to citizen participation (see Table 1). In particular, we obtained numerous examples of initiatives related to participatory budgeting and open government initiatives. Interestingly, we observe that *Smart environment* is a principal dimension of many initiatives from both research papers and EUROCITIES case studies, and is receiving an increasing interest in the last years. Specifically, most of these initiatives are aimed at influencing citizens to change their behavior to a more sustainable one. In EUROCITIES network, we also observe a relatively higher attention to *Smart living* and *Smart people* initiatives. In the opposite side of the spectrum, we note that *Smart economy* and *Smart mobility* are the dimensions with less attention in terms of citizen participation, in both the research literature and EUROCITIES network. This leads us to believe that there are decision-making areas where issues to

be decided are not left to citizens, but to policy makers.

[Figure 3]

In Table 2, we show the smart dimension co-occurrences, i.e., the initiatives addressing (at least) two dimensions. The table gives two co-occurrence matrices: one (on the left) associated to the research literature initiatives, and another (on the right) associated to the EUROCITIES network case studies. The values in the diagonals of the matrices represent the total numbers of initiatives addressing (at least) each dimension. As observed previously in the analysis of Figure 3, apart from *Smart governance* (29 initiatives), which appears in many of the surveyed participative initiatives, *Smart Environment* is the second dimension most addressed in the research literature (19 initiatives), and *Smart Living, Smart Governance* and *Smart People* are the dimensions with highest interest in EUROCITIES network (32, 34 and 37 initiatives, respectively).

Analyzing the remainder values of the matrices, in the literature, we observe that a relatively high number of SC initiatives about environmental issues also address governance aspects –5 initiatives; e.g., (Anttiroiko, 2016; Ielite, 2015). In these initiatives, citizens not only make decisions about environmental issues, but also promote actions in a bottom-up fashion. In EUROCITIES network, in contrast, the emphasis on *Smart living* and *Smart people* actions is augmented by the fact that issues from the two dimensions are addressed together by a significant amount of initiatives –15 initiatives; e.g., *A City For All* project in Barcelona, Spain. This reveals the relevance that sustainable city development and growth have in the network, ultimately aimed to empower and transform citizens (EUROCITIES, 2016). For this source, it also notorious that in general *Smart mobility* initiatives do not address issues from the other dimensions.

[Table 2]

In Figure 4, we show information about the participation levels for each SC dimension, from the initiatives surveyed in the research literature and EUROCITIES network. In the figure charts, we first observe that *Smart governance*, which is the dimension with more participative initiatives, puts

greater emphasis on the collaboration –e.g., Anttiroiko, 2016– and discussion –e.g., Snow, 2016–

levels than in the petition level –e.g., Cardullo, 2017. Regarding the research literature, after *Smart*

*governance*, *Smart economy* and *Smart environment* are dimensions that compile a relatively high

number of initiatives. With respect to *Smart mobility*, the literature reflects more initiatives at the

petition and collaboration levels. This can be explained by the existence of initiatives that monitor

transport data in real time where citizens receive information, but do not provide feedback (Kamilaris,

2017), and initiatives in which citizens generate data as users of specific electronic applications

(Zuccalà, 2017).

In EUROCITIES network, we can observe *Smart Governance, Smart living* and *Smart people* show

the highest numbers of participation initiatives. The predominance of the petition level in *Smart living*

initiatives responds to initiatives in which particular groups receive assistance and help on different

issues. For instance, there are tourism initiatives in which citizens receive information of cultural and

leisure events (e.g. *SynAthina: Athens' community platform*), and initiatives aimed to aid and advice in

a variety of aspects related to healthcare (e.g. *Cities welcome refugees - Helsinki*), education (e.g.

*Creating a one-stop-shop for young people*), social inclusion (e.g. *Welcome to Sweden. The*

*Gothenburg Language Introduction Centre*), and volunteering (e.g. *Mentoring its young people*, *The*

*CO-MENT*). In *Smart governance*, the discussion level prevails, being numerous those initiatives

where citizens are consulted on different issues for debate (e.g. *Gijon's new governance model*). This

facilitates the generation of different networks among stakeholders, leading to the promotion of public

value.

[Figure 4]

Table 3 shows the co-occurrence matrices of the participation levels in the initiatives surveyed

from the literature and EUROCITIES network. In this case, the values in the matrix diagonals

represent the total numbers of initiatives having each participation level. From them, we can observe

that in both data sources there is not a predominant participation level. Nonetheless, while there is a

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relatively higher number of participative initiatives at the collaboration level in the literature, there are relatively more initiatives at the discussion level in the experience of the cities members of the EUROCITIES network. From the remainder values in the matrices, we also notice that in the literature, approximately half of the initiatives achieve (at least) two participation levels. This does not occur in the EUROCITIES network, where petition and collaboration barely appear together in the initiatives.

[Table 3]

In addition to frequencies and co-occurrences, we can also analyze the achieved participation levels over the years. Hence, in Figure 5 we show the numbers of petition, discussion and collaboration participative initiatives in the last 7 years, from both the research literature (left bar chart) and EUROCITIES network (right bar chart). Whereas in the literature, the discussion and collaboration levels of participation are the most reported, the experiences of the EUROCITIES network present an evolution from the petition model (beginning), the discussion model (in the middle of the period of study), to the collaboration model (at the end of the period of study). This reflects, on the one hand, the theoretical lenses for participation models in SCs and, on the other hand, the evolution of the SCs to introduce more advanced participation models focused on citizen empowerment in the last years.

[Figure 5]

*RQ2: To what extent citizen engagement is promoted and evaluated in smart city initiatives?*

To study the mechanisms for which citizens are involved in the participation processes, we focus our analysis on the *types of participation* (open-selected) and the used *participation tools*, whose scores obtained in this research can be found at Appendices A and B.

As for the types of participation, Figure 6 shows the number of analysis cases with open/selected participation for each SC dimension in both research literature (left bar chart) and EUROCITIES network (right bar chart) initiatives. For both sources, *Smart governance* and *Smart environment* are the dimensions with relatively highest percentages of open participation initiatives. The majority of

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them includes citizens in decision-making tasks and promotes bottom-up processes (Castelnovo, 2016). For the remainder SC dimensions, in general, the number of open initiatives is greater than the number of selected initiatives, except for *Smart living* in EUROCITIES network, where there is a predominance of initiatives targeted to specific stakeholders, such as disadvantaged people (*Cities' strategies against homelessness: the integrated chain approach*), users of particular services (*The Youth Hub* project), business entities (*Ghent: Bridges to, on and from The Site*), and NGOs (*A City for All* project).

In the literature, *Smart mobility* has also a significant number of selected participation processes. In this case, we identified initiatives aimed to address cyclists' mobility problems (Cardullo, 2017), and provide more efficient logistic and transport management (Bresciani, 2016).

In the figure (right bar chart), we also show the evolution over time of the participation types in the last 7 years by the initiatives surveyed. It can be seen that whereas the superiority of open participation is clearer in the literature; participation initiatives in SCs of EUROCITIES network have been balanced over the years and even mainly undertaken as selected stakeholders in the 2013 and 2015 years. Nonetheless, it can be appreciated that the selected initiatives seem to have certain decreasing trend over time.

[Figure 6]

To conclude our analysis, Table 4 shows the 10 most used participation tools in the SC initiatives surveyed from the research literature and EUROCITIES network. In both cases, ad hoc e-participation platforms and social media are among the most used tools, and represent the preferred digital platforms for citizen participation processes. Also, while in the research literature there is a predominance of computer-assisted participation solutions (mobile apps, sensors and IoT applications, software APIs, and Open Data), the majority of top participation tools in the experiences of SCs in EUROCITIES network are human-oriented (meetings, seminars/talks/lectures, social and cultural events, working/discussion groups, and exhibitions/festivals). Other tools, such as workshops and

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symposiums, seem that are used in a more moderate way, but are discussed in both the research papers and EUROCITIES network case studies.

[Table 4]

*RQ3: Are the creative cities those that most promote citizen participation and engagement?*

To answer this question, we focus on the participative initiatives of the SCs in EUROCITIES network, distinguishing between "creative" cities belonging to the network *Creative citizenship* working group [http://www.eurocities.eu/eurocities/working_groups/Creative-citizenship&tpl=home], and the rest of the cities, catalogued as "non-creative."

Assessing the creativeness of these two groups of cities, we considered the 2018 city rankings of the *Innovation Cities Index* [https://www.innovation-cities.com] and the *Cities in Motion Index* [http://citiesinmotion.iese.edu], which respectively use 162 and 83 indicators to rank and compare 500 and 165 cities around the world. These two rankings have a Person Correlation Coefficient of 0.784, showing a strong positive correlation between them. For this reason, we normalized and merged the two rankings into a single one. In the generated ranking, we observed that the average rank scores of non-creative and creative cities were 0.62 and 0.80, respectively; being 0 and 1 the minimum and maximum score values. We also observed that, on average, the more SC initiatives in a city, the higher its normalized ranking score, as shown in Figure 7. These results allow us to measure the creativeness of the cities as their number of participative initiatives.

[Figure 7]

Of the 112 analysis cases identified in EUROCITIES network in the sample selection section, 48 were implemented in *non-creative cities* –in particular, 35 cities from 15 countries-, and 64 were implemented in *creative cities* –in particular, 27 cities from 14 countries. Therefore, although creative cities are less than the non-creative ones, they have developed more participative initiatives. In fact, conducting a two-tailed Mann-Whitney U test we validated with statistical significance (p-value < 0.05) that creative cities promote citizen participation more than non-creative cities, in terms of the

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number of participative initiatives per city. We performed such test since the data samples did not follow a normal distribution, as stated by the Kolmogorov-Smirnov test.

Figure 8 provides more details about this issue, showing the cumulative distributions of the initiatives conducted by the cities of the two studied groups in the last 10 years and for each smart city dimension.

[Figure 8]

In the figure, we can see that in creative cities, the number of initiatives per year has increased meaningfully since 2012 for the *Smart living*, *Smart people* and *Smart governance* dimensions, and since 2015 for the *Smart environment* dimension, whereas in non-creative cities the number of initiatives per year tends to be quite constant. In addition, in both groups of cities, the dimensions with more participative initiatives are *Smart living* and *Smart people*. For creative cities, there is also a relatively higher importance of *Smart governance* actions. *Smart mobility*, in contrast, seems to be the dimension where initiatives present less participation aspects. Finally, for the *Smart economy* and *Smart environment* dimensions, we observe opposite situations between non-creative and creative cities. In the former, economy actions present more participatory processes than environment actions, and in the latter, the situation is in the other way round.

Regarding the type of participation, Figure 9 shows the distribution among SC dimensions and evolution in the last 10 years of open and selected participation initiatives for non-creative *vs.* creative cities. In general, there are more open initiatives in each group of cities for all the dimensions, except in non-creative cities for *Smart living*. Interestingly, we did not identify a *Smart environment* initiative with selected participation. Moreover, in the creative cities, we observe certain increment trend on the number of open initiatives over the last years. Performing a two-tailed Mann-Whitney U test, we did not obtain statistical significant differences between creative and non-creative cities in terms of the number of open/selected initiatives.

[Figure 9]

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With regards to the level of participation, we observed that the distribution of the different participation levels was quite similar in non-creative and creative cities for all the dimensions except *Smart environment* and *Smart mobility*, where non-creative cities do have relatively low number of initiatives achieving the collaboration level, in comparison to creative cities. On the other hand, analyzing the evolution of the participation levels over time, for both non-creative and creative cities, we did not observe clear patterns in the distribution of the three levels. Again, performing a two-tailed Mann-Whitney U test, we did not obtain statistical significant differences between the two groups of cities with respect to the number and proportion of the different participation levels achieved by the SC initiatives.

Finally, we compare the participation tools used in the two groups of cities. Ad hoc e-platforms represent the most frequent tool in EUROCITIES network initiatives of cities from both groups, although they appear in greater degree in creative cities. As non-electronic tools, meetings, seminars, workshops, and social and cultural events are popular tools in both types of cities, showing again the more social focus and nature of non-creative cities of the EUROCITIES network case studies. Creative cities, on the other hand, do have SC initiatives that make use social media, digital maps and devices, and living labs, which are barely or not used in initiatives of non-creative cities. This shows that creative cities put a stronger emphasis on technological participative solutions than non-creative cities.

## Conclusions

Based on an empirical study, this paper gathers interesting insights regarding the participative models of governance that are taking place in European SCs. Through a literature review analysis in the main e-government databases and the case studies presented in the EUROCITIES network, we compile a total of 149 smart city initiatives from 76 European cities categorized according to a number of variables, ranging from contextual (i.e., time) to participation-based (i.e., participation levels, types

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and tools), and SC dimensions.

Findings indicate an increasing interest in citizen participation within SCs, measured as the number of related research papers and EUROCITIES network case studies published/reported per year. This growth has been more significant since 2015, which shows the current and future potential of citizen participation in the governance of smart cities. This trend would reinforce the idea that e-government models are not only having high relevance in the field of public management, but also in the democratic theory (Albert & Passmore, 2008). In fact, for a democratic polity to exist it is necessary for a participatory society to exist (Pateman, 1970) and ICTs are offering in the last years opportunities for interaction, communication and more participatory democracy (Held, 2006), thus having a great potential to strengthen the democratic aspects of governance (Anttiroiko, 2004).

Nonetheless, whereas the research literature has put more focus on smart environment initiatives, EUROCITIES network has made a higher emphasis on social issues through the smart people and smart living initiatives. This finding could reveal a difference between the need of focusing on the concept or on the goal of the SC movement. The scientific literature seems to be more focused on defining the context in which the city becomes smart, going beyond sector-specific approaches (Fernández-Anez et al., 2018), although in the light of global commitments to achieving sustainable development goals, there is a lively debate about the difficulty of linking the terms "smart city" and "sustainability" (Glasmeier & Nebiolo, 2016; Ahvenniemi et al., 2017), or even as a subsystem that remains outside the SC model as the basis and support for any urban development (Fernández-Anez et al., 2018). By contrast, the experiences have focused their efforts on sector-based initiatives and projects in one or a few specific areas (Fernández-Güell et al., 2016), mainly based on those directly linked to improving the quality of life (the main goal pursued by smart cities -Rodríguez Bolívar, 2019a-), which have led them to focus on smart people and smart living initiatives which are closer to the citizenry. Moreover, findings show that, in general, more reported European citizen participation processes have aimed to achieve higher levels of participation (discussion and collaboration) than

processes that just provide citizen information and petition functionalities. This result is a product of both the new innovative forms of participative governance models required to be implemented in smart cities –where the central role of governance in smart cities is generally acknowledged (Rodríguez Bolívar, 2015b, 2016; Fernández-Anez et al., 2018)–, and its foundations on the concept of network governance, understood as the outcomes of interactions among all actors in the public domain (Rodríguez Bolívar, 2015a, 2016; Gil-García et al., 2016).

These governance models have also been introduced into the smart projects implemented in the sample SCs, using open participation processes more than selected participation projects. This finding shows us how power structures are changing in the policy making arena within SCs. The goal of creating public value through governance models has meant a new way of understanding public management, since it has to be developed through the collaboration of stakeholders distinct than government (Stoker, 2006). This open participation at community level is not only refereed to participation in public policy and decision making, but also to service design and delivery (Millard, 2018), which helps to increase the innovation, diversity and creativity into SCs (Anttiroiko, 2016). Nonetheless, the way in which this participation is produced is different according to our selected literature review *vs*. empirical experiences in the sample EUROCITIES network cities. This way, although both of them highlight the use of ad-hoc e-participation platforms, findings of this research show that the citizen participation in the research literature is mainly promoted through the use of ICTs such as mobile applications, sensors and IoT devices, and Open Data.

By contrast, empirical experiences in the sample cities members of the EUROCITIES network, with the exception of ad-hoc platforms, have been mainly based on offline and face-to-face methods for citizen participation, including meetings, seminars/talks, and social and cultural events. This issue could be an expression of the need of local governments in SCs to play the leading role in all smart projects, organizing and monitoring all citizen entries and opinions, as it has been demonstrated by recent research (Rodríguez Bolívar, 2019b). One question to be solved by future research could be

which of the tools used are more effective for a truly citizen involvement into the smart city, as well as the impact of these tools on trust and confidence on local governments. Also, future research should undertake studies regarding strategies involved in the role of governments in SCs and the reasons of local governments to play these roles.

Finally, based on our previous comments, our findings demonstrate that sample creative cities, which are fewer than the sample non-creative cities, have conducted more participative initiatives, especially in the last five years. This finding was tested and found significant using the Mann-Whitney U test methodology and seems to be in the line of recent research that also suggests that a relevant commitment to SC policy initiatives, such as open participation models, is in particular positively associated to higher overall innovation rates, as well as innovation rates in high tech, ICT and IoT patents (Caragliu & Del Bo, 2018). This innovation impulse increases a city's stock of knowledge, one of the main recognized drivers of economic growth (Caragliu & Del Bo, 2018). Therefore, future research could analyze whether creative smart cities are those with a higher economic growth in the European context.

Despite previous comments, the way that citizen participation is produced in both creative and non-creative cities is the same one. Thus, our findings indicate that both groups of cities usually promote open participation models and discussion/collaboration levels are higher than the petition level for all the smart city dimensions. By contrast, creative cities put a stronger emphasis on technological participative solutions than non-creative cities. This way, in creative cities, tools such as social media, digital maps and devices, and Living Labs are commonly used, making it easier for citizens to participate in innovative cities (Foth & Hearn, 2007; Anttiroiko, 2016). Also, it helps these cities to solve urban challenges with more citizenry-centric solutions, increasing their citizens' quality of life, as prior research has demonstrated (López-Quiles & Rodríguez Bolívar, 2018). This way, future research could analyze the impact of smart projects designed and governed with the active help of technological participative solutions on the citizens' quality of life in SCs.

Furthermore, findings show that creative cities present more initiatives oriented towards smart governance, smart living and smart people dimensions. Therefore, these cities no longer focus primarily on economic objectives, but serve to strengthen ties among citizens through participation initiatives that foster social cohesion (Florida, 2003; Rodríguez Bolívar & Meijer, 2016). Nonetheless, future research should analyze additional factors that could promote citizens to be involved in SC policies and smart projects. In particular, we find interesting the consideration of the stakeholders involved in the participative initiatives and the relationships between them, the existence (or lack) and characterization of feedback from government and/or citizens in the participation processes, and the impact that participation has on the citizens' opinion, media, and government policies. Also, future studies could be focused on the problems and challenges addressed in each smart dimension, e.g., energy efficiency, resource management, and urban planning in smart environment. Finally, it could be interesting to extend this research to non-European cities, conducting a comparison between cities around the world. In brief, it is possible that our findings may be context-dependent, and more studies could help to make deeper knowledge in this issue.

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## Author information

**María E. Cortés-Cediel**, MSc, is a PhD student of Government and Public Administration at Universidad Complutense de Madrid. She researches citizen participation in smart cities. She can be reached at mcorte04@ucm.es.

**Iván Cantador**, PhD**,** is a senior lecturer of Computer Science at Universidad Autónoma de Madrid. He researches personalized e-government services. He can be reached at ivan.cantador@uam.es.

**Manuel Pedro Rodríguez Bolívar**, PhD, is a full professor of Accounting at Universidad de Granada. He researches smart cities, DLT technologies and e-government. He can be reached at manuelp@ugr.es.

## Data Availability

The data analyzed in this paper is publicly available at the EUROCITIES network website,

http://eurocities.eu

The data consists of descriptions, categories and metadata of smart city case studies, and do not contain any personal data or user information.

For reproducibility purposes, the authors provide the gathered data in a single SQL file at

http://ir.ii.uam.es/egov

## Software information

To process and analyze the gathered data, the authors have implemented a number of computer programs. More specifically, the programs process both reference files in RIS and CIW formats, and the EUROCITIES database to retrieve the analyzed research papers and EUROCITIES case studies. Their code is available in a zip file at http://ir.ii.uam.es/egov

The zip file contains 1) a *data folder* with the queries launched to Scopus and Web of Science, and the references obtained with such queries, and 2) a *source folder* with the implemented Java classes, being `es.uam.eps.irg.smartcities.references.ReferenceManager.java` the main one.

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# Appendix A. Smart city initiatives surveyed from the research literature

| Initiative | Reference | City | Country | Dimensions | Participation levels | Participation types | Participation tools |
|---|---|---|---|---|---|---|---|
| ELLIOT project | Vicini et al., 2012 | Milan | Italy | ECO | D | S | DIG |
| The Alliance for Internet of Things Innovation (AIOTI) | Robert et al., 2017 | Lyon | France | ECO | C | S | EPLT, LAB |
| The Cuckoo's Nest approach | Artto et al., 2016 | Helsinki | Finland | ECO | P, D | O | WS |
| Otaniemi Metro Centre (The Cuckoo's Nest approach) | Artto et al., 2016 | Helsinki | Finland | ECO | P, D | O | WS |
| Ruskeasuo Health Park (The Cuckoo's Nest approach) | Artto et al., 2016 | Helsinki | Finland | ECO | P, D | O | WS |
| Dampbusters project | Balestrini et al., 2017 | Bristol | UK | ENV | D | O | WS, SM, DIG |
| Dublin Beta | Cardullo & Kitchin, 2017 | Dublin | Ireland | ENV | P, D | O | EPLT, SM |
| Fix-Your-Street | Cardullo & Kitchin, 2017 | Dublin | Ireland | ENV | P, D | O | EPLT, APP, SM |
| Smart Kalasatama | Anttiroiko, 2016 | Helsinki | Finland | ENV | P, D, C | O | EPLT, LAB |
| Smart Mature project | Grimes et al., 2017 | Glasgow | UK | ENV | P, D, C | S | EPLT |
| SOCIOTAL project | Van Kranenburg et al., 2014 | Novi Sad | Serbia | ENV | _ | S | _ |
| Dublin's Silicon Docks | Pétercsák et al., 2016 | Dublin | Ireland | ENV | P, D, C | O | EPLT |
| Quarto Gardening | Trivellato, 2017 | Milan | Italy | ENV | P, D, C | O | EPLT |
| The SENSEable Pisa project | Vinci et al., 2017 | Pisa | Italy | ENV | P, C | O | SNSR, EPLT, SM |
| REMOURBAN | García-Fuentes & Torre, 2017 | Valladolid, Nottingham | Spain, UK | ENV | C | S | _ |
| Geocraft | Scholten, 2017 | Amsterdam | Netherlands | ENV | C, D | O | EPLT, GAME |
| Air Singel | Mulder, 2015 | Rotterdam | Netherlands | ENV | D | O | MEET, SM |
| Smart Mobility Hub | Cardullo & Kitchin, 2017 | Dublin | Ireland | MOB | P | S | LAB |
| Koklaamo | Anttiroiko, 2016 | Tampere | Finland | MOB | C | S | LAB, EPLT |
| MOBISEC | Melendreras-Ruiz & García-Collado, 2013 | Murcia, Varna | Spain, Bulgaria | MOB | P, C | O | GAME, APP |
| Travel Planner | Kamilaris & Ostermann, 2017 | Aarhus | Denmark | MOB | C | S | SNSR, EPLT, APP |
| Sharing Cities | Zuccalà & Verga, 2016 | Milan | Italy | MOB | C | O | EPLT, APP, SNSR, SM |
| Internet Week | Snow et al., 2016 | Aarhus | Denmark | GOV | D, C | O | EPLT |
| Aarthus Open Data | Snow et al., 2016 | Aarhus | Denmark | GOV | P | O | OD, DB, EPLT |
| Tog | Cardullo & Kitchin, 2017 | Dublin | Ireland | GOV | D, C | S | EPLT, SM, DIG |
| Coding for Ireland | Cardullo & Kitchin, 2017 | Dublin | Ireland | GOV | D, C | O | EPLT |
| CIVIQ | Cardullo & Kitchin, 2017 | Dublin | Ireland | GOV | D | O | EPLT, SM |
| Dublinked | Cardullo & Kitchin, 2017 | Dublin | Ireland | GOV | P | O | OD, DB |
| Helsinki Region Infoshare (HRI) | Anttiroiko, 2016 | Helsinki | Finland | GOV | P, C | O | LAB, EPLT, API, APP |
| Open Ahjo, Helsinki Loves Developers | Anttiroiko, 2016 | Helsinki | Finland | GOV | C | O | LAB, EPLT, API, APP |
| Open Finland Challenge | Anttiroiko, 2016 | Helsinki | Finland | GOV | C | S | LAB, GAME, APP |
| CitySDK | Anttiroiko, 2016 | Helsinki | Finland | GOV | C | O | LAB, API, APP, DB |
| D-CENT | Anttiroiko, 2016 | Helsinki | Finland | GOV | C | O | LAB, LAB, APP, API, DB |
| Open Tampere | Anttiroiko, 2016 | Tampere | Finland | GOV | C | S | LAB, GAME, APP, API, DB |
| Milano per Scelta | Trivellato, 2017 | Milan | Italy | GOV | P, D | O | EPLT |
| Talk London | Praharaj et al., 2017 | London | UK | GOV | P, D | O | _ |
| OrganiCity | Deligiannidou et al., 2017 | Aarhus, London | Denmark, UK | GOV | P, D, C | O | EPLT, API, APP |
| Decide Madrid | Cantador et al., 2017 | Madrid | Spain | GOV | D, C | O | EPLT |
| Open Urban Service Network | Hosio et al., 2014 | Oulu | Finland | GOV | D, C | O | EPLT, API |
| Applab | Mulder, 2014 | Rotterdam | Netherlands | GOV | C | O | EPLT, APP, OD, SM |
| Open Data Portal | Effing & Groot, 2016 | Berlin | Germany | GOV | C | O | EPLT |
| Betri Reykjavk (Better Reykjavik) | Effing & Groot, 2016 | Reykjavik | Iceland | GOV | P, D | O | EPLT |
| Better Reikjavik | Gil et al., 2019 | Reykjavik | Iceland | GOV | D, C | O | EPLT, SM |
| OrganiCity | Gutiérrez et al., 2016 | London, Aarhus | UK, Denmark | GOV | P, D, C | O | EPLT, API, APP |
| WeLive project | López de Ipiña et al., 2018 | Bilbao, Novi Sad, Helsinki | Spain, Serbia, Finland | GOV | D | O | EPLT, APP, API |
| MONICA project | Meiling et al., 2018 | Hamburg | Germany | LIV | C | S | SNSR, EPLT, APP, DIG |
| Quarto Food Club | Trivellato, 2017 | Milan | Italy | PEO | C | S | HUM |
| Dokk1 | Castelnovo, 2016 | Aarhus | Denmark | PEO | P, C | O | DIG, HUB |
| Oma Tesoma | Anttiroiko, 2016 | Tampere | Finland | ENV, GOV | C | S | LAB, EPLT |
| Amsterdam living lab | Bifulco et al., 2017 | Amsterdam | Netherlands | ECO, ENV, GOV, MOB, LIV, PEO | P, D, C | O, S | EPLT, LAB, SM, APP |
| 22@Barcelona district | Bifulco et al., 2017 | Barcelona | Spain | ECO, ENV, LIV | P, D, C | O | EPLT |
| Crowdsourcing urban sustainability governance | Castelnovo, 2016 | Ghent | Belgium | ENV, GOV, LIV | P, D, C | O | EPLT, LAB, SM, APP |
| Amsterdam Smart City Platform (ASCP) | Nesti, 2018 | Amsterdam | Netherlands | ECO, ENV, GOV, MOB, PEO | P, D, C | O | EPLT, SM |
| The Media@Komm project | Singh, 2015 | Stuttgart | Germany | ECO, PEO | P, D, C | O | EPLT, DEB |
| MyNeighbourhood project | Oliveira et al., 2015 | Lisbon, Milan, Birmingham | Portugal, Italy, UK | GOV, PEO | P, D, C | O | GAME, LAB, EPLT |
| SEAP, Sustainable Energy Action Plans | Ielite et al., 2015 | Riga | Latvia | ENV, GOV | P, D, C | O | EPLT, MEET, SURV, GRO, WS, DEB |
| Livings Labs Rotterdam | Mulder, 2015 | Rotterdam | Netherlands | ENV, MOB | C | S | LAB |

# Appendix B. Smart city initiatives surveyed from EUROCITIES network

| Initiative | Year | City | Country | Dimensions | Participation levels | Participation types | Participation tools |
|---|---|---|---|---|---|---|---|
| Brussels Regional Programme for a Circular Economy | 2016 | Brussels | Belgium | ECO | C | O | LECT, GRO |
| Tampere Demola co-creation centre | 2008 | Tampere | Finland | ECO | C | S | - |
| New Life for Marketplaces | 2014 | Rome | Italy | ECO | C | S | EPLT, MEET |
| Brainport Eindhoven | 2002 | Eindhoven | Netherlands | ECO | P, D | S | - |
| Creative Mikser – networking meetings for creative entrepreneurs | 2011 | Warsaw | Poland | ECO | P, D | O | EPLT |
| Ljubljana's RogLab model | 2012 | Ljubljana | Slovenia | ECO | C | S | WS, DAY, ART, GAME, EXH, LECT |
| Connecting SMEs and big business | 2009 | Gijon | Spain | ECO | C | S | EPLT |
| Brighton & Hove reuse system for furniture and equipment | 2003 | Brighton | UK | ECO | D, C | O | - |
| Grondstoffen Collectief Almere | 2016 | Almere | Netherlands | ECO, ENV | P, D, C | O | EPLT |
| Tampere - from linear to circular bioeconomy | 2013 | Tampere | Finland | ECO, GOV | C | O | - |
| Cities supporting entrepreneurship and small businesses: Co-operative Glasgow | 2013 | Glasgow | UK | ECO, GOV | C | S | EPLT |
| The City as a Commons: Regulation on collaboration between citizens and the city | 2012 | Bologna | Italy | ECO, GOV, LIV, PEO | C | O | LAB, EPLT, WS, SM |
| Action plan 'Social City' Dortmund | 2008 | Dortmund | Germany | ECO, LIV, PEO | D | O | MEET |
| Munich creates nucleus for circular economy | 2011 | Munich | Germany | ECO, PEO | D, C | O | EPLT, SM, MEET |
| Gothenburg's entrepreneurial hub | 2012 | Gothenburg | Sweden | ECO, PEO | C | S | - |
| Glasgow Ethnic Entrepreneurship Programme | 2015 | Glasgow | UK | ECO, PEO | C | S | - |
| Ostend Velodroom, revitalising a skatespot | - | Ostend | Belgium | ENV | D, C | O | EPLT, MEET |
| INURDECO – Integrative Urban Development Concept - Hiukkavaara - Sustainable Northern Winter City | - | Oulu | Finland | ENV | P, D, C | O | LAB, GAME, SURV, SM, DIG, WS, DAY, EVNT, EPLT |
| Tampere creates circular bioeconomy hub | 2016 | Tampere | Finland | ENV | C | O | EPLT, MEET |
| Lille promotes circular economy construction | 2016 | Lille | France | ENV | C | O | - |
| The Mill island | 2004 | Bydgoszcz | Poland | ENV | D | O | MEET |
| Gothenburg's 'Smart map' | 2016 | Gothenburg | Sweden | ENV | C | O | EPLT, SM, DIG |
| Gothenburg promotes sustainable consumption | 2016 | Gothenburg | Sweden | ENV | C | O | EPLT, DIG |
| Edinburgh in Bloom | 2010 | Edinburgh | UK | ENV | P, D, C | O | EPLT, GRO, SM, APP |
| Can local aspirations change the world? | - | Nantes | France | ENV, GOV | P, D | - | - |
| Digital 3D modelling of Rennes Metropole | 2018 | Rennes | France | ENV, GOV | D | O | EPLT |
| Sustainability street by street | 2012 | The Hague | Netherlands | ENV, GOV | D, C | O | - |
| Free State of Amsterdam | 2009 | Amsterdam | Netherlands | ENV, GOV, LIV | D | O | EPLT, GRO, SM |
| Munich develops flagship smart city district | 2016 | Lyon, Vienna, Munich | France, Austria, Germany | ENV, GOV, MOB | C | O | EPLT, SNSR |
| Masterplan Energy Transition Dortmund | 2012 | Dortmund | Germany | ENV, LIV | P, D, C | O | EPLT, WS, MEET |
| Energy efficiency through participation | 2011 | Malaga | Spain | ENV, LIV, PEO | P, D | O | EPLT, MEET |
| Cycle Superhighways | 2012 | Copenhagen | Denmark | ENV, MOB | P, D | O | EPLT, APP |
| Antwerp participatory budgeting | 2014 | Antwerp | Belgium | GOV | P, D | O | EPLT |
| Can local aspirations change the world? | - | Antwerp | Belgium | GOV | P, D | - | - |
| Ghent: Citizens' Budget: co-creation in practice | 2016 | Ghent | Belgium | GOV | D, C | O | EPLT, SM, MEET |
| Come out of your shell | 2016 | Ostend | Belgium | GOV | D | O | EPLT, SM, MEET |
| La fabrique citoyenne - The citizen factory | 2014 | Rennes | France | GOV | D | O | EPLT, MEET |
| SynAthina: Athens' community platform | 2013 | Athens | Greece | GOV | P, D | O | EPLT, MEET |
| Can local aspirations change the world? | - | Genova | Italy | GOV | D | O | - |
| Participatory Budget in Milan | 2015 | Milan | Italy | GOV | D | O | EPLT |
| Gdansk openness policy | - | Gdansk | Poland | GOV | P, D | O | EPLT, SM, MEET |
| Ursus Social Museum | 2014 | Warsaw | Poland | GOV | D | S | MEET, DEB |
| Decidim.Barcelona | 2015 | Barcelona | Spain | GOV | P, D | O | EPLT |
| Can local aspirations change the world? | - | Barcelona, Madrid, Zaragoza | Spain | GOV | P, D | - | - |
| CITIZEU project: E-citizen Dialogue Platform | - | Gijon | Spain | GOV | D | O | EPLT, GRO |
| Gijon's new governance model | 2016 | Gijon | Spain | GOV | D | O | EPLT |
| Area C - Milan's congestion charge zone | 2011 | Milan | Italy | GOV, MOB | D | O | - |
| Ghent Commons Transition Plan | 2017 | Ghent | Belgium | GOV, PEO | P, D, C | O | - |
| Majdan Solin! | - | Solin | Croatia | GOV, PEO | C | O | EPLT, MEET |
| POGON - Zagreb | 2009 | Zagreb | Croatia | GOV, PEO | P, D, C | O | ART, LECT, DEB, WS, LECT |
| CHAOS Method | 2015 | Oulu | Finland | GOV, PEO | D, C | S | EPLT, GRO, SM |
| Shake, shape and share your city! | 2013 | Nancy | France | GOV, PEO | P, D | O | LAB, EPLT, WS |
| The Labo Europe Rennes | 2017 | Rennes | France | GOV, PEO | D | O | EPLT, SM, MEET |
| Youth election project U18 | 1996 | Berlin | Germany | GOV, PEO | P, D | O | EPLT, MEET |
| OpenBorough | 2016 | Amsterdam | Netherlands | GOV, PEO | P, D | O | - |
| Vienna's neighbourhood oasis | 2015 | Vienna | Austria | LIV | C | O | MEET |
| Creating a one-stop-shop for young people | 2013 | Oulu | Finland | LIV | P | S | MEET, LECT, WS, LECT, EPLT |
| Investing in children and their families | 2013 | Nantes | France | LIV | P | S | MEET, LECT, WS, LECT, EVNT |
| The 'great debate': Nantes, la Loire, and us | 2014 | Nantes | France | LIV | D | O | MEET, DEB, EPLT |
| SeniorNetworks | 2002 | Cologne | Germany | LIV | P | S | MEET, GRO, EVNT |
| Bologna - Incredibol | 2010 | Bologna | Italy | LIV | P | O | EXH, GAME, LECT, WS |
| Cities' strategies against homelessness: the integrated chain approach | 2013 | Rotterdam | Netherlands | LIV | P | S | MEET, GRO, EVNT |
| Improving accessibility for people with disabilities | 2013 | Ljubljana | Slovenia | LIV | P, D | S | EXH, LECT, WS |
| Welcome to Sweden. The Gothenburg language introduction centre | 2013 | Gothenburg | Sweden | LIV | P | S | MEET, GRO, EVNT |
| Gothenburg - Turn International | 2012 | Gothenburg | Sweden | LIV | P, D | S | EPLT |
| Project Filur - Stockholm | 2010 | Stockholm | Sweden | LIV | P | S | MEET, GRO, EVNT |
| Mentoring its young people, The CO-MENT (Collaborative Mentoring) | 2013 | Belfast | UK | LIV | P | S | MEET, LECT, LECT, EVNT |
| The Youth Hub | 2013 | Birmingham | UK | LIV | P | S | MEET, EVNT |
| Tackling unemployment at local level | 2013 | Newcastle | UK | LIV | P | S | MEET, GRO, EVNT |
| Ghent: Bridges to, on and from The Site | 2007 | Ghent | Belgium | LIV, PEO | D | O | MEET |
| Artistic involvement – a temporary society is active in a specific neighbourhood during 30 months to empower the neighbourhood | - | Ostend | Belgium | LIV, PEO | C | O | EPLT, MEET |
| Cities welcome refugees: Helsinki | 2015 | Helsinki | Finland | LIV, PEO | P | S | - |
| Shared productions | 2009 | Nantes | France | LIV, PEO | C | O | - |
| Hamburg: citizen participation in refugee integration | 2015 | Hamburg | Germany | LIV, PEO | P, D | S | - |
| Leipzig Pass | 1992 | Leipzig | Germany | LIV, PEO | P | S | EVNT, EXH, MEET |
| Cities welcome refugees: Gdansk | 2015 | Gdansk | Poland | LIV, PEO | D | O | - |
| Beavers - Festival of Culture and Art Education | 2009 | Ljubljana | Slovenia | LIV, PEO | C | O | - |
| A City for All | 2013 | Barcelona | Spain | LIV, PEO | P | S | MEET, GRO, EVNT |
| CreArt - networking creative cities | 2012 | Valladolid | Spain | LIV, PEO | P, C | S | EPLT, WS, MEET, ART, LECT |
| Brighton & Hove shapes future through creativity | 2015 | Brighton | UK | LIV, PEO | - | - | - |
| Leeds boosts migrant support project | 2014 | Leeds | UK | LIV, PEO | C | S | EPLT, MEET |
| European Platform on Sustainable Urban Mobility Plans | 2014 | Gent, Copenhagen, Krakow, Funchal, Maribor | Belgium, Denmark, Poland, Portugal, Slovenia | MOB | P, D | O | EPLT |
| Intelligent Transport Systems Factory | 2012 | Tampere | Finland | MOB | C | O | EPLT |
| Lindholmen Science Park | - | Gothenburg | Sweden | MOB | C | S | - |
| Assistance for independent living, Sofia | 2016 | Sofia | Bulgaria | MOB, LIV | P, D | S | EPLT, GRO, SURV |
| Contact Visits Vienna | 1977 | Vienna | Austria | PEO | P, D | S | MEET |
| Cities welcome refugees: Vienna | 2015 | Vienna | Austria | PEO | P | S | - |
| Nicosia Pop Up Festival | 2016 | Nicosia | Cyprus | PEO | C | O | EPLT, SM, MEET |
| KomKuK - linking up creatives | 2015 | Dusseldorf | Germany | PEO | C | O | EPLT, WS, MEET, LECT, EXH |
| Cities welcome refugees: Leipzig | 2015 | Leipzig | Germany | PEO | P | S | - |
| SynAthina | 2013 | Athens | Greece | PEO | D | O | - |
| Zaikin's Park, a park for the community | 2000 | Chisinau | Moldova | PEO | C | S | EXH, EXH, GAME, LECT, WS |
| Cities supporting e-inclusion and citizen participation | - | Malaga | Spain | PEO | P, D | O | EPLT |
| Leeds 2023 - Culture for transformation | 2017 | Leeds | UK | PEO | C | O | EPLT, SM, MEET, EVNT |
| The Liverpool Air Project | 2015 | Liverpool | UK | PEO | D | O | EPLT, SM, MEET |
| Cities Supporting eInclusion and citizen participation | 2016 | Birmingham, Braga, Ghent, Malmo, Munich, Nantes, Rotterdam, Vienna | UK, Potugal, Belgium, Sweden, Germany, France, Netherlands, Austria | PEO | P | O | EPLT, MEET |

**Research literature survey**  **EUROCITIES network survey**

Databases

WOK   SCO   DGRL   EUROCITIES network

❶ Selection of papers and case studies about citizen participation in smart cities

formal query   formal query   formal query   formal query

208 papers   272 papers   53 papers   86 case studies

merge

❷ Removal of duplicates

430 unique papers

filter   filter

❸ Selection of participative initiatives in European smart cities

56 initiatives (from 34 papers)   93 initiatives
**65 analysis cases (29 cities; 16 countries)**   **112 analysis cases (62 cities; 20 countries)**
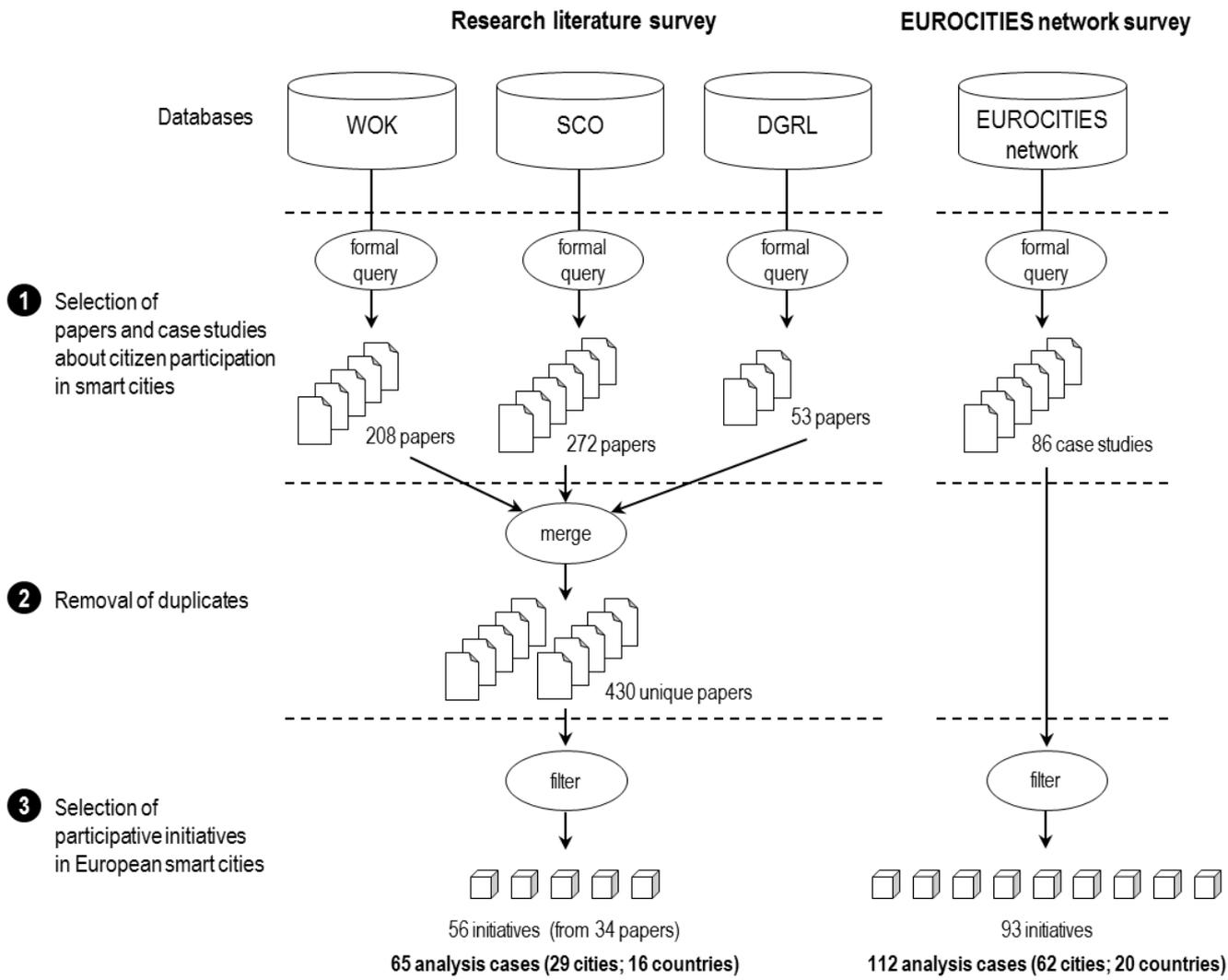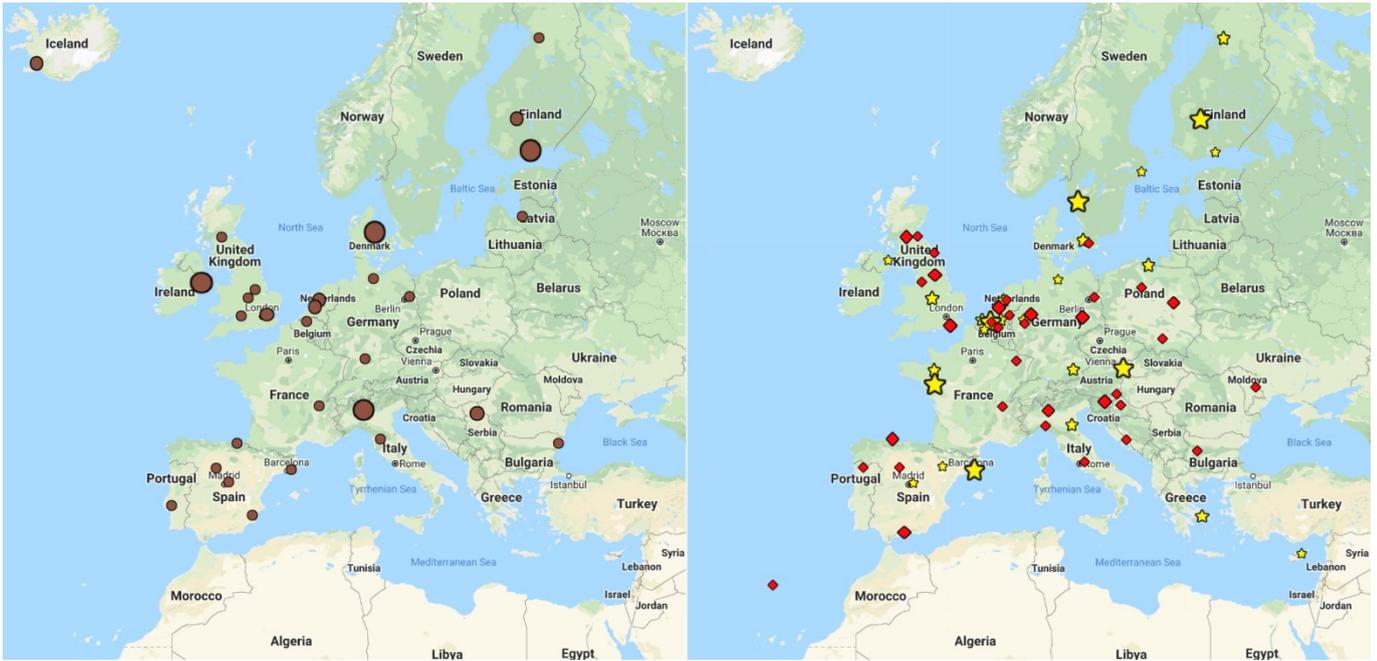
**Figure 1.** Followed survey methodology.

**Figure 2.** Cities where the analyzed smart city initiatives were implemented: collected only from the research literature (left) and only from EUROCITIES network website (right). The size of a marker is proportional to the number of initiatives in the corresponding city. Star markers correspond to creative cities in EUROCITIES network.
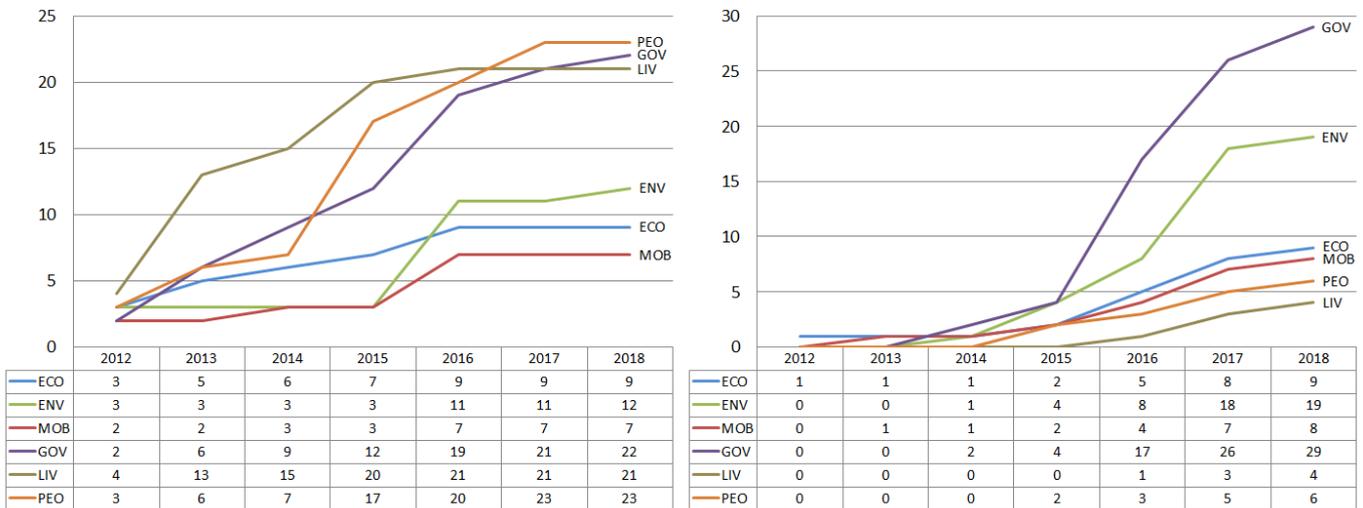


**Figure 3.** Cumulative distribution of initiatives from the research literature (left) and EUROCITIES network (right) per SC dimension and year.
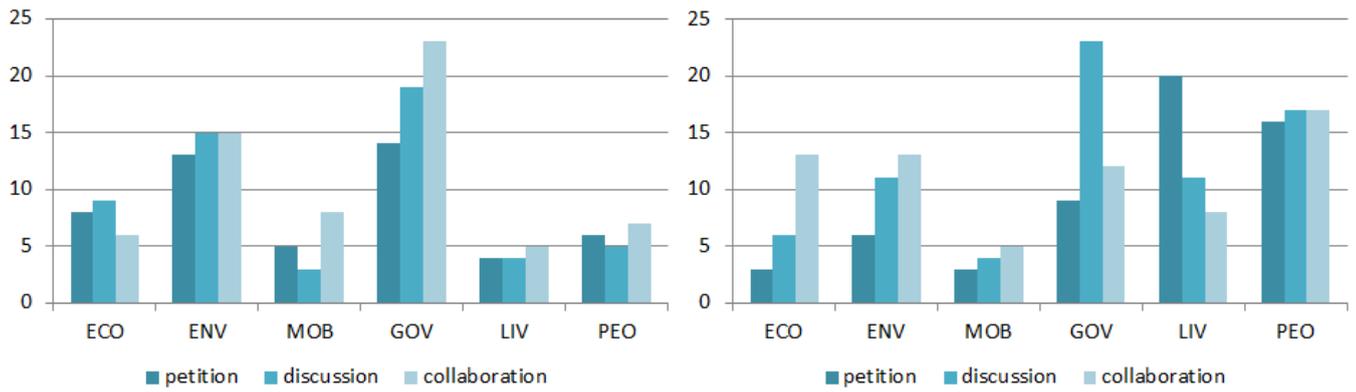
**Figure 4.** Level of participation in initiatives from research literature (left) and EUROCITIES network (right) per SC dimension.
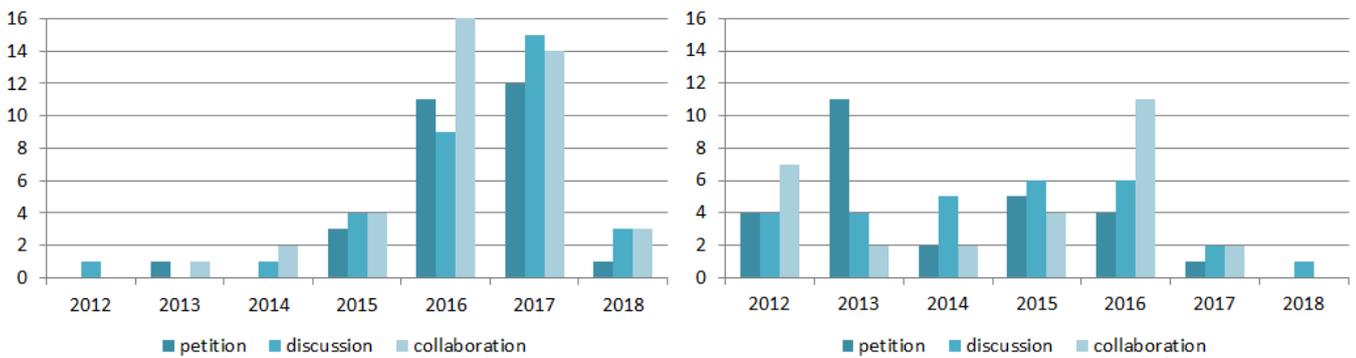


**Figure 5.** Evolution over time of the number of research literature (left) and EUROCITIES network (right) initiatives with each participation level.
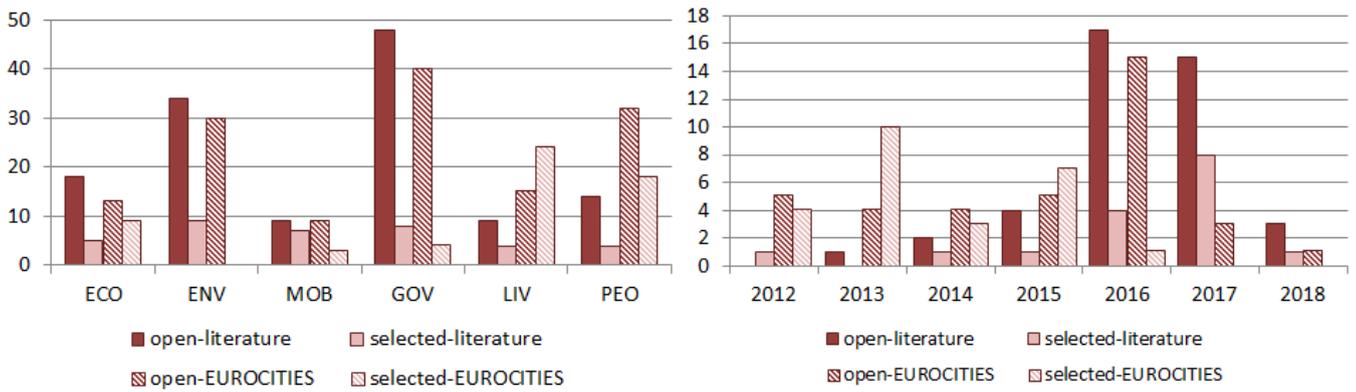


**Figure 6.** Type of participation in initiatives from research literature and EUROCITIES network per SC dimension (left) and year (right).
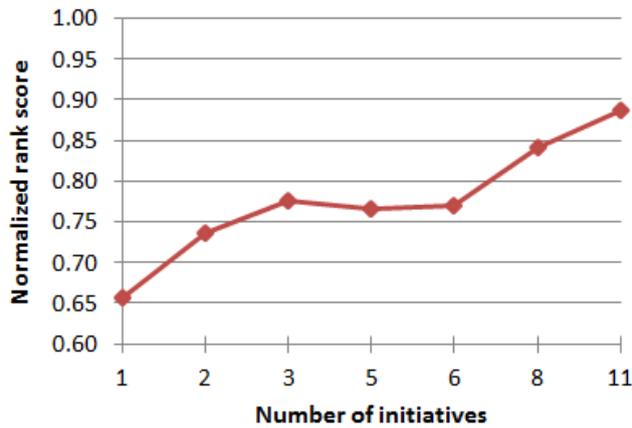
**Figure 7.** Average normalized rank scores of EUROCITIES network cities with respect to the number of participative SC initiatives.



| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| ECO | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 9 |
| ENV | 0 | 0 | 1 | 2 | 3 | 3 | 3 | 3 | 5 | 5 |
| MOB | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 4 | 4 |
| GOV | 0 | 1 | 1 | 2 | 2 | 4 | 5 | 6 | 8 | 8 |
| LIV | 1 | 2 | 2 | 3 | 5 | 8 | 9 | 10 | 11 | 11 |
| PEO | 1 | 3 | 3 | 4 | 5 | 6 | 7 | 11 | 12 | 13 |

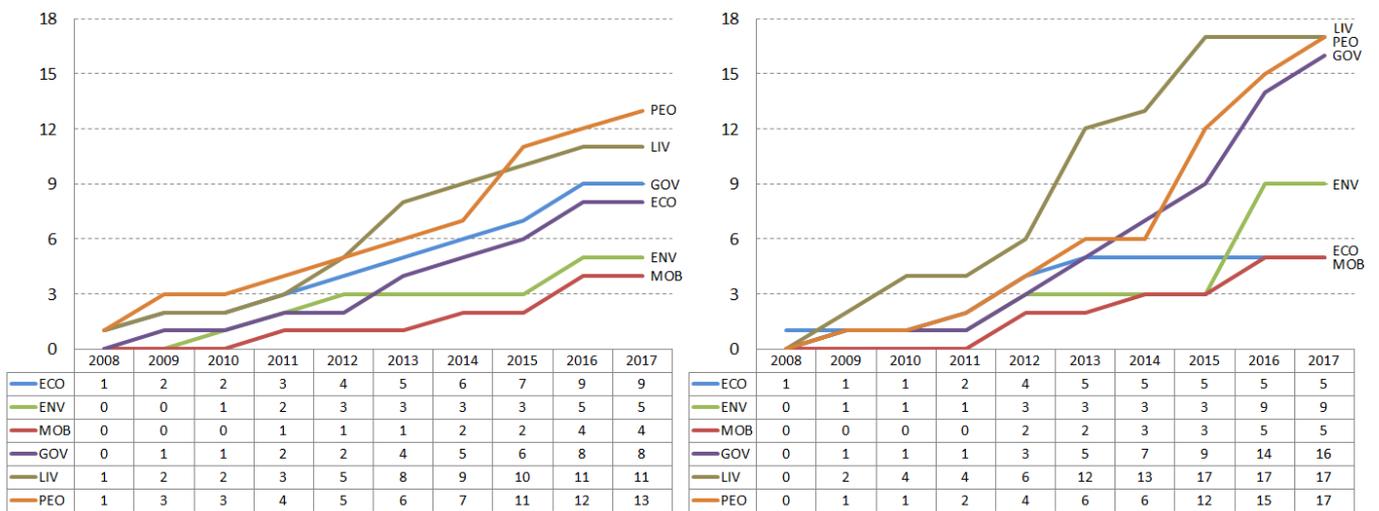| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| ECO | 1 | 1 | 1 | 2 | 4 | 5 | 5 | 5 | 5 | 5 |
| ENV | 0 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 9 | 9 |
| MOB | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 3 | 5 | 5 |
| GOV | 0 | 1 | 1 | 1 | 3 | 5 | 7 | 9 | 14 | 16 |
| LIV | 0 | 2 | 4 | 4 | 6 | 12 | 13 | 17 | 17 | 17 |
| PEO | 0 | 1 | 1 | 2 | 4 | 6 | 6 | 12 | 15 | 17 |

**Figure 8.** Cumulative distribution of surveyed initiatives from EUROCITIES network per SC dimension and year: non-creative cities (left) vs. creative cities (right).
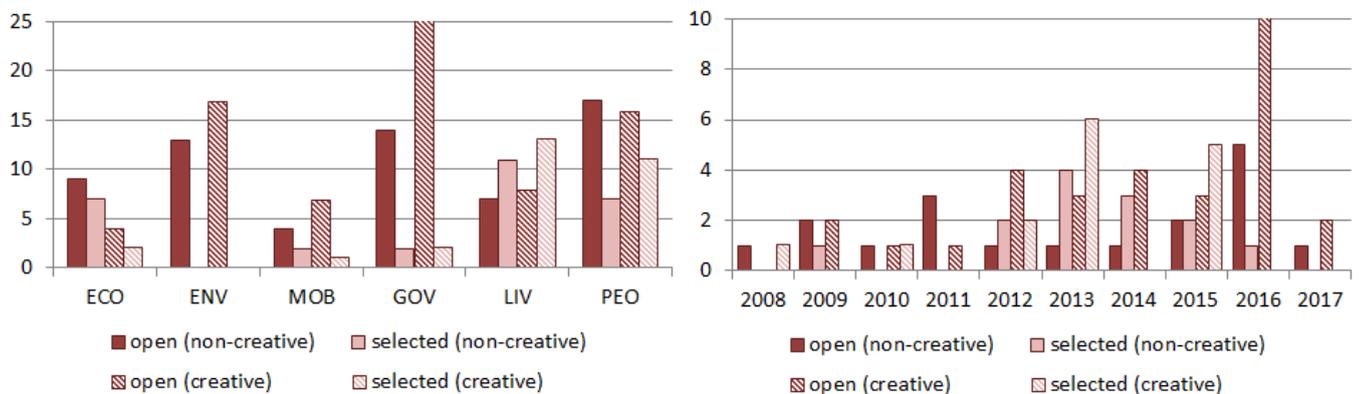


**Figure 9.** Type of participation in initiatives from non-creative and creative cities per SC dimension (left) and year (right).

**Table 1.** Keywords used in the formal queries to collect research papers about citizen participation.

| Citizen participation keywords | | |
|---|---|---|
| citizen* participation | digital participation | co-participation |
| citizen* collaboration | electronic participation | co-design |
| citizen* cooperation | e-participation | co-production |
| citizen* involvement | smart participation | co-creation |
| citizen* engagement | participatory innovation | co-decision |

**Table 2.** Co-occurrences of SC dimensions addressed by the initiatives from the research literature (left) and EUROCITIES network (right). The values along the matrix diagonals correspond to the numbers of initiatives addressing each dimension.

| | Literature review | | | | | | EUROCITIES network | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ECO | ENV | MOB | GOV | LIV | PEO | ECO | ENV | MOB | GOV | LIV | PEO |
| ECO | **9** | 3 | 2 | 2 | 2 | 3 | **16** | 1 | 0 | 3 | 2 | 5 |
| ENV | - | **19** | 3 | 5 | 3 | 2 | - | **19** | 4 | 7 | 3 | 1 |
| MOB | - | - | **8** | 2 | 1 | 2 | - | - | **10** | 4 | 1 | 0 |
| GOV | - | - | - | **29** | 2 | 3 | - | - | - | **34** | 2 | 9 |
| LIV | - | - | - | - | **4** | 1 | - | - | - | - | **32** | 15 |
| PEO | - | - | - | - | - | **6** | - | - | - | - | - | **37** |

**Table 3.** Co-occurrences of participation levels in the research literature (left) and EUROCITIES network (right) initiatives.

| | Literature review | | | EUROCITIES network | | |
|---|---|---|---|---|---|---|
| | petition | discussion | collaboration | petition | discussion | collaboration |
| petition | **28** | 21 | 17 | **45** | 28 | 7 |
| discussion | - | **33** | 20 | - | **52** | 12 |
| collaboration | - | - | **40** | - | - | **42** |

**Table 4.** Top 10 participation tools used in the research literature (left) and EUROCITIES network (right) initiatives.

| tool | num. initiatives | tool | num. initiatives |
|---|---|---|---|
| ad hoc e-platforms | 40 | ad hoc e-platforms | 55 |
| mobile apps | 16 | meetings | 41 |
| living labs | 15 | seminars/talks/lectures | 16 |
| social media | 13 | social and cultural events | 13 |
| software APIs | 9 | social media | 14 |
| datasets | 5 | workshops/symposiums | 14 |
| gamification | 5 | working/discussion groups | 12 |
| sensors - IoT | 5 | exhibitions/festivals | 8 |
| workshops/symposiums | 5 | gamification (competitions) | 4 |
| open data | 3 | debates/forums | 3 |