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Analysing the scientific evolution of e-Government using a science mapping approach

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ABSTRACT

This study presents a science mapping approach to analysing the thematic evolution of the e-Government field. We combine different bibliometric tools to analyse the evolution of the cognitive structure of this research topic, allowing us to discover the dynamics over different years and detecting the most prominent, productive, and highest-impact subfields. Science mapping provides a novel perspective to reveal the scientific frontiers and dynamic structure with visualization methods. Findings indicate symptoms of a research field in constant evolution that has not yet reached a stage of maturity, and specially, in the following areas of study: smart cities (provision of public services), e-Participation (political area) and technologies used and citizen's acceptance (technological tools).

1. Introduction

The implementation of information and communication technologies (ICTs) in public organizations has become a key objective in political agendas and governmental strategic programs (Gil-García & Pardo, 2005) as a central part of the process of modernizing the public administration (Chan & Chow, 2007). This process of modernisation and reform, broadly termed e-Government, has also enabled greater information accessibility and transparency (Jaeger & Bertot, 2010), improved public service delivery (Lindgren & Jansson, 2013), and produced greater interaction and citizens' participation in public administration (Zheng, Schachter, & Holzer, 2014).

The use of ICTs has been proved to be helpful for society to improve democratic models (Harder & Jordan, 2013; Puron-Cid, 2014), increasing trust in governments (Armstrong, 2011; Michener & Bersch, 2013) and improving citizen participation in public affairs (Harrison & Sayogo, 2014; Medaglia, 2012; Rodríguez Bolívar, 2015a). Also, it has helped governments to introduce electronic administration in public services (Girish, Williams, & Yates, 2014; Lindgren & Jansson, 2013), increasing organizational flexibility and agility to respond in a dynamic environment (Holgersson & Karlsson, 2014).

Nonetheless, previous studies (Alcaide Muñoz, Rodríguez Bolívar, & Garde Sánchez, 2014; Grönlund, 2004; Rodríguez Bolívar, Alcaide Muñoz, & López Hernández, 2016) have highlighted that the e-Government is a multi-disciplinary field of knowledge being analysed from different approaches. These studies have attempted to analyse the limitations of prior research in the e-Government field and the development of this research topic, offering a critical evaluation of e-Government research (Alcaide Muñoz & Rodríguez Bolívar, 2015; Andersen & Henriksen, 2005; Bélanger & Carter, 2012; Heeks & Bailur, 2007; Sannarnes, Henrinken, & Andersen, 2006) and using for this purpose bibliometric and scientometric methodologies with different approaches (Akkaya, Wolf, & Krcmar, 2010; Joseph, 2013; Snead & Wright, 2014).

However, performance analysis has not been performed in order to measure, quantitatively and qualitatively, the contribution of e-Government and the impact of the specific research themes on the field of knowledge, with the intention of understanding the dynamics over different years in the evolution of e-Government research and detecting the most prominent, productive, and highest-impact subfields. Rapidly thereafter, the desire to map the science landscape, graph the boundaries of knowledge domains, and understand the structural dynamics of the science phenomena has become a focus area for research (Archambeault, Bidian, & Evans, 2016).

Accurately forecasting the trajectories of scientific domains and technologies is essential to the investment strategies of public administrations to operate in the area of science and technology nowadays and in the future and, by this way, in their model of reforms. In this

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regard, a key question is (Van Raan, 2014): are there specific patterns hidden in the mass of published knowledge in e-Government at a meta-level, and if so, how can these patterns be interpreted? Here, science mapping provides a novel perspective to reveal the scientific frontiers and dynamic structure with visualization methods (Garfield, 1994).

Nonetheless, up to now, there are no studies in the e-Government research field which use performance analysis and science mapping in order to deal directly with sets of terms shared by documents, mapping the literature directly from the interaction of key terms. These tools could allow us to examine the evolution of the e-Government research topic and a longitudinal study based on an inclusion index could be used to detect conceptual nexuses between research themes in different periods (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011a, 2011b).

Therefore, the aim of this article is to present a general approach to analysing the thematic evolution of the e-Government research field. This approach combines performance analysis of science mapping for detecting and visualizing conceptual subdomains, using a methodology originally performed by Cobo et al. (2011a, 2011b). This approach allows us to quantify and visualize the thematic evolution of the e-Government research topic. Based on this knowledge, this paper contributes to previous studies on e-Government (Alcaide Muñoz & Rodríguez Bolívar, 2015; Andersen & Henriksen, 2005; Grönlund, 2004; Hofman, Räckers, & Becker, 2012; Joseph, 2013; Rodríguez Bolívar et al., 2016; Scholl & Dwivedi, 2014) in the use of the bibliometric and meta-analysis techniques.

To achieve the aim of this paper, we will perform a co-word analysis with a longitudinal framework which produces strategic diagrams in order to categorize the detected themes. Results show a graphical and dynamic vision of the e-Government field, identifying new topics that have appeared and others that have disappeared, gaps, and research areas for future study.

The remainder of the paper is organized as follows. Section 2 gives a brief overview of the utility of systematic literature reviews (bibliometric and scientometric studies), science mapping, and longitudinal studies. Section 3 details the methodological approach used to analyse the evolution of the e-Government research field. In Section 5, we analyse the results. Finally, conclusions and discussions are shown.

2. Utility of science mapping and longitudinal studies

Previous studies have identified many research themes in the field of e-Government, using bibliometric and scientometric methodologies with different approaches (Alcaide Muñoz, Rodríguez Bolívar, & López Hernández, 2016; Dwivedi & Weerakkody, 2010; Joseph, 2013; Sannarnes et al., 2006; Scholl & Dwivedi, 2014; Snead & Wright, 2014). These studies have analysed the limitations of previous research in the e-Government field and the development of this multidisciplinary research topic, offering a critical evaluation of e-Government research (Alcaide Muñoz & Rodríguez Bolívar, 2015; Bélanger & Carter, 2012; Rodríguez Bolívar et al., 2016). Also, these studies identified publication outlets, methodological approaches, data collection technique used by the academic, sampling, disciplines, countries analysed, institutions and authors who published the most articles in each research topic into the e-Government field (Alcaide Muñoz & Rodríguez Bolívar, 2015; Alcaide Muñoz et al., 2014; Rodríguez Bolívar et al., 2016; Scholl, 2009, 2013; Scholl, Janssen, Scholl, Wimmer, & Bannister, 2014).

This way, prior research has allowed members of the academic community to identify the historical roots of a determined field of study, the prospects for future research, and the trends in e-Government research to focus subsequent research (Sidorova, Evangelopoulos, Valacich, & Ramakrishnan, 2008). The contribution of these studies is, thus very important because they do not only serve as a synopsis of existing research, but also as an identifier of emerging trends, gaps, and areas for future studies, offering a descriptive state of the art in field of e-Government.

In the academic literature, meta-analytic studies can also be found about information technologies, digital government and public e-services (Arduini & Zanfei, 2014; Orlikowski & Iacono, 2001; Rana, Dwivedi, & Williams, 2015), and about transparency in governments and online disclosure of public financial information (Alcaide Muñoz et al., 2016; Rodríguez Bolívar, Alcaide Muñoz, & López Hernández, 2013). These studies identify the moderator variables explaining the heterogeneity of results regarding incentives for each one of the goals pursued in them (Rose & Stanley, 2005). This methodology is used as a robust statistical technique to draw overall conclusions from results obtained in previous statistical analysis. This technique enables the researcher to achieve clear, and coherent conclusions, systematically extracted from previous research and highlighting common points to all that would be difficult to identify by descriptive analysis alone or systematic review (Rosenthal, 1979).

Nonetheless, up to now, prior research has not analysed to the root of e-Government in order to offer dynamic evolution of this field of knowledge, which allow us to have a clear idea of the origin of the e-Government themes, their evolution over time, the disappeared research topics, and those that are currently in vogue. This analysis could be of interest to identify the trend in research of the e-Government field of knowledge, as well as to examine the specialization of certain research topics.

This way, in the last few years, novel methods have been used show research change and continuity over time (Cocosila, Serenko, & Turel, 2011). An analytical procedure that capture this essence is known as science mapping (Cobo et al., 2011a), which displays the structural and dynamic aspects of scientific research (Börner, Chen, & Boyack, 2003; Cobo et al., 2011a, 2011b), and is a spatial representation of how disciplines, fields, specialities, and individual papers or authors are related to one another (Small, 1999). It is focused on monitoring a scientific field and delimiting research areas to determine their cognitive structure and evolution (Cobo et al., 2011b).

In this study, we carried on a co-word analysis to build a science map (Small, 2006). It is a content analysis technique that is effective in mapping the strength of the association between information items in textual data (Callon, Courtial, Turner, & Bauin, 1983). According to Cobo et al. (2011a), this study deals directly with sets of terms shared by documents, mapping the pertinent literature directly using the interactions of key terms. This technique returns a set of clusters which can be understood as conglomerates of different scientific aspects. They allow the analysis of the research topics' dynamic evolution by measuring continuance across consecutive sub-periods (Cobo et al., 2011a, 2011b). In addition, it is possible to use a longitudinal framework in order to analyse the evolution of a research field along consecutive time periods (Garfield, 1994).

In other words, this study allows us to show conceptual evolution that describes how e-government is conceptually, intellectually, and socially structured. It attempts to find representations of intellectual connections within the dynamically changing system of scientific knowledge (Cobo et al., 2011b). Also, constructing a map of relationships of e-Government could show us areas that are proximate and facilitate the making of new connections between them. At the very least such a map can aid us in tracking how these relationships change as new discoveries are made, and perhaps lead to a more informed management of science and information (Small, 1997). This way allows the academic, researchers and Ph. D. students to set up a solid theoretical framework, which support their studies, thesis, results and findings, as well as support the improvement of the maturity that e-Government field, as a science area, needs. On the other hand, the public managers and policy-makers could know the research topics that have been further analysed with successful results, which allow them to have a clear idea of the projects to undertake and to invest resources (Lee, 2008).

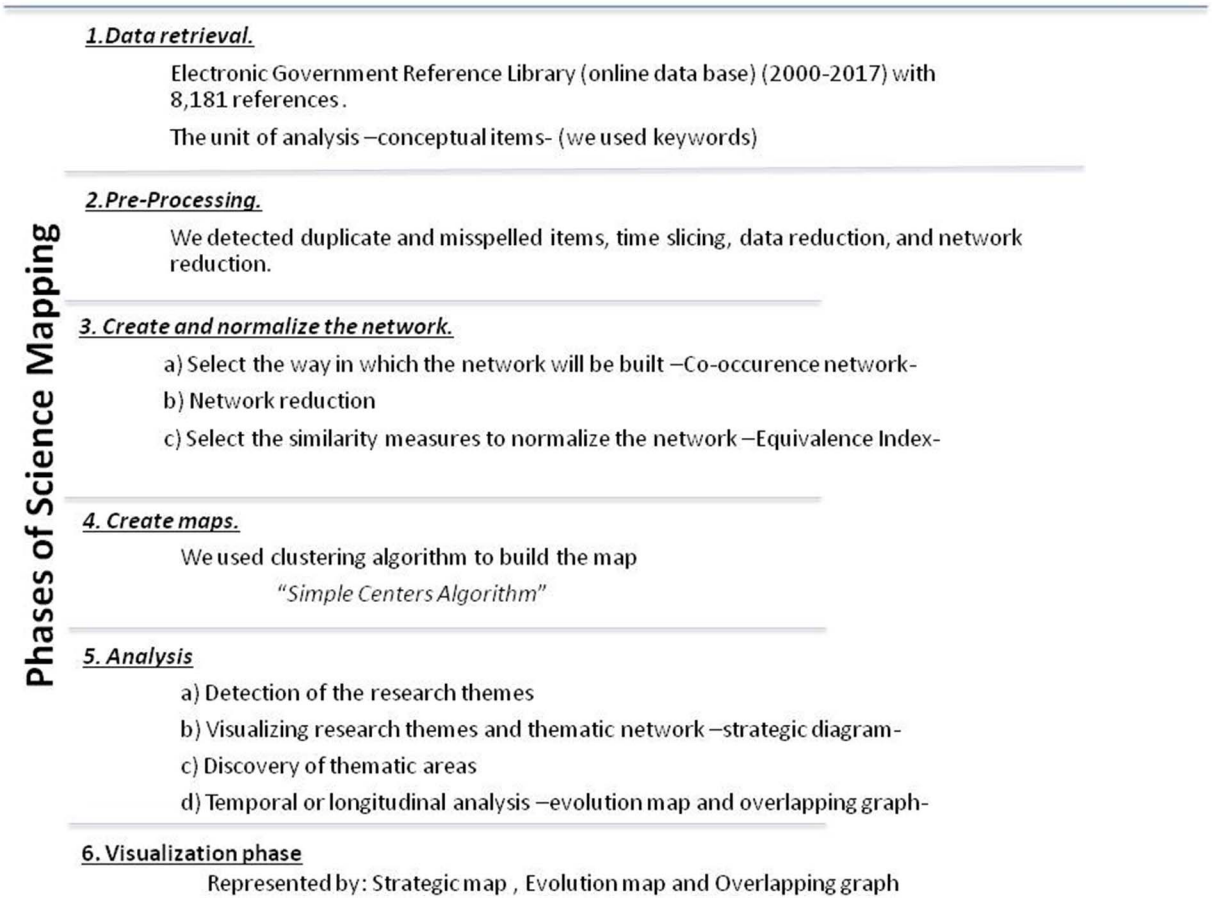

Fig. 1. Workflow of science mapping.
(Source: Own elaboration based on Cobo et al. (2011b).)

3. Methodology and software tool

Keeping in mind the aim of this paper, we used SciMAT (http://sci2s.ugr.es/scimat), which is a powerful open source science mapping software tool. It allows us to analyse the evolution and relevance of the literature focused on e-Government. This tool was designed according to the science mapping analysis approach, which allow us to analyse a research field, to detect and visualize its conceptual subdomains (particular topics/themes or general thematic areas) as well as to perform a longitudinal framework in order to analyse and track the conceptual, intellectual or social evolution of e-Government through the course of consecutive time periods (Cobo et al., 2011a).

With the intention of carrying out an exhaustive analysis, we describe each step of workflow in our science mapping analysis. According to Börner et al. (2003) and Cobo et al. (2011b), a science mapping analysis has different steps: data retrieval, data preprocessing, network extraction, network normalization, mapping, analysis and visualization. At the end of this process, the authors have to interpret and obtain conclusions from the results (see Fig. 1).

1. *Data retrieval phase*. First, the authors have to decide which the online bibliographic databases is appropriate. In our study, we used the Electronic Government Reference Library (EGRL) database (http://faculty.washington.edu/jscholl/egrl/), because it is the greatest comprehensive database in the study domain of electronic government (Dwivedi, Singh, & Williams, 2011; Scholl, 2010a, 2010b). It now contains 8181 (1981–2017) references of predominantly English-language, peer-reviewed studies about e-Government. The time period of the analysis is the time horizon 2000–2016 (there is only one article in 2017, so it is not considered) and the selected unit of anlaysis is the keyword analysis. In this way, we carried on a longitudinal or temporal analysis to study the structual evolution of the e-Government field (research themes).
2. *Pre-processing phase*. We preprocessed the data in order to detect duplicate and misspelled items, time slicing, data reduction, and network reduction. In the case of data reduction, the SciMAT allows to filter the data using a minimum frequency as a threshold, i.e., only the units of analysis (keywords) with a frequency greater than or equal (in a given period) to the selected threshold are considered.
3. *Create and normalize the network phase*. The network is built using co-occurrence network. Then the network is filtered to keep only the most representative items. Finally, a normalization process is performed using a similarity measure (see Fig. 1).
4. *Apply a clustering algorithm to get the map phase*. Once the normalization process was finished, we applied a technique to build the science map and its associated clusters, called "*Simple Centers Algorithm*" (Coulter, Monarch, & Konda, 1998).
5. *Analysis phase* – see Fig. 1. Finally, we performed analysis methods which allowed us to discover useful knowledge from data, networks, and maps (Cobo et al., 2011b). It is focused on monitoring a scientific field and delimiting research areas to determine its cognifitve structure and its evolution (Noyons, Moed, & Van Raan, 1999). For this, we established four steps in order to analyse a research field in a longitudinal framework:

a) *Detection of the research themes*. In each period studied, the corresponding research themes were detected by applying the simple centres algorithm (Coulter et al., 1998) to a normalized co-word network. The clustering process locates keyword networks that are strongly linked to each other and that correspond to centres of

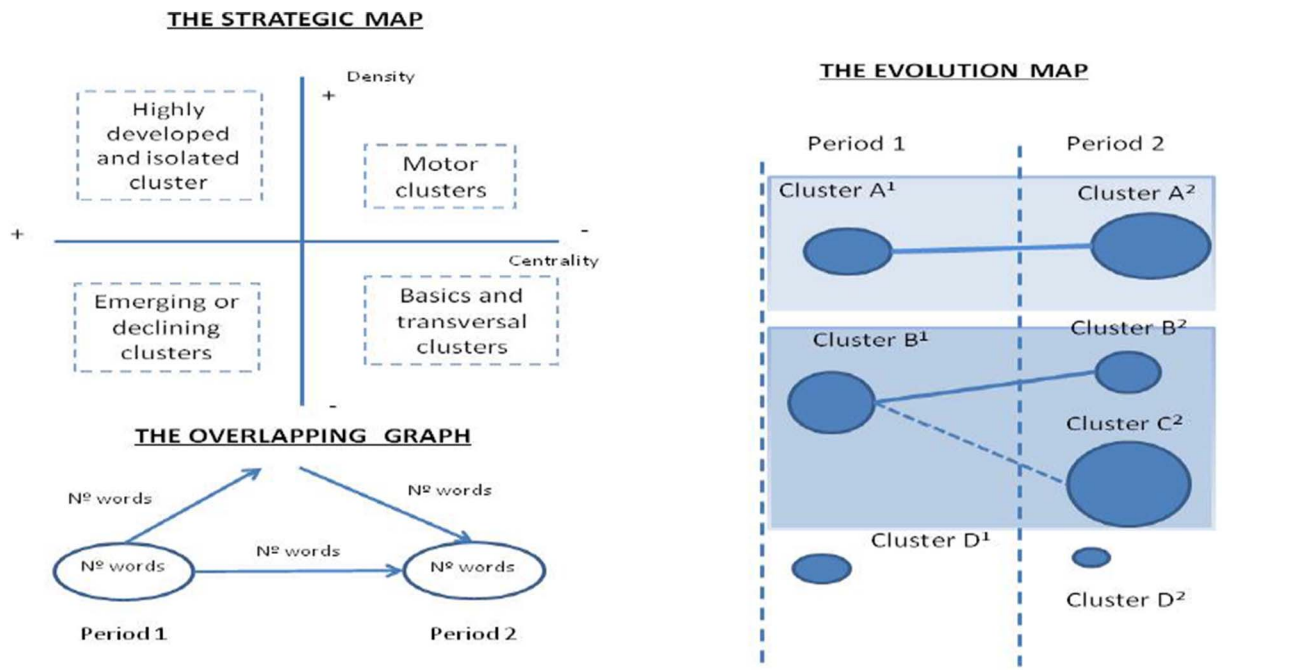

Fig. 2. Examples of Strategic Diagraph, Evolution Map and Overlapping Graph.EVOLUTION MAP: Cluster D^1 is discontinued, and Cluster D^2 is considered to be a new cluster. The solid lines mean that the linked cluster shares the main item (usually the most significant one). A dotted line means that the themes share elements that are not the main item. The thickness of the edges is proportional to the Inclusion Index, and the volume of the spheres is proportional to the number of published documents associated with each fluster.
OVERLAPPING GRAPH: The horizontal arrow represents the number of items share by both periods. The upper incoming arrow represents the number of new items in period 2, and the upper outgoing arrow represents the items that are presented in period 1, but not in period 2.
(Source: Own elaboration based on Cobo et al. (2011b).)

interest or to research problems that are the subject of significant interest among researchers.

b) *Visualizing research themes and thematic network*. In this phase, the detected themes were visualized by means of a strategic diagram (He, 1999). The strategic diagram (see Fig. 2) shows the detected clusters of each period in a two-dimensional space, and categorizes them according to *density and centrality* measures (Callon, Courtial, & Laville, 1991).

Centrality measures the degree of interaction of a network with another, and can be seen as the measure of the importance of a theme in the development of the entire research field analysed. On the other hand, *density* measures the internal strength of the network, and it should be interpreted as a measure of the theme's development. Given both measurements, a research field can be visualized as a set of research themes, mapped in a two-dimensional strategic diagram and classified into four groups: *motor cluster* (upper-right quadrant with high density and strong centrality – called "*motor themes*-); *highly developed and isolate clusters* (upper-left quadrant with marginal importance for the field – called "*specialized themes*"); *emerging or declining clusters* (lower-left quadrant with low density and low centrality – called "emerging or disappearing themes"); and *basics and transversal clusters* (lower-right quadrant themes not developed – called "*transversal and general themes*").

Discovery of thematic areas – Temporal or longitudinal analysis. In this phase, the evolution of the research themes over a set of periods of time is first detected and then analysed in order to identify the main general areas of evolution in the research filed, their origins, and their interrelationships. This allows us to discover the conceptual, social or intellectual evolution of the field. SciMAT is able to build an evolution map (Cobo et al., 2011a) and an overlapping items graph (Price & Gürsey, 1975) to detect the evolution areas (see Fig. 2).

For this purpose, the inclusion index is used to detect conceptual nexuses between research themes in different periods and, in this way, to identify the thematic areas in a research field. In addition, as each theme is associated with a set of documents, each thematic area could also have an associated collection of documents, obtained by combining the documents associated with its set of themes. In this sense, the *evolution map* shows temporal evolution of research themes of e-Government and the *overlapping graph* represents the number of associated keywords – see Fig. 2.

6. *Visualization phase*. Following the science mapping workflow, visualization techniques were used to represent a science map and the results of the different analyses. In this sense, the network results from the mapping step were represented by a strategic map, evolution map and overlapping graph (Cobo et al., 2011a). Finally, when the science mapping analysis was finished, it was time for experts to analyse the results and maps, using their experience and knowledge.

4. Analysis of the results

In recent years, the implementation of ICTs in the public sector has attracted the interest of researchers and scholars, and this has been reflected in a gradual increase in the number of studies published in international journals from 2000 to 2006, reaching a total of 8094 articles published on e-Government, specially, in the period 2000–2012 (see Fig. 3). This increase was higher in recent years (2009–2014), when there were a total of 4330 articles published, representing 53.50% of all e-Government articles published since 2000. Although it is remarkable the decline of articles published since 2013, being more evident in 2016.

4.1. Visualizing e-Government themes

In the first sub-period 2000–2004 (see Fig. 4), we can observe that "*countries*" and "*public administration*" are motor themes, i.e. these themes are well development and important for the structuring of the e-Government field. These research topics are related to how the e-

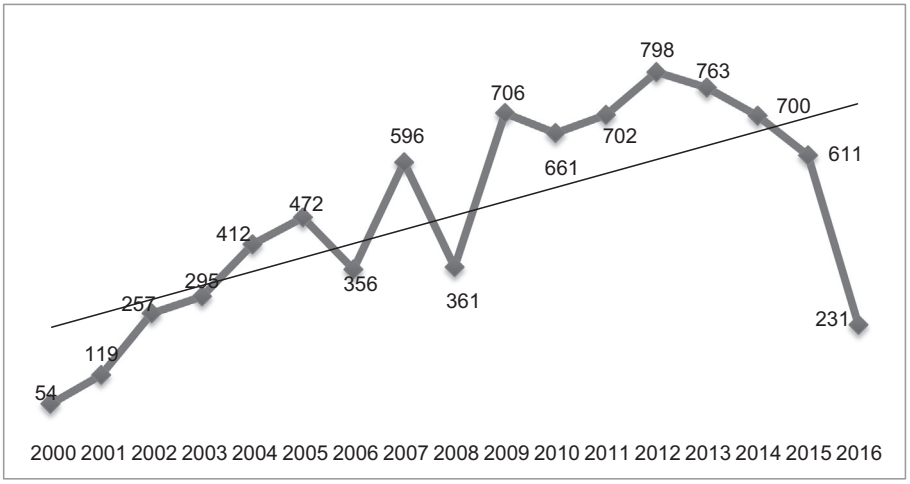

Fig. 3. Time sequence for articles on e-government (2000–2016).
(Source: Own elaboration.)

Government constitutes a central element in the process of modernising public administration and delivery of public online services (Gasco, 2003), favouring the development of the countries (Haldenwang, 2004). In addition, the new technologies suppose an institutional and technological innovation and organisational changes in public sector (Melitski, 2003).

Also, we can find that "*democracy*" is an important and development research topic in e-Government field. These studies are focused on how ICTs favour the formal political process, with more effective communication and informed citizens' participation in decision-making about public issues, using new and more advanced technologies and tools. However, the "*community*" research theme is an emerging research area, weakly developed (see Fig. 4). The main research contributions in this area were initially focused on citizens and how they play a crucial role in the process of e-Participation. They can be consulted by the governments through ICT-based platforms and Websites, getting

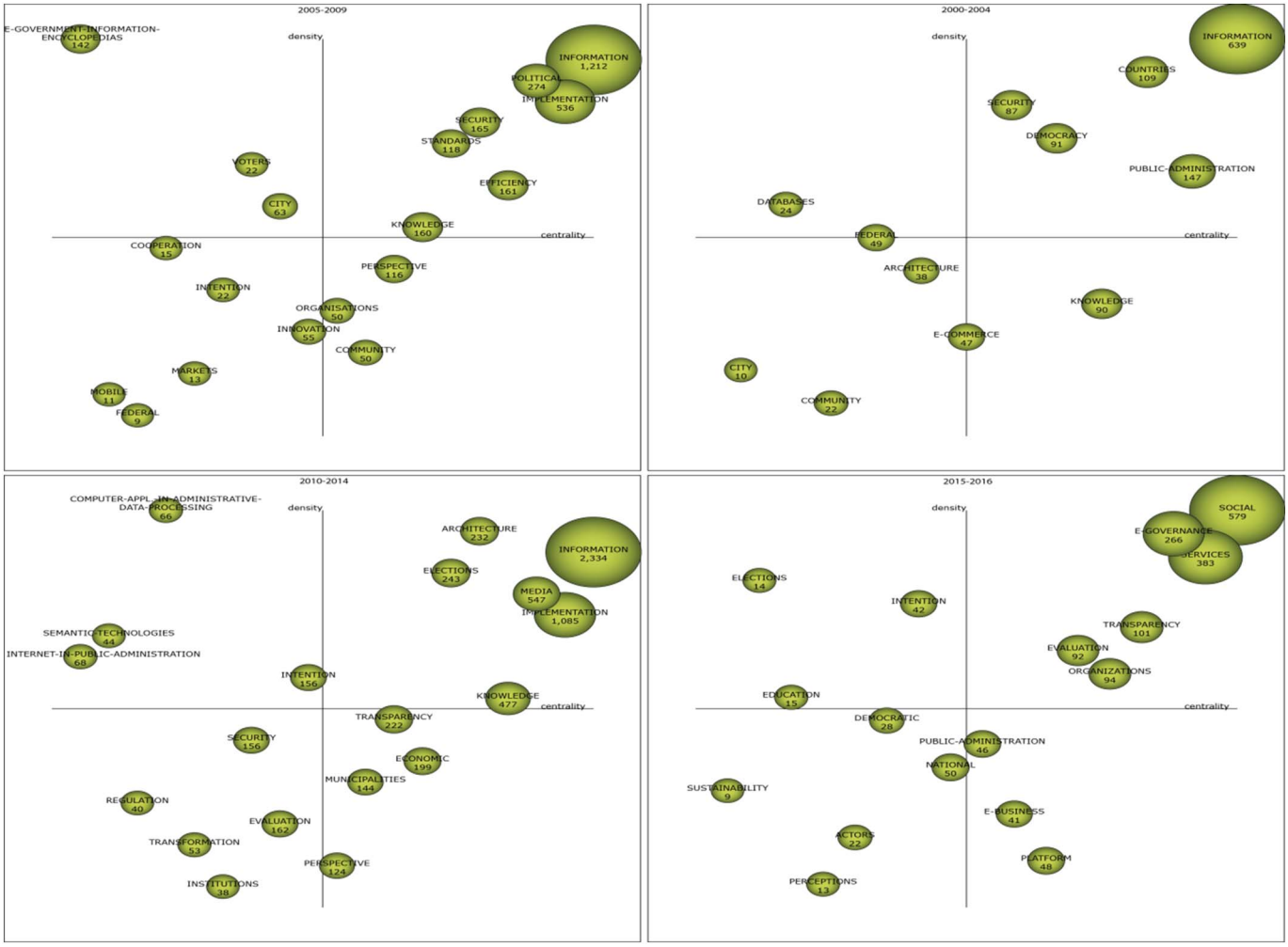

Fig. 4. Strategic diagrams from 2000 to 2016.
(Source: SciMAT.)

involved in public affairs and asserting their rights, configuring virtual communities.

In addition, e-Government studies adopt different approaches and levels of governments – state and local governments. Studies on federal governments are related to federal normative, laws and policies of e-Government, as well as, management and coordination of strategic projects. Meanwhile, studies on cities and municipalities are related with the implementation of e-services in local government, because they are considered the closest tier of government to citizens (Cegarra, Córdaba, & Moreno, 2012), manage very large budgets, and provide a wide variety of services, which lead local governments to be a central focus on public sector reforms (Smith & Fridkin, 2008).

On the other hand, "*security*" is another motor research area (see Fig. 4). These studies are focused on e-Voting systems security, privacy strategies, secure data collection, digital signatures and privacy of personal data. Also, academics analyse how digital identification tools increase the trust of citizenry in new technologies, platforms, apps, and systems (Banaszak & Rodziewicz, 2004). In this sense, there is a research theme that is emerging – "*architecture*". These studies have analysed how the architectures arbitrary-nested favour delivery integrated public services, which allow the highly available Websites compositions execution (Lakhal, Kobayashi, & Yokota, 2004).

Finally, "*e-commerce*" is an emerging research topic that is becoming a basic area. In this area, we find research about how the implementation of new technologies and framework of e-Government increases organizational flexibility and favours online public services delivery (West, 2004), and analyze the management of e-transformation in the public sector (Reddick, 2004). "*Knowledge*" is also a basic research theme that will become in motor theme due to its central feature of the functioning of government.

In the second sub-period 2005–2009 (see Fig. 4), we can observe that "*political*" is an important area for the structuring of the e-Government field. Here, the studies focus on e-Participation, i.e. how new technologies have allowed citizens greater involvement in public affairs (for example for the design of improved public services), and how governments use platforms and apps to create more affordable, participatory and transparent public sector management models. In addition, virtual "*communities*" have evolved from being an emerging topic to becoming a basic area, and "*voters*" topic has become in a specialized theme.

On this last case, the researchers focused their studies on activities that used ICTs in order to enable and enhance the formal procedure of voting, demonstrating that the adoption of e-Voting systems has the potential to positively affect democratic deliberation and citizen engagement in politics (Bannister & Connolly, 2007). These empirical articles highlighted that the adoption of ICTs could make a significant contribution to the achievement of good governance goals, making governance more efficient and effective (Dawes, 2008).

Likewise, "*security*" and "*standards*" have taken a greater presence in the e-Government area (see Fig. 4), given that it is necessary to guarantee security and privacy in all online processes, setting security protocols in e-Voting systems and storage of personal data, which increase the citizen trust in e-Government.

Furthermore, as noted previously, "*knowledge*" is a well-developed and important theme, which favours a knowledge sharing and cooperation between organizations. Hence, "organizations" have become in a basic theme (see Fig. 4). These studies focus on institutional infrastructure inside governments, structural risk and factors that affect the successful of e-Government implementation, cooperation in the creation of open source software, as well as, the building of interoperable system (Janssen & Scholl, 2007).

Related to the above topics, we find with "*implementation*" and "*efficiency*" (motor themes), and "*innovation*" (emerging theme). Indeed, numerous governments have made huge investments in order to provide extensive and proactive online services and that, interest began to be identified in the factors that determine the public's acceptance of e-Government services (Hung, Chang, & Yu, 2006), as well as, risks that could jeopardize complex innovation process in public sector (Hartley, 2005).

"*City*" became a specialized topic, and there was a change to knowing the satisfaction, trust and attitudes of citizenry ("*perspective*" is a basic theme). In other words, the services began to propose a more user-oriented approach, where the citizen must be placed at the centre of the development and the provision of electronic public services. Hence, research was focused on the development of a comprehensive model for measuring user satisfaction (Verdegem & Verleye, 2009), since user satisfaction has a decisive influence on adoption and use of online services.

Finally, in this period of time, academics tried to analyse the greater interaction between politicians, public managers and citizens, hence this dialogue has been directed through "*mobile*" phones (emerging theme), which have been used by governments to provide more access to information and services for citizens, businesses, and civil servants (Ntaliani, Costopoulou, & Karetsos, 2008). In this direct contact play a key role call-centres, online kiosks, libraries or/and civic centres, which favours social inclusion of disadvantaged citizens ("*e-Government-information-encyclopedias*" is a specialized topic).

In the third sub-period 2010–2014 (see Fig. 4), we can observe that "*elections*" and "*media*" are motor themes. Researchers show a particular interest in social networks and other Web 2.0 tools as communication channels favouring interactions with citizenry and increasing efficiency and quality of public services (Rodríguez Bolívar, 2015a, 2015b). In this sense, academics try to analyse the usefulness of social media and social networks for different purposes such as political campaigns (Williams & Gulate, 2013).

Similar to the previous period, "*implementation*" and "*knowledge*" are motor themes and important for the structuring of e-Government field. However, "*municipalities*" have increased the interest of academics (it is a basic research topic). These studies have investigated the factors that might contribute to the establishment of trusting relationship between city councils and citizens, and favours development of civic engagement (Cegarra et al., 2012). In addition, "*transformation*" and "*institutions*" are weakly developed themes (see Fig. 4). These studies analysed t-Government, structural changes and greater benefits in the public sector, as well as impediments blocking transformation.

In this context, research focuses on determining a set of usability factors for evaluating e-government websites and describes causal effects, which determine the extent to which e-government website usability affects user satisfaction and their intention to revisit sites for continued usage, hence, "*evaluation*" is an emerging theme (see Fig. 4). And the "*perspectives*" (it is basic topic) keep its relevance to capture citizens' attitudes, satisfaction, trust and acceptance of e-Government.

Likewise, many governments have hard-worked to increase openness and transparency to disclose information, and how this openness reduces corruption, hence, "*transparency*" is now a basic theme, but it will become a motor theme in the next sub-period. Finally, "*regulation*" is a marginal and a weakly developed theme, "*semantic-technologies*" and "*computer-application in administrative data processing*" are specialized research topics. All of them will disappear in the next subperiod of time.

In the last sub-period 2015–2016 (see Fig. 4), we can analyse what the research trends will be in the next few years. In this figure we can observe that the "*social*" media, "*e-Governance*" and "*services*" will be the research topics that will structure and shape the e-Government's field of knowledge. Specially, these approaches are analysed under Smart City context, i.e. how the smarter technologies engage citizen in creating new set of services, become active users, favouring the participation and cooperation among all stakeholders. In this sense, the citizenship could access rich information and get involved in public affairs, being easier the interaction with public managers and politicians and their participation in the decision-making process ("*transparency*" is a motor theme).

In addition, "*evaluation*" will be an important research topic in e-Government field (see Fig. 4). Here, the studies focus on identifying and quantifying cost and benefits derived from successful e-Government systems (services, e-Participation applications, Websites, smart card, social media tools, infrastructures, institutional changes, and so on), implementation and adoption. These findings could be helpful to overcome obstacles by early adopters (for example, governments in developing countries), knowing in advance the institutional environment to lead to a positive impact of ICTs on public administration ("*organizations*" is also a motor theme).

On the other hand, the use of Web 2.0 technologies and social network tools support civic discourses, improve legitimacy of political processes, and nowadays, they have gained momentum. It has favoured a more "*democratic*" society (Kropczynski, Guoray, & Carroll, 2015) (see Fig. 4). In this context, elected politicians and candidate see social media and Web 2.0 tools as an opportunity to communicate with the public, giving citizens a more active advisory role in public affairs. But this research topic has lost interest, and has become an unimportant external tie ("*elections*").

4.2. 4.2. Analysis of evolution detected throughout the different sub-periods

In each sub-period the keywords are not the same, in a lexicographic sense or in number. That is, the e-Government terminology evolves throughout the time period, using different keywords to describe the content of the documents. New topics with their associated keywords appear and others disappear. On the other hand, there is a subset of keywords that have remained unchanged during consecutive sub-periods (internet, services, citizens, e-Voting, deliberation, public opinion, democracy, or society) and a subset of keywords that has only been used in some sub-periods, for example: incoming keywords (social media, open data, twitter, smart city, or disabled users) and outgoing keywords (administrative reform, transactions costs, anti-corruption, electronic archive, or e-modernization).

Based on the philosophy of Price and Gürsey (1975), Fig. 5 shows that the number of new and transient keywords is high, and similarly, the number of shared keywords between successive sub-periods has decreased; thus the lower similarity index (0.34, 0.33 and 0.30). These signs are symptoms of a research field in constant evolution that has not yet reached a stage of maturity.

Once the keywords' evolution was analysed, we studied the thematic evolution of the research e-Government field through the thematic areas (see Fig. 6). Many results achieved in this epigraph confirmed the evolution initially shown in the previous section.

Initially, research was related to how e-Government phenomenon can modernize, transform and innovate governments in order to delivery public services, disclosure of information and favour participation of citizenry in public affairs ("*public administrations*" and "*countries*"). These studies continued with the identification of factors that determine the acceptance of services by citizens ("*implementation*" and "*efficiency*"), i.e. the academics tried to analyse citizens' attitudes relating to online public sector services, whether e-Government was attempting to improve service delivery, and whether citizenry trusted governments (West, 2004). Over time, these studies began to focus on challenges which political and public managers must face in order to implement e-Government initiatives, and what determining factors might encourage the successful implementation of these kinds of initiatives (Welch, Hinnant, & Moon, 2005).

In this context, the initial studies analysed how new technologies favour the formal political process ("*democracy*") and how new platforms, Websites or apps improve the participation of citizens in public affairs ("*communities*"). However, nowadays the studies discuss the re-emergence of citizen co-production in the delivery of public services, using new technology tools ("*social*" and "*media*"); i.e., they analyse the possible emergence of a new social contract that empowers the public to play a far more active role in the functioning of governments (Linders, 2012; Rodríguez Bolívar, 2015a, 2015b).

In addition, e-Government studies adopt different approaches and levels of governments –state and local governments. In the first phase, the articles analysed the barriers in the implementation of e-Government initiatives where academics highlighted that most e-Government projects were abandoned because major goals were not attained and/or there were undesirable outcomes ("*city*" and "*state*"). Over time, these studies started to highlight the obstacles to exercising the rights of citizens, and how they can achieve this freely and democratically through the application of social media tools ("*e-governance*").

Furthermore, the researchers initially analysed the different stages of development and growth model of e-Government (Andersen & Henriksen, 2006) as well as the benefits of the use of Internet-oriented customer Web design ("*e-commerce*"). Similarly, these studies focused their interest on the analysis of the governmental webs ("*evaluation*") to determine the satisfaction of users in the delivery of online public services, accountability, and interactivity (Verdegem & Verleye, 2009).

On the other hand, the initial studies focused on barriers and risk of the implementation of e-Governments user-centered initiatives in order to try to understand how users come to accept and use technology (Hung et al., 2006), factors that could influence their decisions about how and when they will use technology ("*perspective*") (Hung et al., 2006), and the digital-divide in the access, use, and appropriation of technologies by certain sectors of citizenship.

In other words, initial research focused on the search for advanced tools to enable users to access and navigate more efficiently on the Internet, facilitating the provision of services, access to a greater amount of and better quality information, interactivity and participation of citizenry (Gant & Chen, 2001). Later there was a further deepening in the analysis of new applications of interactive tools, such as smart-phones ("*mobile*") which offer greater data storage capacity—-virtual clouds—and activities, and greater connectivity in real time, favouring e-democracy ("*democratic*") (Hung et al., 2006).

Nowadays, research analyse how many governmental organizations around the world have adopted platforms, applications and tools to promote an informed citizenry vis-à-vis voting decisions and improves information transparency, monitoring the behavior of public managers and politicians, and promoting the democratic process by offering debate and discussion on important issues of public concern ("*social*", "*e-*

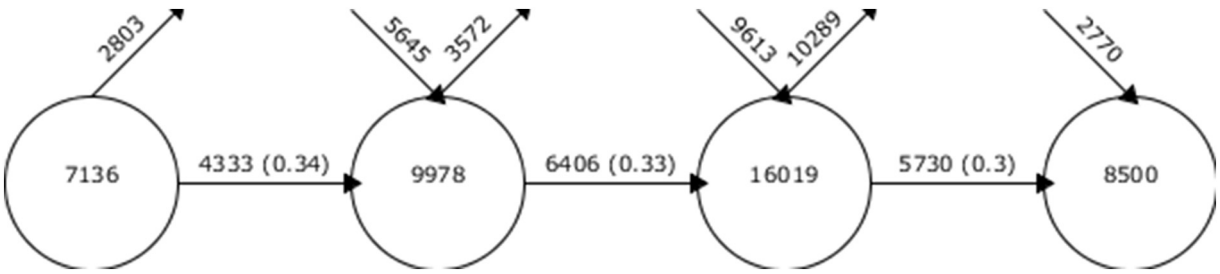

Fig. 5. Overlap fractions (incoming and outcoming keywords between successive subperiods).
(Source: SciMAT.)

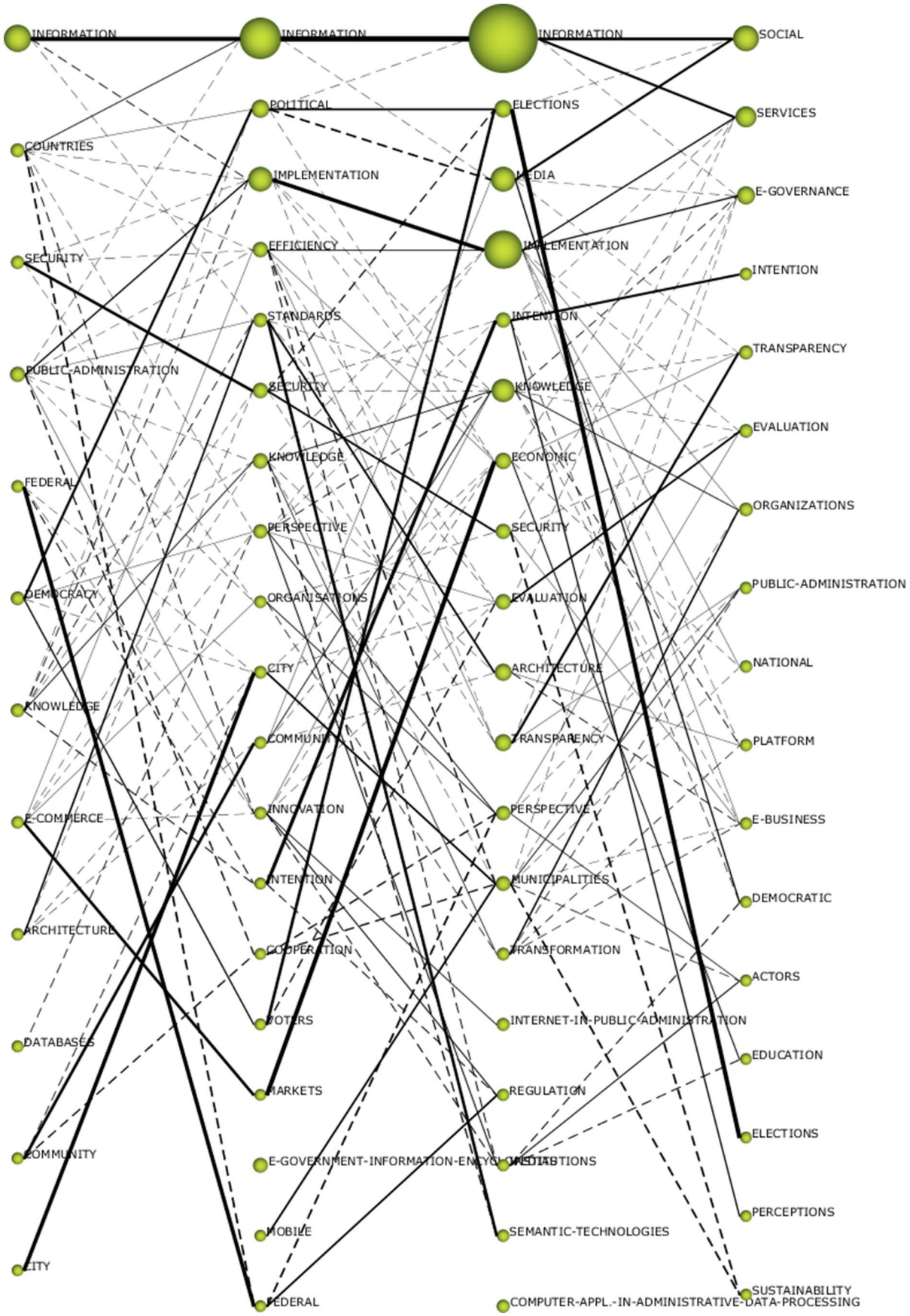

Fig. 6. Thematic evolution of the e-Government research field (2000–2016).
(Source: SciMAT.)

governance", "*democratic*" and "*transparency*"). Finally, these tools are characterized by the bidirectional potential of communication which fosters a higher level of commitment so that citizens and governments can act constructively, creating ideas and producing initiatives on public online services ("*services*") (Rodríguez Bolívar, 2015a, 2015b).

5. Conclusions and discussion

The e-Government field of knowledge has acquired great relevance in the last decade (Alcaide Muñoz & Rodríguez Bolívar, 2015). Indeed, the results reflect a gradual increase in the number of studies published in international journals since 2000, especially in the period 2009–2014. Two main issues arise from our findings: a) there are a higher number of new and transient keywords between sub-periods, which is a symptom of a research field in constant evolution that has not yet reached a stage of maturity and, b) an evolutionary trend exists in each of the research themes in the e-Government field.

This paper shows that the emerging studies focus on how the implementation of e-Government phenomenon favours organizational flexibility and online public services delivery. However, studies have pursued to describe the development of a comprehensive model of measuring user satisfaction (James, 2009; Verdegem & Verleye, 2009) and have identified the determining factors of the implementation of public services (Welch et al., 2005). In this regard, recent research is working on offering insights about advanced and innovative services in order to improve the overall quality of citizens' life (Allwinkle & Cruickshank, 2011; Piro, Gianci, Grieco, Boggia, & Camarda, 2014). In fact, trends in research are focusing on the need to obtain findings about cases studies, platforms, systems and ubiquitous applications that allow to public services delivery mainly in the context of the current so-called smart cities, such as, intelligent transportation systems, public safety, social, health-care, educational, building and urban planning, environmental, and energy and water management applications (Anttiroiko, Valkama, & Bailey, 2014).

Also, it is necessary to offer ways of effective citizen participation to creating ideas and producing initiatives on public online services. These studies could help urban planners and public managers, because they may use these frameworks in understanding the pattern of their services development. Also, these evidences may provide a useful guideline for services designers to design characteristics of old and new citizen-centric smart city services.

On another hand, initial studies analysed how ICTs have played a key role in democratic political and governance process. But the new technologies should go beyond by not only supplying information on public policies, but also giving citizens an opportunity to create together (Chen & Redner, 2010). So, many governmental organizations around the world have adopted platforms, applications and tools to promote an informed citizenry vis-à-vis voting decisions, improving information transparency, trying to achieve an increase public confidence in government and monitoring the behavior of public managers and politicians. In other words, the e-Participation provides advantages and benefits such as democratic and legitimacy gains, social inclusion, public policy and service quality improvement, and contribution to the education (Granier & Kudo, 2016).

However, the participation is also a research topic widely criticized, mainly focused on both its relevance and its efficacy. The lack of willingness and competence of ordinary citizens to contribute to policy-making is often highlighted, especially when it comes to technical issues (Mahrer & Krimer, 2005; Parvez, 2006). In this respect, participation is considered as policy instrument aiming at ensuring the acceptance of a measure or a project, without any ambition to consider citizens' input. Others lay the emphasis on its insufficient social inclusion and lack of representativeness. Therefore, these impediments also play a part in limiting the role of e-participation and in moderating its implication in the democratic process.

Academics and scholars have highlighted that little research has focused on actual practices of citizen involvement in smart cities so far (Meijer & Rodríguez Bolívar, 2016). It will be necessary to know if there are successful experiences in e-Participation in smart cities so the other public administrations and cities can learn from them; if there are different models of e-participation into smart cities and which one fits better the smart cities framework; what organizational issues are relevant to enhance e-participation under the smart cities framework?; what public policies must be taken to promote e-participation in smart cities?; what incentives can enhance e-participation in smart cities?; and are there any risks in this kind of participation in smart cities?

In addition, these technologies are redefining the understanding and practices associated with democratic participation and engagement, and contribute to improving the structure of the public sphere (Criado, Sandoval-Almazan, & Gil-García, 2013). Despite previous comments, Web 2.0 technologies have some risk associated with their use (Picazo-Vela, Gutiérrez-Martínez, & Luna-Reyes, 2012; Rodríguez Bolívar, 2015a, 2015b). Are policy makers willing to bear these risks to advance citizens' participation? How are they going to manage Web 2.0 technologies to reduce these risks? These questions remain unanswered and future research could analyse these concerns because policy makers will have to be aware of these risks and their potential solutions before adopting Web 2.0 technologies as tools for citizen participation.

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