From conventional governance to e-democracy: Tracing the evolution of e-governance research trends using network analysis tools

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A B S T R A C T

The adoption of e-governing practices has revolutionised the administrative machinery of governments worldwide by improving efficiency, transparency, and accountability. Researchers and administrators often aim to identify emerging research fronts and the timeline of the evolution to forecast and implement technology. In this work, we systematically investigate the trajectory of the global evolution and emerging research fronts as well as the prospects for e-governance using citation network analysis. The growth curve fitted to the number of articles published per year shows that the research activities are still in the ascendant phase. We visualise the global main path of the citation network and investigate the patterns to trace the knowledge diffusion path, major milestones, and emerging research fronts. The cluster analysis identifies the major topics of research as administration and information system management, e-governance framework design, efficiency or quality evaluation, and the application of social networks and open data leading to e-democracy. The adoption of open data and social networking for user interactions with government that leads to participatory governance are the emerging research trends. We also identify research that can have a future impact based on network parameters. The results contribute to the literature by setting the focus of future research, and assisting administrators in selecting suitable models and methodologies, and manufacturers with the development of required technical devices suitable for the upcoming phase of symbiosis.

1. Introduction

The revolutionary growth of e-governance in the recent past has resulted in efficiency, accountability, and transparency, and enhanced citizen engagement in the governments' strategic decision-making processes. Almost all countries have at least some form of online service for their citizens (Nations, 2014). The number of countries scoring high on the *E*-governance Development Index (EGDI) increased from 10 in 2003 to 29 in 2016 (Peña-López et al., 2016). According to the United Nations, the main objective of an e-government is to deliver government information and services to citizens by utilising the Internet and the world-wide-web (Nations, 2005). The term *E-governance* has a wider meaning concerning the use of information and communication technologies (ICTs) to enhance the governance process and support e-Democracy, e-Government, and e-Business (Bannister & Connolly, 2011; Holmes, 2001; Okot-Uma & London, 2000). *E*-governance is the *application of electronic means for the interaction between government and citizens and government and businesses, as well as in internal government operations to simplify and improve democratic, government and business aspects of Governance* (Backus, 2001). The definition of e-governance

has changed over time to accommodate evolutionary changes in related fields. According to the definition by Marche and McNiven (2003), e-governance *is a technology-mediated relationship between citizens and their governments from the perspective of potential electronic deliberation over civic communication, over policy evolution and in democratic expressions of citizen will.*

E-governance at its preliminary stage was confined to the digitisation and storage of enormous volumes of manual documents, but the rapid advancement of ICTs started the *era of digitisation & communication*, which also revolutionised e-governance administration to reach the level of multi-channel delivery of e-services for daily life (Feroz Khan, Young Yoon, Kim, & Woo Park, 2014; Rana, Dwivedi, Williams, & Weerakkody, 2016; Reddick, 2005; Sivarajah, Irani, & Weerakkody, 2015). Research and development (R&D) in fields related to e-governance development, transformation, and implementation models; benchmarking and evaluation models; innovation, diffusion, and adoption models; re-engineering frameworks; efficiency; assessment, and so on contributed significantly to the overall improvement in the quality of e-governance. *E*-governance models are implemented in E-services (connecting citizens with their government), E-administration

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(improving government processes), and E-society (building interactions with and within civil society) (Heeks, 1999). Each is implemented in three stages, *viz.*, Business Process Automation (BPA), Business Process Improvement (BPI), and Business Process *Re*-engineering (BPR) (Moon, 2002; Moon & Norris, 2005; van Reijswoud & de Jager, 2007). Nevertheless, the economy of a country is the major factor affecting the implementation of e-governance. However, recent reports indicate that several other determinants play critical roles in the successful implementation of e-governance such as user trust and adaptability, perceived usefulness, and the relative advantage of promoting e-governance. The compact network structures that integrate information procurement, dissemination, and management greatly contribute to convenient public administration. The virtual media of the internet, apart from mass media channels, put considerable pressure on the stakeholders of e-government, prompting them to follow the tenets of the religion, culture, and society (Savolainen, 2016). Hence, the sociocultural factors evolving from the social norms and cultural values are significant determinants that influence stakeholders' acceptance of e-services (Seng, Jackson, & Philip, 2010).

R&D in various domains has significantly promoted the diversity and rapid growth of e-governance applications, among which the advancement of ICT is the major contributor. The introduction of smartphones and Web 2.0+ technologies are notable examples. The landscape of the research domain is characterised by diversity and the emergence of numerous multi-disciplinary sub-domains. The developments in the fields of Management, Computer Science, Electronics, and Communication Engineering reflect in the administrative systems of the e-governance domain that are advancing in parallel, as the improved government processes and interactions between government and civil society show (Heeks, 1999; Moon, 2002; Moon & Norris, 2005; van Reijswoud & de Jager, 2007).

Recent advancements in ICT have significantly improved the efficiency in the delivery of e-service and promoted citizens' participation in their government's decision-making process (Peña-López et al., 2016). As per the recent trends, e-governance is expected to empower citizens to participate in the government's strategic decision-making process and provide access to data related to decision-making (de Jager & van Reijswoud, 2008; Feroz Khan et al., 2014; Nam, 2017; Peña-López et al., 2016; Porumbescu, 2015; Rodríguez-Bolvíar, Alcaide-Muñoz, & Cobo, 2018; Susha, Zuiderwijk, Janssen, & Grönlund, 2015; Weerakkody, El-Haddadeh, Al-Sobhi, Shareef, & Dwivedi, 2013). Recently, e-democracy and e-participation are buzzwords associated with e-governance. They refer to online activities including online discussions and consultations among governments, elected representatives, political parties, and citizens as part of a democratic process (Palvia & Sharma, 2007). The functions of ICT-based democracy (e-Democracy) are described by Kim (2008) as follows: *E-democracy articulates political and democratic procedures involving citizens in societal decision-making in various ways through the use of ICT*. Royo and Yetano (2015) view e-participation as *a cost-effective tool to actively involve citizens in government activities*. Hence e-participation is one of the defining characteristics in exercising e-Democracy, as Macintosh (2004), Smith and Dalakiouridou (2009), and Linders (2012) illustrate. Open governments share information that is critical for decision making by technologists, policy-makers, and citizens.

A research review is a potential source to provide an overview of the dynamic development of knowledge that consequently helps researchers extend the current theories and develop new theories (Webster & Watson, 2002). It also helps to uncover the areas that need further attention from researchers by constructing suitable research frameworks, especially on emerging research fronts. There are several research reviews in the domain of e-governance, which portray the vivid spectrum of research activities in related topics, including the transition and transformation of e-service delivery patterns, implementation and re-engineering models, assessment, benchmarking, and so on (Bolvar, Muñoz, & Hernández, 2010; Chadwick, 2003; Dawes,

2008; Grönlund & Horan, 2005; Irani, Love, & Montazemi, 2007; Yildiz, 2007). Meijer and Bekkers (2015) attempted to frame a metatheory to reduce confusion on fragmented theoretical studies on e-government for further development. Bannister and Grönlund (2017) provided a brief historical evolution of the contribution of ICT to e-government and noted that a systematic historical survey to trace their evolution has yet to be undertaken. Technological development plays a significant role in the successful implementation of many e-government initiatives. However, in the past, administrators tended to embrace the latest technologies before fully exploiting or implementing older ones, which resulted in several incomplete projects according to Bannister and Connolly (2012). The structured time-sensitive checkpoint analysis of e-government research by Joseph (2013) identified three trends: the first deals with studies that are either conceptual or rely solely on secondary data sources for the analysis; the second deals with studies that focus on geographic locations; and the third set of studies has no dominant topic, indicating the vast diversity of subjects in the field. Medaglia and Zheng (2017) analysed the presence of governments on social media platforms and observed that most studies focused on governments rather than users. They also opined that the typical characteristics of social media platforms and the relationship among the constructs of the government social media phenomenon are under-investigated. Sæbø, Rose, and Flak (2008) reviewed the status of e-participation and suggested a model for emerging research fronts and its initial content. Many authors also traced the community of leading contributors to the field of e-governance (Chen, Jubilado, Capistrano, & Yen, 2015; Erman, 2009; Erman & Todorovski, 2010; Scholl, 2009, 2014).

Regardless of the availability of these reviews, the dynamics of innovations and R&D in e-governance has not been investigated systematically as the interdisciplinary nature of e-governance, ranging from ICT to sociology, caused many reviewers to focus on a particular theme related to e-governance. A comprehensive understanding of the impact of these inter-linkages on the knowledge structure of e-governance is currently limited, as previous reviews did not scrutinise the main pathways of historical developments linking various themes and topics of research. The unfolding of the temporal development of research trends is useful for the successful strategic planning of e-governance for administrators and policy makers. The conventional methods employed in most of these reviews limited the focal theme, data sets, or time spans, but the increasing volume of research articles and the diversity of the research trends demand the use of efficient computing techniques to process the vast collection of bibliometric information. The corpus of research articles is a reliable source of innovations in early indicators. The main objective of this study is to investigate the dynamics of R&D activities in e-governance by analysing the corpus of research articles using the tools of social network analysis (SNA). The use of SNA tools has been emerging as a fruitful methodology for analysing a research discipline more objectively (Otte & Rousseau, 2002). Erman (2009) suggested this approach as a unified methodology to investigate interdisciplinary research on e-governance, but the analysis was restricted to the author citation network. In a later work, Erman and Todorovski (2010) analysed the co-author network limited to EGOV Conference Community and Saip, Kamala, and Tassabehji (2016) identified the core clusters based on factor analysis.

SNA has been employed in various domains to gain insights into the structure of complex relations among actors in a network (Barabási, Albert, & Jeong, 2000; Barabási, Gulbahce, & Loscalzo, 2011; Colizza, Barrat, Barthélemy, & Vespignani, 2006; Ebel, Mielsch, & Bornholdt, 2002; Sankar, Asokan, & Kumar, 2015; Vázquez, Flammini, Maritan, & Vespignani, 2003; Wang, González, Hidalgo, & Barabási, 2009). A citation network is a directed network in which nodes are the articles and citations are the edges that can be traversed for the major paths of information flow on the evolution of research fronts, following the principles of network theory. Recently, citation network analysis (CNA) has emerged as a systematic and scientific method of analysing research articles in an area to identify research fronts, evolving techniques, and

future trends. A complex network formed by citations is the niche of information from the evolution of the area to research fronts. Borrowing tools from SNA, CNA evolved as a computer-based technology forecasting tool and an alternative to an expert-based approach (Kajikawa & Takeda, 2009; Rodríguez Bolívar, Alcaide Muñoz, & López Hernández, 2016; Shibata, Kajikawa, & Matsushima, 2007; Shibata, Kajikawa, Takeda, Sakata, & Matsushima, 2011). In this work we analyse the citation network of research articles on e-governance to obtain a holistic picture of the knowledge structure of the area in terms of the sub-domains and their theme-wise connections by extracting the main path of evolution and various clusters.

The rest of the paper is organised as follows. The second section presents a detailed description of the data, and the CNA methodology, which uses techniques from *Main Path analysis* and *Cluster analysis*. This section also provides the assessment details of the network parameters to find the emerging clusters as well as the emerging research topics and a parametric equation to find the highly proficient articles therein. The results in the third section are summarised in the fourth section. The results and their implications are discussed in the fifth section.

2. Methodology

In this work, we adopt a two-pronged approach of carrying out the main path and cluster analysis of the citation network of research articles on e-governance. The schema of the analysis is given in Fig. 1. The first step involved in this study is to construct the citation network of e-governance by collecting citation data from Web of Science (WoS). The next step is to extract the largest component for further analysis.

The main path in an acyclic directed network is the chain of links connecting the most significant nodes. The first step for obtaining the main path of a citation network is to assign a weight to each directed link connecting two nodes. Three major measures suggested by Hummon and Dereian (1989) for estimating the weights of the links are Node Pair Projection Count (NPPC), Search Path Node Pair (SPNP) and Search Path Link Count (SPLC). The SPLC of a directed link counts all possible *search paths* within the acyclic network originating from the tail node of the link and its ancestral nodes (Batagelj, 2003; Hummon & Dereian, 1989). In other words, the SPLC of a given link gives the count of all search paths in the network traversed through the link. The index SPLC is presumed to be the best measure to be considered as traversal weight, as SPLC gains high value, if more number of search paths pass through it (Batagelj, 2003; Hummon, Doreian, & Freeman, 1990). The main path in a citation network is constructed, starting from a source node, by adding links with the highest weight step by step until a sink node is reached. Each link in a main path facilitate diffusion of

knowledge to the publications at a later date and hence is widely used to trace the trajectories of scientific evolution (Garfield, Sher, & Torpie, 1964; Hummon et al., 1990; Hummon & Carley, 1993; Hummon & Dereian, 1989; Liu, Chen, Ho, & Li, 2014). Garfield et al. (1964) observed the correspondence between the historical account of the events and citation relations. The nodes in the main path represent milestones in the evolution of a research domain. The priority search algorithm proposed by Hummon and Dereian (1989) adopts a *local* approach in selecting links of a main path and hence the total traversal count may not be the largest of the traversal counts of all paths in the network. The sum of the traversal count of all the links in a *global* main path is the largest of all possible paths. The first step of obtaining a global main path is to identify the link with the highest traversal count emanating from all sources. The beginning node of this link is the first node of the global main path. The next link of the global main path is obtained by the same procedure, starting from the end node the first identified link and continued until a sink node is reached. In case of ties, all links with the tie are considered. In this work, we constructed the global main path as implemented in the software package PAJEK (Batagelj & Mrvar, 1998).

We carried out the global main path analysis inspecting all the possible global main paths to trace the knowledge flow through the articles that are milestones in the history of the evolution of e-governance representing the emergence and divergence of research streams. The main path algorithm in the citation network involves two phases in which the first phase is to create a weighted citation network and assign significant traversal weight to the links based on their ability to diffuse knowledge. The second phase is to execute priority search algorithm for selecting the most significant follower of an article based on the traversal weight of links attached to it. The priority search algorithm selects the next connecting link of a node as the one with the largest traversal weight and iterates the procedure for all the links from source to sinks (Liu & Lu, 2012).

The topological clustering of the largest component for identifying the diversity of streams in a research domain was suggested by Newman (2004). The nodes in a particular cluster are connected more with the nodes in the same cluster than with nodes of other clusters. The clustering algorithm based on modularity computes the quantity Q given by

$$Q = \sum_{1}^{Nm} \left[\frac{ls}{l} - \left(\frac{ds}{2l} \right)^2 \right]$$

(1)

where Nm is the number of clusters, l is the total number of links, ls is the number of links between the nodes in cluster S and ds is the sum of degrees of the nodes in the cluster (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008; Newman & Girvan, 2004). Each term in Eq. (1)
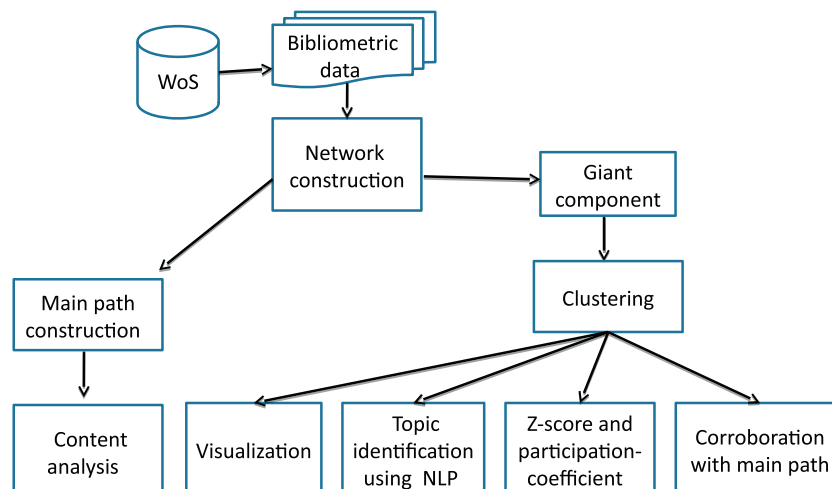

Fig. 1. The schema of the analysis.

corresponding to a cluster is the difference between the fraction of links that fall within the cluster and the expected value of the same quantity if the links are distributed randomly without considering cluster structures. A high value of Q indicates a good division of the network into clusters.

After clustering the giant component of the citation network, the role of each paper within a cluster is investigated based on z-score defined by

$$z_i = \frac{k_i - \overline{k}_{s_i}}{\sigma_{k_{s_i}}} \qquad (2)$$

where k_i is the number of links of node i to other nodes in its cluster s_i, $\overline{k}_{s_i}$ is the average of k over nodes in cluster s_i and $\sigma_{k_{s_i}}$ is the standard deviation Guimerá & Amaral, 2005; Shibata et al., 2011), (Power, Schlaggar, Lessov-Schlaggar, & Petersen, 2013). The z-score measures how well-connected a node within its cluster and it can be utilised to assess the prominence of a node in its cluster. The links of a node may be limited to its cluster or distributed across other clusters. The participation coefficient given by

$$p_i = 1 - \sum_{s-1}^{N_M} \left(\frac{k_{is}}{k_i} \right)^2 \qquad (3)$$

measures the role of connections of a node to nodes in different clusters where k_{is} is the number of links of node i to nodes in cluster s and k_i is the total degree of node i. The value of p_i is 0 if all links are within its cluster and close to 1 if its links are distributed uniformly among other clusters. These indices were introduced first by Guimerá and Amaral (2005) for analysing biological networks and classified nodes into non-hub nodes and hub nodes. The non-hub nodes with $z_i < 2.5$ is further divided in to four categories (i) ultra-peripheral nodes with $p_i < 0.05$ (ii) peripheral nodes with $0.05 < p_i \leq 0.62$ (iii) non-hub connect nodes with $0.62 < p_i \leq 0.80$ and (iv) non-hub kinless nodes with $p_i > 0.80$. The hub nodes with $z_i \geq 2.5$ can be classified further into (v) provincial hubs with $p_i \leq 0.30$, (vi) connector hubs with $0.30 < p_i \leq 0.75$ and kinless hubs with $p_i > 0.75$. According to Shibata et al. (2011), a cluster with hub papers of large z-score and small p values, different topic of discussion from other clusters, and articles with recent publication dates are typical features of an emerging cluster. An article in the emerging cluster with highest value of betweenness centrality is the most promising one in the citation network (Shibata et al., 2011).

For identifying the research topic of each cluster, the content analysis was made automated with Natural Language Processing (NLP) based on the procedure proposed by Shibata et al. (2011) using abstracts of the articles. We finally compared the nodes in the main path with clusters to detect the stage-wise development of sub-domains.

3. Results

We retrieved the citation data for the research articles on e-government published from 1989 to 2016 from the Web of Science (WoS) by using the keywords *e-government*, *egovernment*, *e-governance*, or *egovernance* as query terms. We considered only research articles and avoided review papers and other materials without any restriction on language. The retrieved information was subsequently converted to a citation network. The citation network contains 89,638 nodes consisting of the retrieved articles and the references therein, and 116,790 directed edges or links. The giant component of the network contains 60,597 nodes and 86,204 edges. We show the fitted growth curve

$$f(t) = \frac{\alpha}{1 + e^{(-(t-\beta)/\gamma)}}. \qquad (4)$$

to the number of year-wise retrieved cited articles using Eq.4 in Fig. 2. The number of articles at present shows that the research area is still in the growth and diffusion phase, and has not reached maturity. This

indicates the future scope of research and development in e-governance and that it can attain higher growth.

3.1. Tracing the evolution trajectory

We traced the evolution of the research activities using main path analysis (Batagelj, 2003; Hummon & Dereian, 1989). We obtained the global main path in the citation network using the algorithm described in the previous section based on SPLC. Fig. 3 shows the global main path extracted from the citation network. Table 1 lists the articles in the global main path. The analysis of the topics discussed in the core nodes in the main path can shed light on the evolution of the research activities in the area. The main path consists of the single base path with two major emerging branches. The main path of the evolution of e-governance shows four *phases* based on the research topics.

With the extensive use of the internet worldwide after 1990, e-governance research became vibrant, dynamic, and trended towards the construction of models to implement e-services. The models helped in the transition of the conventional hierarchy to an e-services-based system in an integrated and standardized manner. The main path derived by our analysis starts with an article on the degree and type of social interactivity with the internet by Stowers (1999) and it was the motivation behind subsequent articles by Kaylor, Deshazo, and Van Eck (2002), McNeal, Tolbert, Mossberger, and Dotterweich (2003), and Thomas and Streib (2003). Kaylor et al. (2002) and Thomas and Streib (2003) investigated the benchmarking and evaluation of the degree to which a government website interacts with its users. McNeal et al. (2003) evaluated existing e-governance information systems based on the maturity models suggested by Layne and Lee (2001) and Ho and Coates (2002).

In the early stages of e-governance development, the digitisation process was not carried out in an integrated manner, resulting in system failures and chaos. The emphasis in the first phase of the evolution of e-governance spanning the period up to 2005 was on the development of a well-structured framework for transforming conventional administrative systems to digital government platforms. Different maturity models were introduced to integrate the data and administrative frameworks in connection with the transformation of manual systems to digital and automated systems. The main path captures the maturity models proposed by Layne and Lee (2001), Chen and Gant (2001), and Ho and Coates (2002). These articles framed the basic structure of e-administration in the history of e-governance development. Layne and Lee (2001) utilised multiple data sets and methods of analysis to characterise participants' behavioural patterns. The study also analysed the core factors contributing to major challenges to e-government implementation. The maturity model of the implementation of e-governance proposed by Layne and Lee (2001) is widely accepted as a major reference model by many subsequent researchers. The article addressed various issues connected with transforming conventional administrative systems to e-government systems. Another model proposed by Chen and Gant (2001) in the same year, which analysed the efficient use of Application Service Providers (ASP) to transfer e-government benefits at the local administration level, also attracted the attention of many researchers. Doty and Erdelez (2002) carried out an analytical study based on the findings of Chen and Gant (2001). The core of research in e-governance focused on developing models until the start of the 21st century, and it dramatically helped with e-governance implementation. The period up to 2005 can be considered as the first phase of development.

With the widespread use of the internet and other electronic communication gadgets, stakeholders began to accept the switchover from conventional to e-governments, and began adopting e-services. The next issue to arise was the evaluation of the implemented e-services. Assessing and benchmarking the quality, performance, user adoption, and customer satisfaction were the major tasks in the second phase of the main path. During this phase, the evaluation and assessment of
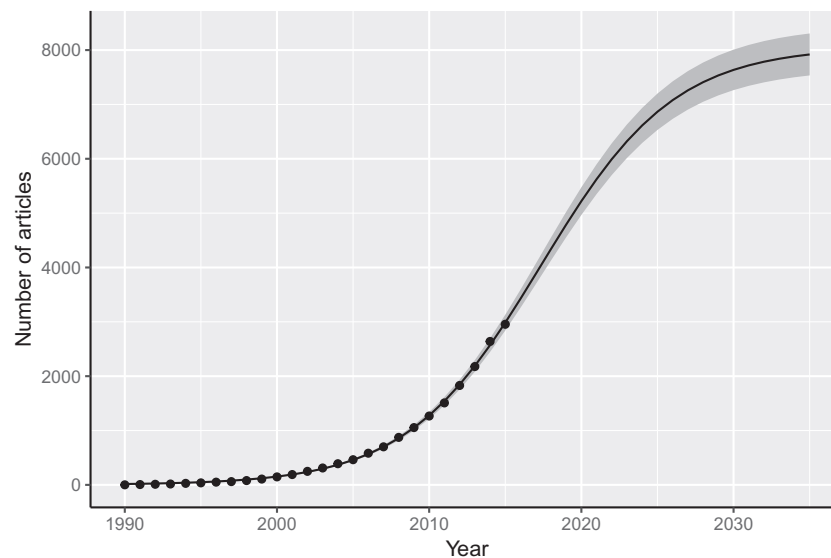
Fig. 2. The growth curve in Eq. (4) fitted to the yearly published articles.

implemented e-governance initiatives were the prominent research trends. The divergence in research streams in the second phase is evident from the articles by Reddick (2005) and Grant and Chau (2006), as Fig. 3 shows. The issues related to the transformation of the existing e-governance information systems and the development of a strong e-governance structural framework were the research themes of Grant and Chau (2006). This study was extended to a customer-centric e-government maturity model focusing on end-users by Andersen and Henriksen (2006). It was later known as the Public sector Process Rebuilding (PPR) model, which is an extension of work done by Layne and Lee (2001).

The second branch of bifurcation in the second phase started with (Reddick, 2005), which triggered the search for methods to increase the interaction between citizens and the government. The article pointed out the need for alternate communication channels and laid the stepping stones for a revolutionary change by incorporating social media and other social networks to increase interactions between the government and the public. The next bifurcation of research was initiated by Reddick (2005). The focus of the first branch is the implications of rules in an administration hierarchy to promote e-democracy, while that of the second branch is on the implementation of e-democracy in the e-governance hierarchy.

The research trend in the third phase is social media adoption, which is a paradigm shift from the previous mainstream research. It was triggered by the work of Helbig, Gil-Garca, and Ferro (2009), which converges the knowledge streams in the second phase. This was an extensive study on the digital divide existing in society in terms of accessing e-governance services. This article paved the way for the exotic use of electronic media for implementing seamless interactions between the government and its stakeholders. Following the same line of research, Verdegem and Verleye (2009) conducted a user acceptance study and proposed a conceptual model based on ICT acceptance theory and confirmed the start of the third phase in the main path of e-governance development. The third phase of research was on increasing customer-centric interactions using multi-channel communication, including social media. The article by Gauld, Goldfinch, and Horsburgh (2010) focused on the need for seamless communication requirements in e-governance, prompted by the observations of Verdegem and Verleye (2009). The article by Reddick and Turner (2012) is a remarkable piece of work related to the upcoming trend of multi-channel communication, including social media, which is considered a panacea to overcome the digital divide in society. Social media adoption in e-governance to promote e-democracy and participatory government is

an emerging research trend. Social media, including social networks such as Facebook and Twitter, are the future channels for implementing seamless interactions between stakeholders and the government, as anticipated in the final stage of the maturity models. Following the research thread in this article, Andersen, Medaglia, and Henriksen (2012) conducted an extensive study on the relevance of social networking in e-governance.

The elaborate study by Feroz Khan et al. (2014), based on the work of Andersen et al. (2012), was followed by other researchers focusing on *social networking* and *alternate channels for government-to-citizen (G2C) interactions*. The core of the research by Feroz Khan et al. (2014) lay in the perspectives of transition from e-government to social or participative government. It initiated the fourth phase of the main path with research trends on e-democracy and related topics. In the emerging future trends in e-governance, known as *E*-democracy or participative governance, citizens gain more prominence in the hierarchical structure of the government administration. They can interactively participate in the government's strategic decision-making process through social media by casting opinion votes and can resolve social and political issues through group discussions on Facebook, Twitter, and other social networks. Social media will be helpful in emergency situations, including natural calamities, as information reaches end-users faster in this way than by any other means. Bonsón, Royo, and Ratkai (2015) extended the scope of the topic of e-democracy by elaborating on the findings of Feroz Khan et al. (2014). The article discussed the impact of different media and stakeholders' roles in Western European local government social media pages. Bonsón et al. (2015) motivated Porumbescu (2015) to correlate government transparency with the increase in citizens' trust in the government, which enhanced the use of social media for G2C interactions. Porumbescu (2016a) carried out case studies on South Korea as an extension of his previous work (Porumbescu, 2015) to relate the propensity of citizens' trust in the government with the increase in e-services adoption. Extending his previous work, Porumbescu (2016b) assessed the relationship between *trust* and *perceptions of public sector performance*. This study triggered efforts by Nam (2016) to analyse the consistency of technological readiness for e-participation with the level of civil liberties. Nam (2017) conducted another study based on the findings of Porumbescu (2016a) and analysed the pros and cons of e-democracy. Considering the results obtained by Porumbescu (2016b), Nam (2016) analysed citizens' attitudes towards open government and predicted that the next trend of research will be on the use of smart mobile applications and open data.

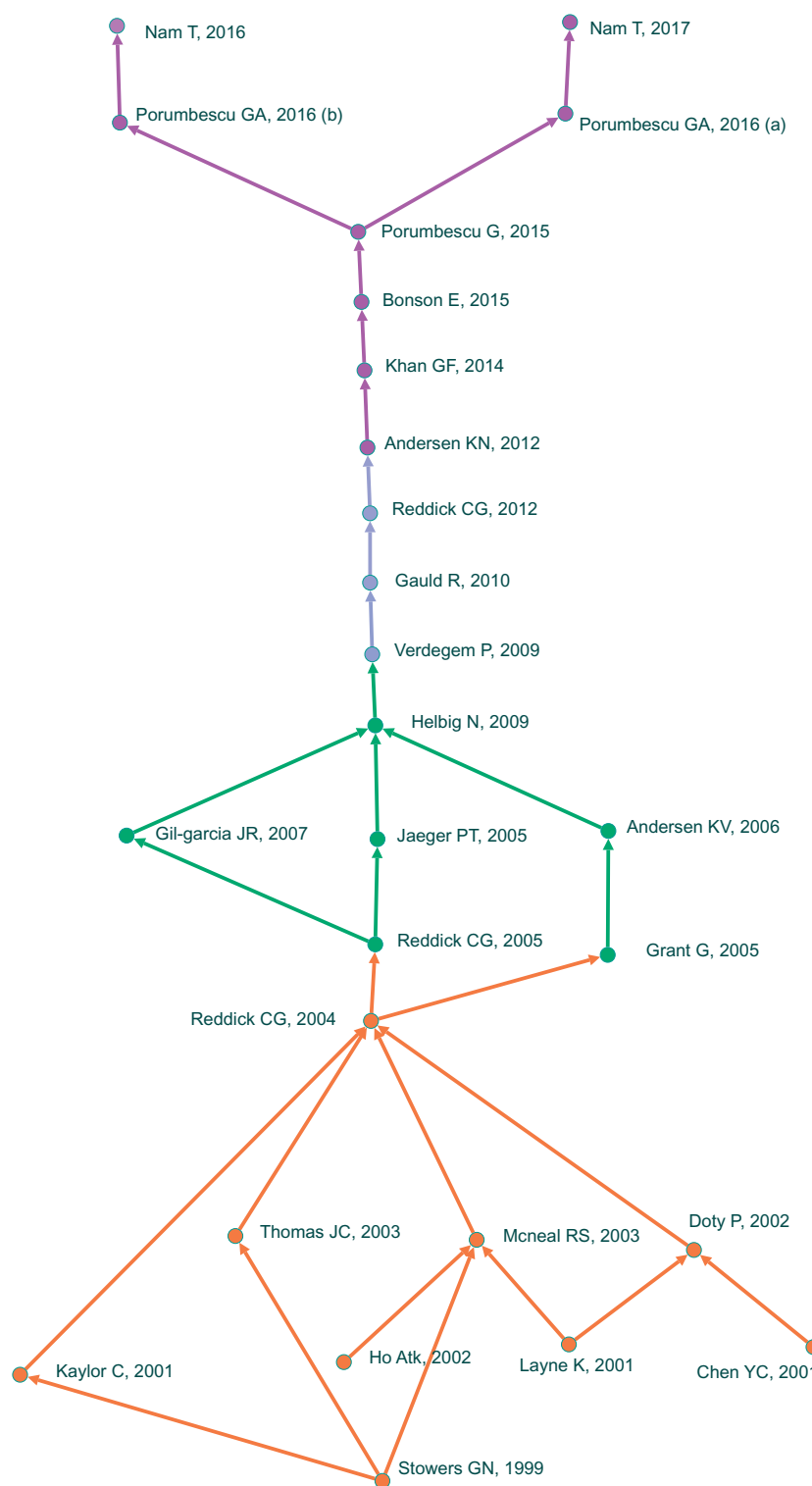The topics revealed by the content analysis of the articles at the end

Fig. 3. The global main path of the e-governance literature.

of the main path in Fig. 3 shows that e-governance is gaining popularity with the support of tools such as smartphones and Web2.0+ technology. The main path reveals that the major topics of discussion in the articles published at the end of the third phase and at the start of the fourth phase are related to *seamless user interactions with government through social media, participatory governance, e-democracy, and transparency provided by open data*. In the fourth phase starting from 2012, *assessments of the user adoption of e-democracy, social networks, and open data implementation* gained prominence.

3.2. Roadmap of major themes

The main path depicted in Fig. 3 indicates the milestone articles of the evolution of the domain. We extracted the themes of these articles using a content analysis. The themes represent four major *phases* of evolution in e-governance. The themes of the sequential evolution of mainstream research on e-governance embedded in the main path, *viz., information system frameworks and maturity models (Phase 1); evaluation models, user satisfaction, and user adoption models (Phase 2); multi-*

Table 1
Articles in the main path in Fig. 3.

Phase	Node	Publication details
1	Stowers GN, 1999	Stowers G N,1999 Becoming cyber-active: State and local government on the world wide web. Government Inform, Quarterly (16)(2) 111–127
1	Kaylor C, 2001	Kaylor, C., Deshazo, R., Van Eck, D., 2002. E-government: A report on implementing services among American cities., Government Information Quarterly 18 (4), 293–307
1	Chen, Y.-C., 2001	Chen, Y.-C.,Gant, J.,2001. Transforming e-government services: The use of application service providers in, US local governments. AMCIS 2001 Proceedings, 308.
1	Layne, K., 2001	Layne, K., Lee, J., 2001. Developing fully functional e-government: A, four stage model. Government information quarterly 18 (2), 122–136
1	Ho, A. T.-K., 2002	Ho, A. T.-K., Coates, P., 2002. Citizen participation: Legitimizing performance measurement as a decision tool. Government Finance Review 18 (2), 8–11.
1	Doty, P., 2002	Doty, P., Erdelez, S., 2002. Information micro-practices in Texas rural courts: Methods and issues for e-government. Government Information Quarterly 19 (4), 369–387.
1	Thomas, J. C., 2003	Thomas, J. C., Streib, G., 2003. The new face of government: citizen-initiated contacts in the era of e-government. Journal of public administration research and theory 13 (1), 83–102
1	McNeal, R. S., 2003	McNeal, R. S., Tolbert, C. J., Mossberger, K., Dotterweich, L. J., 2003. Innovating in digital government in the American states. Social Science Quarterly 84 (1), 52–70.
1	Reddick, C. G., 2004	Reddick, C. G., 2004. A two-stage model of e-government growth: Theories and empirical evidence for US cities. Government Information Quarterly 21 (1), 51–64.
2	Grant, G., 2006	Grant, G., Chau, D., 2006. Developing a generic framework for e-government. Advanced Topics in Information Management 5 (1), 72–94.
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4	Nam, T., 2017	Nam, T., 2017. A tool for liberty or oppression? a cross-national study of the internet's influence on democracy. Telematics and Informatics 34 (5), 538–549.

channel communication, increasing user interaction, and social media (Phase 3); e-democracy, e-participation, social media including social networks, and open data (Phase 4), clearly indicate the roadmap ahead, as Fig. 4 illustrates. The themes marked at the end of the roadmap show the future research trends. The analysis shows that e-governance started with the conventional mode of service delivery and reached the stage of participative governance characterised by citizens' active involvement in the strategic decision-making process of government utilising Web2.0 and social network platforms. These results are further corroborated by the cluster analysis in the next section.

3.3. Cluster analysis

We adopted the following steps to conduct the cluster analysis of the giant component.

Step 1. Identify the main clusters of the giant component of the citation network.

Step 2. Identify the research topics of the main clusters using NLP tools for the titles and abstracts of articles in a cluster.

Step 3. Trace the evolution of clusters by constructing the main path

within each cluster. The nodes in the main path also show the critical papers in a cluster.

Step 4. Compute z-scores and participation coefficients (p) of the nodes in each cluster to investigate the role of each node and the betweenness centrality of the emerging clusters.

Step 5. Corroborate the results with that of the main path analysis.

The clustering of the giant component following the algorithm in Blondel et al. (2008) yielded four significant clusters, as we show in Fig. 5. Table 2 lists the research topics of each cluster. Cluster #1 is the largest cluster (41.56%) and contains a broad spectrum of articles consisting of 25,188 nodes with multiple research topics and recent innovations. Therefore, we carried out a sub-clustering of cluster #1 and analysed the seven major sub-clusters. Table 3 provides the associated topics. The sub-clusters #1, #2, and #5 discuss the evaluation, benchmarking, and maturity models, while sub-clusters #3 and #4 discuss open government, e-participation, and e-democracy. Sub-cluster #6 talks about the issues that arose during the transformation from conventional to participatory governance (e-democracy). The foci of sub-cluster #7 are strategic decision-making, and policy and framework creation for e-governance implementation. We also constructed the
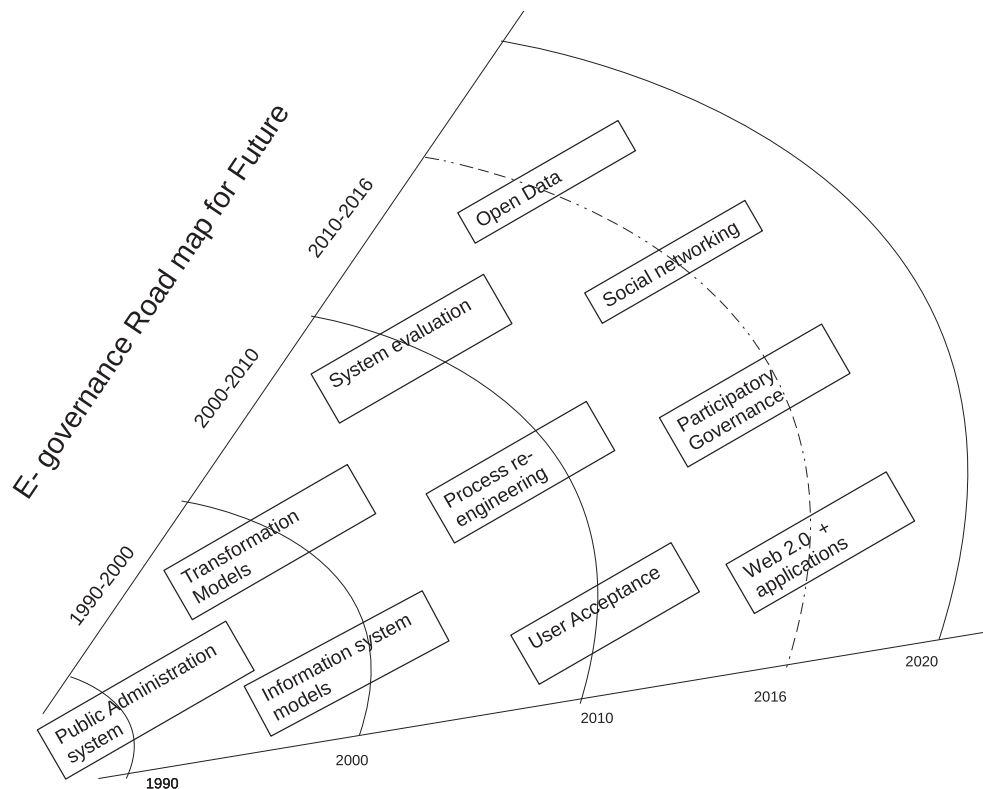
Fig. 4. Roadmap of e-governance research activities.

Fig. 5. The clusters: Cluster #1 - red (41.56%) Cluster #2 - green (31.03%) cluster #3 -Blue (14.18%) Cluster #4 - Pink (3.33%). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

main path of the major clusters (*cf.*Figs. 6, 7, 8, 9). Apart from the trajectory of the evolution, the nodes on the main path also give clues to the topics of research in each cluster. Table 3 lists the main topics of the sub-clusters of cluster #1, which we identified from the text corpus of abstracts by the NLP algorithm in Shibata et al. (2011).

Sub-cluster #6, though relatively small, has the characteristics of an emerging cluster with high z-scores and small *p*-values with relatively recent publications. The topic according to the NLP analysis is *Transformation to open government.* According to the criteria in Shibata et al. (2011)*Jaeger P.T, 2010, Gov Inform Q, V27, P371* is the most promising paper in terms of its impact on future research, with the highest score of betweenness centrality within the emerging sub-cluster#6. This article analyses the pros and cons of the implementation and the objectives to attain in the transition from conventional to citizen-centric e-government or e-democracy. It also projects the advantages of the extensive use of e-government services and the need to include non-governmental social network services to provide better access to the information and services related to the government for citizens.

Cluster #2 contains 31.03% of the articles. The central theme of cluster#2 is quality surveys on user adoption and evaluating customer satisfaction. However, the topics of the articles vary from legislative policy development to improve e-services quality to surveys on user adoption and satisfaction. The first subtopic of discussion is related to legislative policies to improve e-services in general and to individuals with disabilities in particular. The second channel of discussion in this cluster is on models to assess user adoption and customer satisfaction. The articles in this cluster also discuss user acceptance and diffusion, citizen demand, and e-governance implementation. The third topic is on policy-making and methods to bridge the digital divide in society.

The main topic of cluster #3, which contains 2018 nodes (14.18%), is technology adoption and process-re-engineering. The main focus is accessibility and the credibility of the services based on new technologies. The detailed discussions include the adoption of the strategic changes incorporated in e-governance using new methods, gadgets, and the technology introduced by ICT in e-governance. These technological interventions demand process re-engineering to address various issues on policy formulation, design, and implementation. Some articles in this cluster discuss legislative support and provisions to provide disabled persons with internet access.

Table 2
Key words related to the major clusters.

Clusters	Size%	Key words
#1	41.56	Models, e-participation, social media, trust worthiness, local government, open data, web2.0, Transparency, Digital repository
#2	31.03	e-Government services, Information technology acceptance, User adoption, Digital divide, Public management, Inclusion policies, IT strategies
#3	14.18	Accessibility, Municipal websites, Usability, Web credibility, Mobile readiness
#4	3.33	Electronic commerce, Electronic procurement, Military organization procurement, Web-based architecture, Digital government

Table 3
Topics related to the sub-clusters of cluster #1.

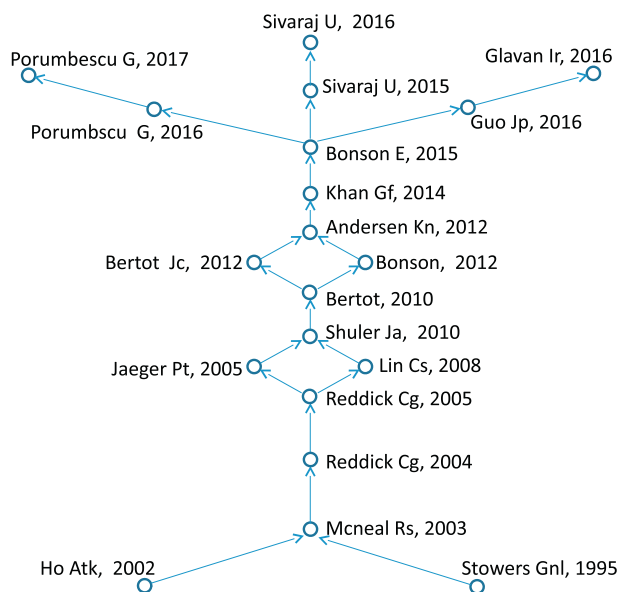| Sub-cluster	Size %	Key words
#1	18.58	Evaluation Models on trust worthiness, user adoption
#2	15.09	Customer satisfaction Models
#3	12.59	Open government
#4	7.05	Open government, e-participation
#5	5.64	Maturity Models, Research reviews
#6	5.16	Transformation to open government
#7	4.40	Policy, strategic decisions, framework creation

Fig. 6. Main path of Sub-cluster #1.

Cluster #4 is relatively smaller, containing 3.33% of the total articles. This cluster is largely based on e-commerce and e-procurement related to government organizations. The topics include e-procurement, digital supply chain management, e-markets, and factors affecting e-business.

The first cluster is relatively larger, with various sub-domains. The main path of the cluster provides insight into the evolution of e-government and discusses topics on trustworthiness and user adoption related to open government. Hence, the cluster could be called the *future trends cluster*. The topic in the second cluster is *assessment of quality efficiency and user satisfaction etc.*, and hence we can call it the *quality assessment cluster*. The third cluster discusses user adoption of new technologies and re-engineering existing processes for better adoption, and hence, we can call it the *adoption cluster*. We designate the fourth cluster as the *e-commerce cluster* as the main topic of discussion is e-commerce related to government transactions and procurement.

The first block spanning 1990–2000 in the roadmap in Fig. 4 is on transforming the government administrative system to the digital platform based on transition models to integrate document digitisation. A major part of cluster #1 is related to this block. As it is the largest cluster, the sub-clusters spread across later blocks. The second block

during 2000–2010 is mainly on constructing implementation models and assessing and evaluating the implemented systems. Cluster #2 on assessment, cluster #3 on user adoption, and cluster #4 on e-procurement mainly belong to this block. The fourth block starting from 2016 is characterised by the introduction of Web 3.0 to extract social opinions from discussions on social media by the semantics of the web, big data analytics, machine learning, and so on. The block is characterised by open data and e-participation, which is the focus of some sub-clusters of cluster#1. The coherence of the cluster themes with the roadmap of e-governance implementation suggests that the development in e-governance closely follows the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) and its extension, the unified theory of acceptance and use of technology (UTAUT) model (Venkatesh, Morris, Davis, & Davis, 2003).

The analysis based on quantitative measures may not always be as objective as that of an expert opinion. We thus conducted a cross-analysis of the emerging topics with the result of main path analysis. The research papers at the leaf nodes of the main path are on *open data, social network, Web 2.0 applications, and participatory governance*. The results of the main path analysis are coherent with the results of the cluster analysis, confirming the accuracy of the method adopted within the constrained environment of our study.

3.4. The Symbiosis maturity model of e-governance implementation

As discussed earlier, the chronological evolution of discussion topics extracted from the content analysis of the articles in the main path (*c.f.*Fig. 3) was depicted in Fig. 4. We see that the evolution of these topics closely relates to the advancement of Web technology. Hence, we propose a conceptual model of the maturity of e-governance implementation based on the development of Web technology. The model is visualized in Fig. 10. The first phase of e-governance during 1989 to 2005 in the main path in Fig. 3 is marked by the adoption of digital technologies for public administration. The introduction and wide application of electronic gadgets, including computers, fax machines, printers, scanners, and so on at the grass-roots level of government administration promoted the implementation of e-governance. Web 1.0 technology, which includes the *web of documents* during 1989 to 2005 helped the transfer of documents to the internet. This period is the first phase of the evolution of e-governance that give *information* prominence. The second phase of evolution of e-governance starting from 2004, which involves two-way interactions between the government and citizens, and interactions within society, was fostered by Web 2.0, known as the *Web of people*, which was capable of connecting billions of people. Web 2.0 technology was the basis of crowds forming on social networks including YouTube, Flicker, Blogs, LinkedIn, Facebook, mySpace, and so on. In the second phase, governments utilised Web 2.0 as a media for communicating effectively with a large group of citizens and to obtain their feedback. The introduction of digital online financial transactions and plastic money also played an essential role in this phase. We can represent the characteristics of this phase as stage 2 of *Interaction* and stage 3 of *Transaction* in the maturity model in Fig. 10. The third phase in the main path, from 2009 to 2012, which was also promoted by Web 3.0 technology, is known as the *Web of data*. It could group even more people, leading to the possibility of semantic web identification of major topics of discussion, social opinion gathering,
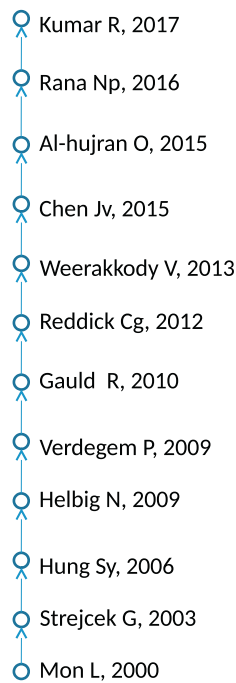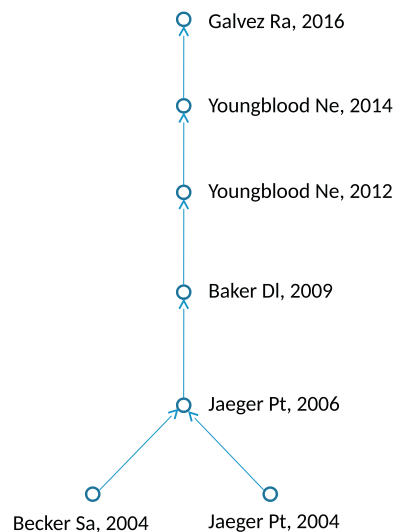
Fig. 7. Main path of Sub-cluster #2.

Fig. 8. Main path of Sub-cluster #3.

system will be able to interact with users with the features of an intelligent human being who can identify persons by capturing biometric information. The e-governance system will also be able to understand the user requirements by using artificial intelligence and machine learning techniques to analyse the historical records of the user activities in the system. In short, the e-governance maturity model can be conceptualized with five stages of maturity. The first four stages agree with the *Gartner group maturity model* proposed by Baum and Di Maio (2000). The fifth stage of symbiosis is expected to evolve with the support of Web 4.0 technology, machine learning, cloud computing, and RFID tagged devices.

4. Summary

The emergence of e-governance has contributed significantly to the effectiveness, precision, and transparency of public administration in addition to the extensive outreach of government services. As the first step, we fitted a growth curve to the number of research articles published per year, and the result shows that research activities in e-governance are still in the emerging stage and have not reached maturity. We analysed the citation network of research articles on e-governance to investigate the evolution of topics and unfolding research trends. The main global path of the citation network portrays the emerging course of research in the e-governance literature and the associated paradigm shifts in research trends. It reveals the change in the priority of research topics over time and uncovers the persistence of rapid changes in the maturity levels of e-government from the global perspective.

The papers in the main path showed four phases: the first phase until 2005 focuses on information systems and implementation models; the second phase between 2005 and 2009 focuses on evaluation models; the third phase from 2009 to 2012 focuses on social networking and multichannel communication; and the fourth from 2012 onwards focuses on e-democracy, open data, and e-participation. The first phase was characterised by the transformation from manual to digital systems by the introduction of personal computers, printers, and e-mail and SMS technology to support e-governance. Several maturity models for e-governance implementation evolved during this period. The second phase is boosted by the widespread adoption of the internet, Web 2.0 technology, and facilities for online money transactions. Researchers concentrated on evaluating services, including user adoption, user satisfaction, the quality and efficiency of services, and so on. During the third phase, e-services were extensively provided through websites and the use of e-mail and SMS increased considerably. The reduction in the cost of electronic accessories associated with e-governance and in using the internet accelerated the third stage developments, which featured the multichannel delivery of e-services. The introduction of smartphones and Web 2.0+ technology promoted user adoption and e-participation in the fourth phase. This phase represents the level of seamless interaction with customers, as many maturity models specify. The result of the main path analysis shows that e-democracy, participatory governance, and open data are the future trends. The future trend is the extensive use of social media for seamless interaction with customers and to empower citizens. *E*-voting, candidates' e-campaigns, e-supported emergency management, citizen participatory governance, and open data are no longer a dream for developing and under-developed countries.

The cluster analysis revealed four main clusters. The analysis identified the major domains of research in e-governance as *information and administrative system modelling; quality surveys and evaluations of user adoption and customer satisfaction; the possibility of process re-engineering; and open data and the role of social networking and e-deliberation leading to participative government*. We corroborated the resulting cluster analysis with the main path. Utilising two topological measures, z-score and the participation coefficient, the study also reveals the emerging research fronts and predicts potential core studies. Most of the reviews in this field are restricted to a limited focal theme, data sets, time spans, or

and analysis of data using artificial intelligence. This stage initiated the transformation of the e-government to the participatory government, with citizen involvement in decision making. So the core feature of this stage is *Transformation*. Web 3.0 also contributes to the fourth phase of e-governance, in which e-participation, e-democracy, and open data are the trends. The upcoming technology Web 4.0, the extension of Web 3.0, could push e-governance to an even higher level. Web 4.0 technology is known as the *web of symbiosis*, or *the intelligent interactive electronic agent*. The computing techniques of artificial intelligence, machine learning, and personal identification using cameras and other connected devices tagged with RFID chips can enhance communication through web channels and provide a more personalised response. The adoption of Web 4.0 technologies utilising more flexible data types into e-government services may be the focus of research in the next phase. Web 4.0 technology offers prospects for the next stage of e-governance characterised by intelligent interaction with users, resulting in the stage of *symbiosis*. With the support of Web 4.0 technology, the e-governance
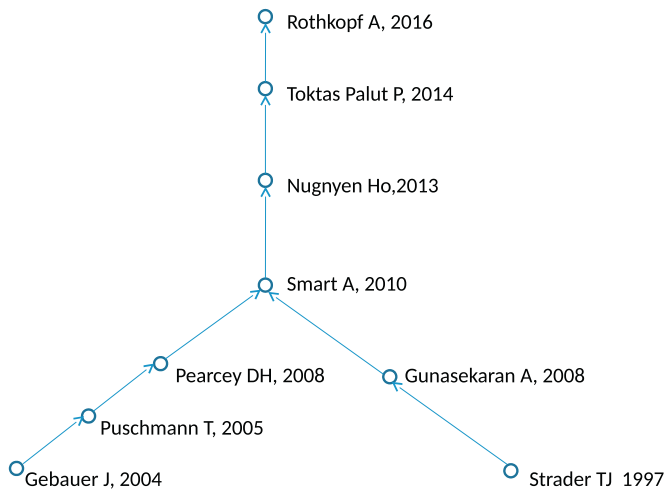
Fig. 9. Main path of Sub-cluster #4.

geographic locations as they adopted conventional methods. The algorithmic approach employed in this study is more appropriate for the field of e-governance, which characterised by a vast corpus of literature with diverse research trends, to elucidate the underlying patterns. The dynamics of the research activities in e-governance the results of this analysis indicate enables subsequent researchers to set their priority, academician to frame curricula for literacy on emerging domains, administrators to adopt policies and legal frameworks, and manufacturers to develop low-cost solutions for technological requirements.

5. Discussion

The main purpose of the study is to trace the development of e-governance and the emerging research fronts in the literature on the domain using CNA. The first phase up to 2005 is characterised by methods and maturity models to transform the conventional governance to e-governance (Doty & Erdelez, 2002; Ho & Coates, 2002; Layne & Lee, 2001; McNeal et al., 2003; Reddick, 2004; Warkentin, Gefen,

Pavlou, & Rose, 2002; Zafiropoulos, Karavasilis, & Vrana, 2012).

After the implementation of an e-governance system, proper evaluation and follow-up are necessary for its success. Collecting feedback and adopting the necessary re-engineering process could lead to higher success rates. The second phase (from 2005 to 2009) saw radical development in the research on the evaluation of existing e-governance systems and several researchers observed that customer-oriented web services were boosted by internet adoption at the grass-roots level (Lee, Tan, & Trimi, 2005). Several performance models to improve the perceived ease of use of websites and to increase customer satisfaction were also developed during this phase. Thus, the second phase witnessed advancements in research in divergent bi-directional paths in *models on the implementation of e-governance* in continuation of the first phase of research and the *evaluation models* on topics related to *service quality, customer satisfaction, and user adoption*. E-governance projects will be successful if there is an exotic use of e-services by customers and high user adoption and satisfaction. The major factors that determine the promotion of user access to e-services are the willingness and mindsets of the stakeholders to adopt the behavioural changes brought about by e-governance. The issues related to privacy, lack of trust, security, and socio-cultural practices are the main factors limiting the usage of e-governance services, leading to the failure of many e-governance systems. Verdegem and Verleye (2009) argued that improved online access is the primary requirement for attracting potential users and increasing efficiency. Transparent, accountable, and accessible e-services would attract users and overcome the restrictions of money and time. Therefore, evaluating the system and close monitoring should be ensured at all stages of development for better transparency, effectiveness, and sustainability. In the transition stage of e-governance, user-centric models of customer satisfaction and user adoption, and models of process re-engineering were the major topics of discussion.

The next stage of e-governance research (2009–2012) flourished with the introduction of Web 2.0 + technology, which promoted the use of social networking to ensure public participation, leading to e-democracy or participative governance. Many authors noted the importance of *social media and social networking*, which enhance participatory governance.

The current phase of research in e-governance after 2012 is mainly on e-democracy, participatory governance, and open data. The
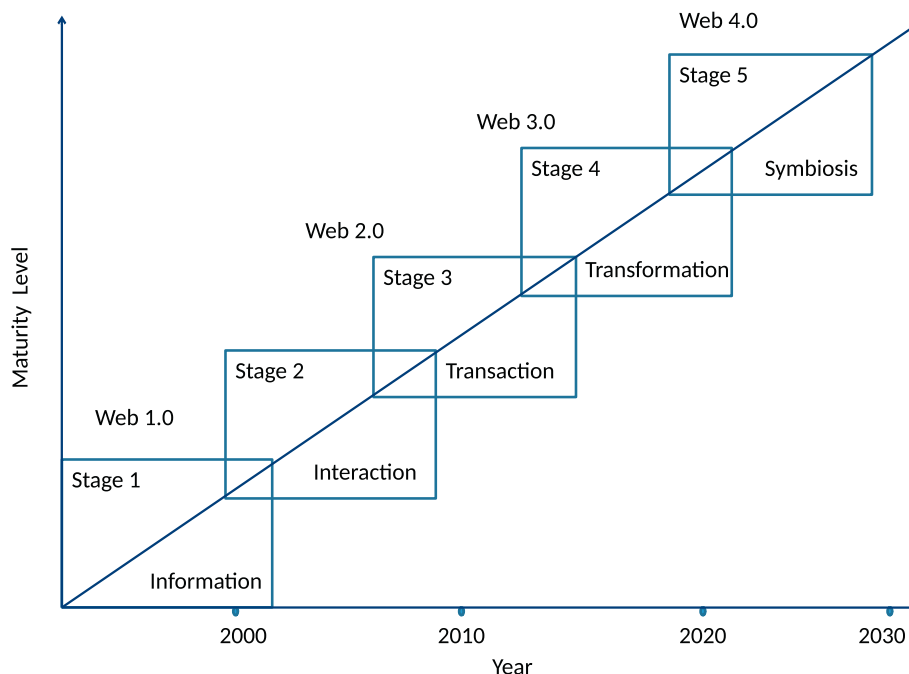

Fig. 10. Extension of the maturity development model.

Table 4
Key determinants related to the entities in G2C interaction.

(E-Government ⟵ **Interaction Medium** ⟶ Citizen)

E-Government	Interaction	Citizen
1 **Political factors**	1 **Service quality factors**	1 **Socio-cultural Practices**
Political Policy	Ease of use	Collectivism
Leadership	Availability	Uncertainty avoidance
2 **System support**	Personalization	Power distance
Infrastructure	2 **Information quality factors**	2 **Motivations to use**
Employees	Accuracy	Purpose
3 **System quality factors**	Usability	Trust
Transparency	Currency	Awareness
Authenticity	3 **Risk factors**	3 **Digital divide**
Responsiveness	Privacy	Age
Openness	Security	Gender
Economic feasibility	4 **Technological innovations**	e-literacy
4 **Strategic, monitoring and evaluation plans for the sustainability of e-governance**	Grass-root level implementation	Physical impairment
	Adoption by users	Poverty
		Cultural background
		4 **Other factors**
		Training obtained
		Previous experience
		Customer satisfaction

alternative channels for accessing e-services are better options *to impart transparency, openness, accountability, and to increase citizen participation* in governments' decision-making processes (de Jager & van Reijswoud, 2008; Sivarajah et al., 2015). The convenience to cast online votes, provision to participate in the government's strategic decision-making process through social networks, the dissemination of government information, collection of public opinions on social issues at a tremendous speed, possibility to trace significant topics of discussion in social network groups, and so on are the remarkable advantages of social networking in e-governance based on Web 2.0 + technology.

The analysis revealed that governance advanced from conventional government services to citizen-oriented e-services by including the direct participation of citizens in the decision-making process of government, leading to *e-democracy or participative governance*. In a participatory government, people often interact with the government in the policy-making and problem-solving processes. A UN survey identified three major activities associated with decision making through e-participation *viz.*, e-information sharing, e-consultation, and e-decision-making (UN-Report 2005). Sharing government-related information and data through open data platforms makes the government process more transparent, increases citizens' trust in the government and improves e-participation for better decision-making. The main topics of discussion in recent years are *open data, participatory governance/e-democracy, social networking, alternative channels for communication, and Web.2.0 +* as the platform for the seamless social interaction with the government. Fig. 1 illustrates the roadmap of research streams in e-governance. Information on the future trends of e-governance is of high interest to a broad community of researchers, administrators, investors, and other stakeholders of e-government. Governments can take strategic decisions by considering the emerging trends of e-democracy and social media adoption in e-governance as the main path and cluster analysis revealed. The adoption of Web 4.0 technology in the next stage of e-governance is expected to bring in radical changes in the G2C interaction channels. This scenario could also provide opportunities for manufacturers to incorporate more features related to convenience into the technical devices used for interaction. For example, by replacing touch screens with more reliable and accurate voice input options in natural language. Social media and the diffusion of smart-phones contributed significantly to citizen engagement in this stage. Open data, one area of focus on the leaf nodes of the main path, is an emerging feature of e-governance that requires high-end techniques and electronic devices to store and process data. The issues related to cloud computing techniques and device design to store and process big data would also attract attention among researchers. Security and privacy are the other major risk factors in the era of the big data. In this scenario, blockchain technology is gaining increased attention and it could be incorporated into e-government-related data storage and transaction processes to enhance protection, privacy, and security.

5.1. Contributions and implications

This study traces the main pathways, as the backbone of development, of e-governance. We identified the sub-domains of the areas using cluster analysis and indicated their chronological positions in the main path of the overall development. The growth curve fitted to the number of articles shows that there is still much to be done to reach maturity, indicating scope for further research activities. We have also identified articles in the emerging clusters with promising future impacts using network parameters. The themes considered in the article could be indicators of the direction of research in the near future. The results of the analysis in this study could help to set the focus of further research, the selection of suitable models and methodologies for administrators, and the development of technologies for manufacturers, in addition to clarifying the current research and future trends. The systematic, algorithmic approach based on SNA tools in this work provides a more objective and impartial view of the evolution of the area, emerging scenarios, and future trends.

5.1.1. Determinants of G2C interactions

The content analysis of the articles of the leaf nodes of the main path in Fig. 3 reveals that e-governance is moving towards citizen-oriented governance by soliciting extensive e-participation in the decision-making process of the government. The implementation of the latest trends in e-services needs seamless interaction between the citizen and the e-government. Hence, the quality of G2C interaction must be enhanced to improve citizens' participation in the decision-making process. It is useful to examine the related factors. Table 4 lists the major determinants associated with the components of G2C interactions extracted from the corpus of articles.

The major determinants associated with the government are political policy, system support, system quality factors, and strategic plans (Davis et al., 1989; Hien, 2014; Irani et al., 2012; Janssen & Wahyudi,

2017; Parasuraman, Zeithaml, & Malhotra, 2005; West, 2004). The policy of the government and its leadership are the major factors associated with the political factors in the implementation stage. Human capital, especially the skill and experience of the employees and infrastructure, are factors related to the system support. The quality of the system is promoted by transparency, authenticity, responsiveness, openness, and economic feasibility (Alalwan, Dwivedi, & Rana, 2017; Carter & Bélanger, 2005; Dwivedi et al., 2017; Nam, 2016; Papadomichelaki & Mentzas, 2009; Parasuraman et al., 2005; Sivarajah et al., 2015). The strategic plans, anticipation of future requirements, evaluation of plans, and monitoring implementation to detect drawbacks early contribute significantly to a successful e-governance implementation.

The major determinants related to the citizen are socio-cultural practices, motivation to use, the digital divide, and various other factors. Collectivism, avoidance of uncertainty, and power distance are prominent socio-cultural factors (Buchenrieder, Dufhues, Theesfeld, & Nuchanata, 2017). The purpose and trust in e-government are the motivating factors for participation (Al-Hujran, Al-Debei, Chatfield, & Migdadi, 2015; Alzahrani, Al-Karaghouli, & Weerakkody, 2017; Chen et al., 2015; Hien, 2014; Hung, Chang, & Yu, 2006; Parasuraman et al., 2005; Pavlou & Fygenson, 2006; Weerakkody et al., 2013). The digital divide arises from age, gender, literacy level, poverty, ethnicity, and cultural practice, major factors that play important roles in e-governance interactions (Helbig et al., 2009; Venkatesh et al., 2003). The other factors promoting interaction are the customer satisfaction with the previous experiences and the training and customer support provided to the user to use the services of the system effectively (Thompson, Higgins, & Howell, 1991; Venkatesh et al., 2003).

The major determinants related to the technological medium of G2C interaction are service quality factors, information quality factors, risk factors, and technological innovations. The service quality factors include the availability, ease of use, and the degree of personalization provided by the websites by storing the customer's details (Davis, 1989; Venkatesh et al., 2003). Some of the major risk factors are related to the privacy and security of personal information and financial transactions. The major factors related to information quality are accuracy, usability, and currency (Davis, 1989; Davis et al., 1989).

6. Conclusion

E-governance is a unique, pervasive, and revolutionary term that represents transparent, accountable, efficient, and customer-oriented government administration with the back-end support of ICT. The research domains in the field are enriched by the diversity and rapid evolution of the related fields. In this study, we systematically investigated the dynamics of the evolution of e-governance, including the evolution, paradigm shifts, diversity of research topics, and emerging research fronts by applying SNA tools to the citation network of e-governance. We visualized the main path of the evolution, which shows four distinct phases. The cluster analysis of the citation network identified the major sub-domains portraying the knowledge structure in the area. The analysis also reveals the emerging research fronts and existing research work that can have future impacts based on the network parameters. The study also revealed that the upcoming technology of Web 4.0 is expected to have a crucial role in steering the direction of the future development of e-governance.

Acknowledgements

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