Understanding the Corpus of E-Government Research: An Analysis of the Literature Using Co-Citation Analysis and Social Network Analysis

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Abstract:

The growing body of published e-government literature highlights the importance of e-government in society and the need to make sense of e-government by academia. In order to understand the future of e-government, it is important to understand the research that has been conducted and highlight the issues and themes that have been identified as important by empirical study. This paper analyses the corpus of e-government research published from 2000 to 2013 using Bibliometric and Social Network Analysis (SNA) methods to develop an intellectual structure of e-government research. Factor analysis, multidimensional scaling and centrality measurement are also applied to the e-government dataset using UCINET to identify the core influential articles in the field. This study identifies three core clusters of e-government research that centre around (i) e-government development models (ii) adoption and acceptance of e-government, and (iii) e-government using social media and highlights areas for future research in the field.

Track: **E-Business and E-Government**

Word count: 5174 words

1. Introduction

After nearly two decades of e-government implementation globally, the body of literature related to e-government research and evaluation has also grown considerably over the decades (Heeks & Bailur 2007), highlighting the importance of e-government in society and the need to make sense of it which has attracted researchers from different disciplines to identify new strategies, theories, techniques, methods and applications to advance the field of e-government research (Lean et al. 2009). Whether e-government is categorised as a research discipline in its own right or as a sub-domain of Information System and/or Public Administration has also been a topic of debate (Irani & Dwivedi 2008) making e-government a truly interdisciplinary area of research. However, after two decades of e-government implementation and near ubiquitous implementation across the world, has e-government now reached maturity and if so where is research in this field going in the future?

In order to address this question and understand the future of e-government research, it is important to investigate the research that has been conducted and highlight the issues and themes that have been identified as important by empirical study. Many studies that have reviewed the e-government literature have applied different methodologies to evaluate it, for example, content analysis (Heeks & Bailur 2007) and systematic literature review (Dwivedi 2009). These studies analysed e-government related conference and journal publications presenting different perspectives and identifying some of the important and relevant issues central to the study of e-government. Heeks and Bailur (2007) argued the current e-government research had not enough contribute neither in theory nor practical recommendations because of certain factors that influenced researchers in selecting research approach and Dwivedi (2009) discovered that researchers with information systems background contributed the largest number of articles in the analysed journal.

Other studies have focused on specific themes, for example design and methodologies used in e-government research (Irani et al. 2012), issues related to e-government implementation (Weerakkody et al. 2015), studies of e-government research in specific country (Paiva 2014; Snead & Wright 2014), e-government research related to policy (Kromidha & Cordoba-Pachon 2014), theories and application used in e-government research (Rana et al. 2011) and e-government adoption research (Rana et al. 2013a; Rana et al. 2013b). While some studies have described e-government research from a qualitative perspectives, few studies have reviewed the current status of e-government research from a quantitative perspective. To date, and to the best knowledge of the authors, there has been no published study that has evaluated the intellectual structure of e-government literature. This paper therefore addresses this omission and presents the findings of an intellectual structure analysis of published e-government research from 2000 to 2013, using Bibliometric and Social Network Analysis (SNA) methods. In addition, this paper provides additional insights to the structure of the research by applying factor analysis, multidimensional scaling and centrality measurement to the e-government publications dataset using UCINET to identify the core influential articles in the field. The remainder of this paper is organised as follows. The methodology section explains in detail the methods used, the process of analysis applied and the constituents of the dataset of e-government publications. The results of the analysis are then presented and the findings discussed. The conclusions highlight the implications of the study and the findings.

2. Methodology

The methodology used in this analytical process of reviewing the e-government literature is divided into four phases summarised in figure 1. The first phase was to compile the dataset of e-government publications, followed by a process of citation analysis, co-citation analysis

and then social network analysis. Each of these phases is described in more detail in the following sections.

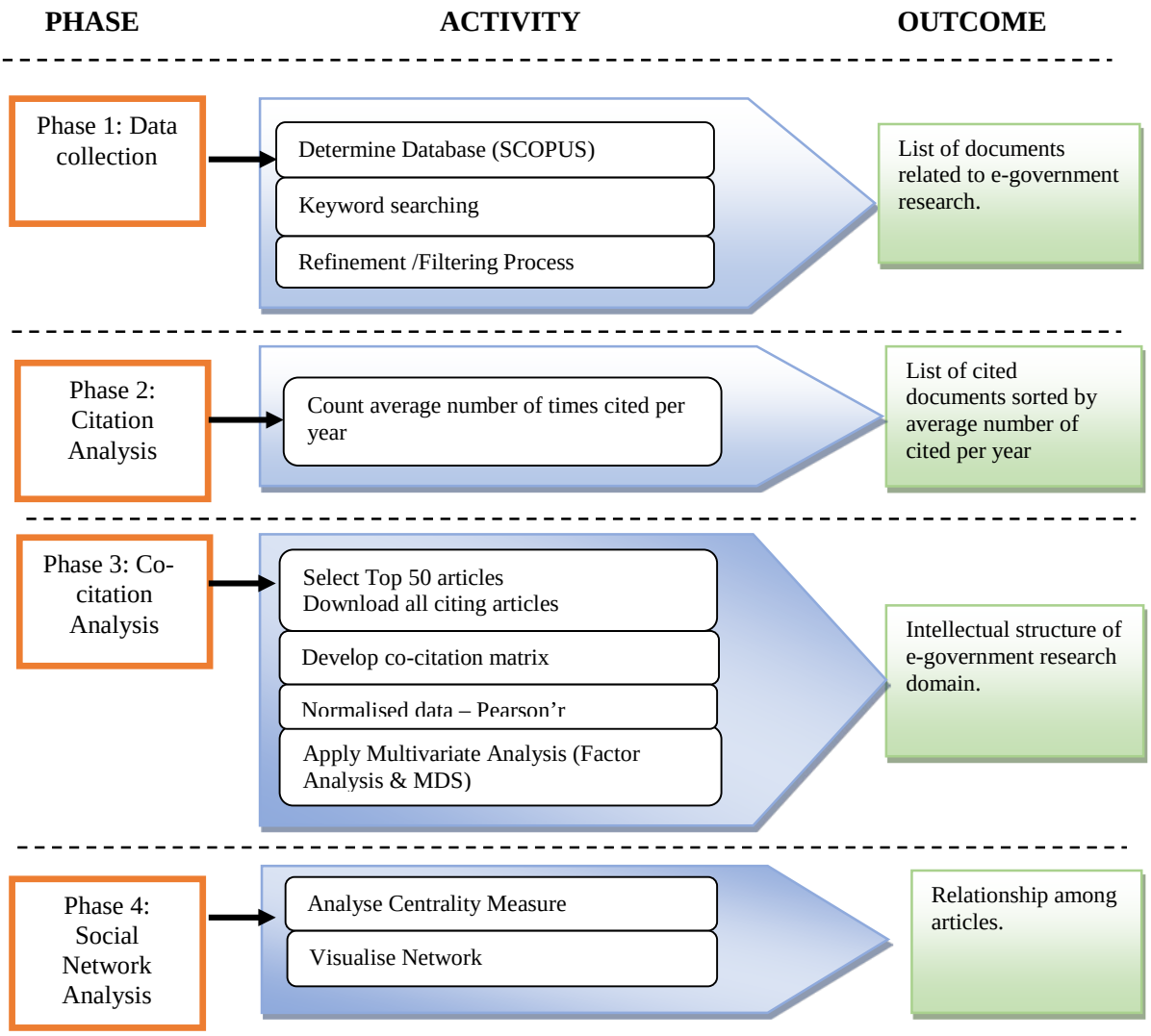

Figure 1: Analytical Process for Reviewing the E-Government Literature

2.1 First phase.

The Scopus database, one of the largest collections of academic publications, was used in this case as the bibliographic database for interrogation. The Scopus contains citations published in more than 20,000 peer-reviewed journals (Anon 2013) including Government Information Quarterly, Electronic Government, International Journal of Electronic Government Research, Information Polity, Transforming Government People, Process and Policy, International Journal of Public Administration, and Public Administration Review. In addition, only 54% of journal titles indexed in the Scopus are covered in Web of Science database (Gavel & Iselid 2008). Furthermore, coverage of the Scopus database in term of citations is 20 percent higher than the Web of Science (Falagas et al. 2008) with full citation analysis accessible from 1996 onwards (Bar-Ilan 2010).

A keyword method was adopted to identify a collection of representative research articles from Scopus. The string/keywords used for the search process were “e-government” OR “electronic government” OR “egovernment” which appeared in the publication title, abstract or keyword sections. Selected publications had to be categorised as article, written in English and a “journal” publication for our purposes. In addition, manual checking was implemented to ensure only the publications related to e-government were selected. The outcome of this phase was a list of articles related to e-government research.

2.2 Second phase.

Citation analysis is the ranking of publications based on the number of times an article has been cited in other articles. A high publication ranking score reflects more influence on the discipline (Culnan 1986). In this phase, information from all selected articles were imported into a spreadsheet and sorted by number of times it was cited up to 01 December 2014. The results list the highest cited article at the top and the lowest cited at the bottom. Obviously, the longer the articles had been published, the more likely they are to have been cited and this could influence the rankings considerably. To address this potential problem, we developed a measurement which considered the publication date independently of the length of time it was published. An average number of times each article was cited per year was counted using the following formula:

$$\textit{Average number of times cited per year} = \frac{\textit{(total number of times cited)}}{\textit{(2014 – publication year)}}$$

For example, an article by Bertot, Jaeger and Hansen (Bertot, Jaeger & Hansen 2012) was cited by 60 articles. After applying the above formula, the article received 30 citations per year. Another example, an article by Cater and Weerakkody (2008) only received 20 citations yearly although the total number of citations is 120.

Thus applying the above formula will give an equal chance that all articles selected are ranked in the list according to citations independent of length of time. Thus, a new list of articles sorted by the above formula was formed for co-citation analysis in the next phase. This list was called cited documents.

2.3 Third phase.

The co-citation analysis method of White and Griffith (1981) was adopted in this phase to achieve the objective of identifying the intellectual structure of the body of e-government literature. Co-citation is a frequency count of earlier publications cited together in later publication (Small 1973). The use of the co-citation analysis method to interpret the intellectual structure of research has been applied by several scholars in a number of studies (White & Griffith 1981; Ponzi 2002; Pilkington & Meredith 2009; Hsiao & Yang 2011; Shiau & Dwivedi 2013). Co-citation analysis identifies similarities between units of analysis of which there are three types - document, author and journal. Small (1973) introduced document co-citation analysis to analyse the intellectual structure of scientific specialties. This method has been extended to author co-citation analysis to measure intellectual structure of information science (White & Griffith 1981) and journal co-citation analysis for mapping economics journals (Mccain 1991) through literature. More recently, scholars have used author co-citation or document co-citation analysis to interpret the intellectual structure of scientific studies. For instance, using document co-citation analysis to demonstrate that documents published in journals are more reliable after having gone through a review process (Ramos-Rodríguez &

Ruíz-Navarro 2004) and are normally based on high quality research (Webster & Watson 2002).

However, co-citation is not without its limitations. For instance, author co-citation analysis is biased in that it only analyses the first author and disregards the co-authors. Furthermore, authors are likely to work in the same research discipline over a period of time and are therefore likely indulge in self-citation, legitimately building on the work they have done previously. Therefore, we consider document co-citation analysis to be a more accurate way of representing the intellectual structure of, in this case, e-government research and an appropriate measure of an article's influence within the body of e-government research.

For document co-citation analysis, two sets of documents were used to develop a co-citation matrix. The first set of documents were cited documents (source documents) which represented highly cited articles sorted by average number of citations per year. The second set of documents were citing documents, which cite source documents. This phase was initiated with imported information of cited documents from the previous phase and meta-data of citing documents downloaded from Scopus into a relational database. Then, a frequency of co-citation for each pair of cited articles was counted and transformed into a 50 by 50 square symmetrical co-citation matrix with the diagonal value treated as zero to represent no single article citing itself (McCain 1990; Ramos-Rodríguez & Ruíz-Navarro 2004). The threshold problem was solved using the trend of an average number of co-citations per article. The average number of co-citation was compared with the number of cited documents and plotted in a graph as shown in Figure 2, which shows how the average number of co-citations decreased when the number of cited documents increased. This trend stabilised at 30 cited documents which is acceptable as a threshold. However, in order to provide more accuracy to our study, we increased the threshold to 50 cited documents which were included in our dataset to improve the validity and reliability of the factor analysis results (Hair et al. 2010; Comrey & Lee 1992).

The co-citation matrix was normalized using Pearson's correlation coefficient for multivariate analysis. Pearson's correlation coefficient was chosen as a degree of similarity measurement that specifies the likeness relationship between all articles and to solve the problem of unlimited divergence between two related articles for the reason of differences in a scale (White & Mccain 1998). The first multivariate analysis techniques implemented using normalized co-citation matrix is factor analysis (FA) which is used to identify the core structure of research (Tabachnick & Fidell 2008). FA reduces and groups items according to their similarity and differences as factors and allows an item (article) to be placed in multiple factors. Factor loadings greater than +-0.7 were used to identify the most appropriate items (McCain 1990; Hair et al. 2010).

The second multivariate analysis technique adopted in this study was multidimensional scaling (MDS), a routine to visualize patterns of proximities among a group of items. In this study, articles were plotted according to the similarity value where the higher the value the closer each pair of articles on the map (Leydesdorff & Vaughan 2006). Unlike FA, MDS maps each article only at a single point. MDS uses stress value to measure goodness of fit where the smaller value is the better representation. Stress values less than 0.2 are considered a representative fit (Hair et al. 2010; McCain 1990). NetDraw (Borgatti 2002) was used to visually map the MDS result. The outcome of this third phase was to present the intellectual structure of e-government research.

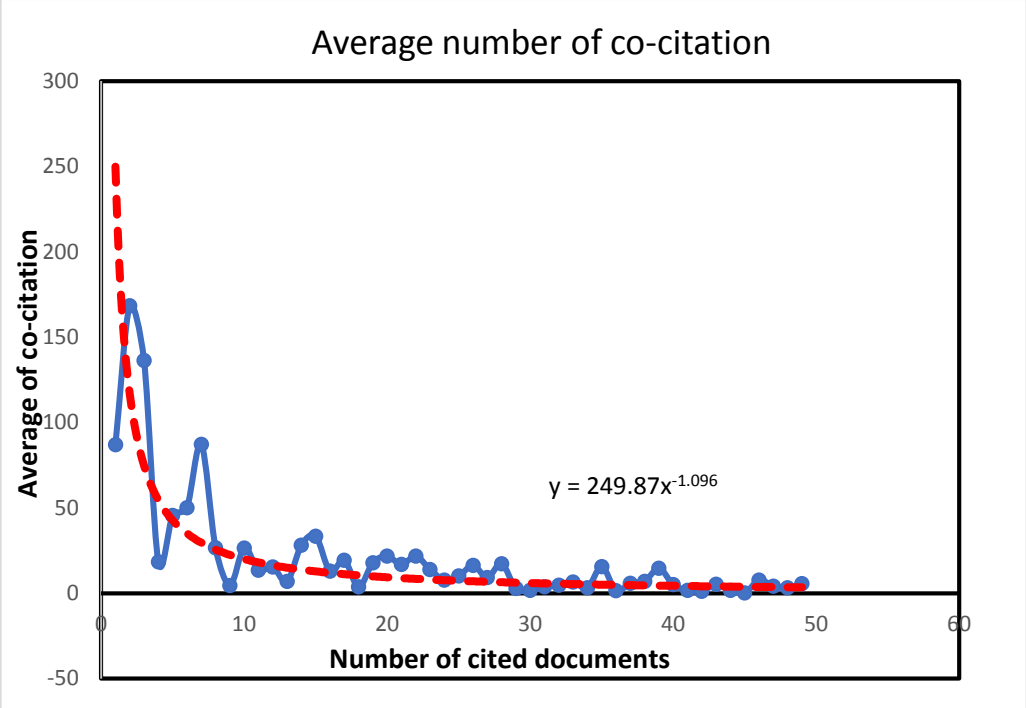

Figure 2: Trend of average number of co-citation

2.4 Fourth phase.

Analysis of document co-citation is critical to understanding the influence and impact of articles on the sub-domain of research and Social Network Analysis (SNA) was used in this instance to achieve this objective. SNA uses centrality measure to identify the most important and influential nodes or articles in the network map. Based on a raw document of co-citation matrix, using UCINET (Borgatti et al. 2002) creates a co-citation network map to measure the actual proportional relationships between articles (Wang & Chen 2014). The three centrality measures of SNA were then applied. Firstly, degree centrality also known as local centrality indicates the popularity ranking of an article and was applied to measure the number of direct links between articles. Second, betweenness centrality was used to measure the number of times an article has been used as the shortest path between two other articles. The higher the value of betweenness centrality indicates the greater influence the article has in the network and is perceived as a leader and likely to manage network processes (Freeman 1979). Finally, eigenvector centrality was used to measure the central article which is connected to other prominent articles (Bonacich 1972). The higher the eigenvector centrality score, the greater the influence of the article on other key articles in the network domain.

3. Analysis and Findings

The number of e-government articles published in refereed journals has increased gradually over the years as illustrated in Figure 3. In total, 1,932 articles were published from 2000 to 2013, beginning with seven articles in 2000 increasing steadily over the next thirteen years with a couple of minor dips in 2004 and 20011. This broadly mirrors the increasing interest in and implementation and adoption of e-government across the globe.

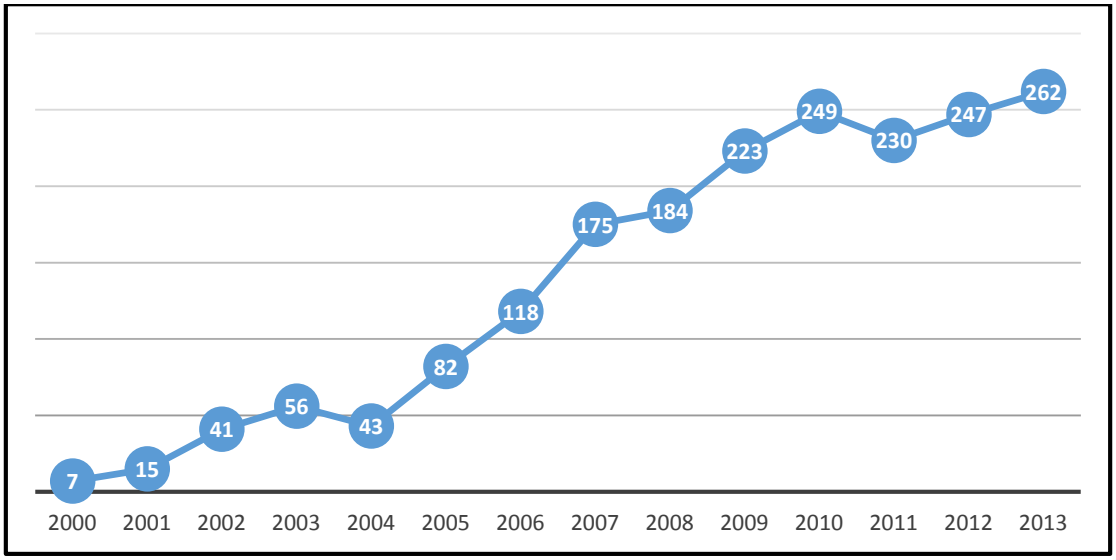

Figure 3: Number of E-government Articles Published Annually (2000-2013)

Having established the dataset of e-government articles, the three phase analytical process described earlier and summarised in figure 1 was applied. The rest of this section will present the findings as follows: (i) the citation analysis will explain the citation results of the dataset. (ii) the co-citation analysis will present the multivariate analysis test results and finally, (iii) the Social Network Analysis will describe the findings of the network analysis tests.

3.1 Citation Analysis

The search process yielded 1,942 cited documents and 26,057 citing documents related to e-government research from 2000 to 2013. A further manual checking process identified seven anonymous articles and three further articles that were not relevant to e-government and these were excluded from this study. The remaining 1,932 cited documents were further analysed. The cited documents were ranked according to the average number of citations per year. The top 50 cited documents are listed in table 1. The highest cited document per year taken as an average was (Layne & Lee 2001), followed by (Carter & Belanger 2005), (Moon 2002) and (West 2004). Using the yearly average counting method allows more recent articles to be included in the top 50 for example articles by (Norris & Reddick 2013), (Bertot, Jaeger & Hansen 2012) and (Bonsón et al. 2012). In total 11 articles published from 2010 to 2013 were listed. This counting method also provides better rankings for (Carter & Belanger 2005) compared to (Moon 2002) even though the total number of citations for (Moon 2002) is higher. Surprisingly, the article by (Bertot et al. 2010) was listed in the top five ranking which highlights an emerging research theme related to social media that has attracted researchers in the field of e-government research.

ID	Authors	Publication Year	No. of Citations	Average Yearly Citations
1	Layne & Lee (2001)	2001	839	64.5
2	Carter & Belanger (2005)	2005	515	57.2
3	Moon (2002)	2002	661	55.1
4	West (2004)	2004	476	47.6
5	Bertot, Jaeger & Grimes (2010)	2010	190	47.5
6	Heeks & Bailur (2007)	2007	267	38.1
7	Yildiz (2007)	2007	257	36.7

8	Ho (2002)	2002	436	36.3
9	Belanger & Carter (2008)	2008	197	32.8
10	Bertot, Jaeger & Hansen (2012)	2012	60	30.0
11	Coursey & Norris (2008)	2008	143	23.8
12	Teo, Srivastava & Jiang (2009)	2009	116	23.2
13	Wang & Liao (2008)	2008	137	22.8
14	Saebo, Rose, Skiftenes (2008)	2008	133	22.2
15	Andersen & Henriksen (2006)	2006	177	22.1
16	Thomas & Streib (2003)	2003	243	22.1
17	Verdegem & Verleye (2009)	2009	109	21.8
18	Ebrahim & Irani (2005).	2005	195	21.7
19	Bonson, Torres, Royo & Flores (2012)	2012	43	21.5
20	Carter & Weerakkody (2008)	2008	120	20.0
21	Reddick (2005)	2005	179	19.9
22	Hung, Chang & Yu (2006)	2006	155	19.4
23	Moon & Norris (2005)	2005	168	18.7
24	Horst, Kuttschreuter & Gutteling (2007)	2007	127	18.1
25	Shareef, Kumar, Kumar & Dwivedi (2011)	2011	53	17.7
26	Helbig, Gil-Garcia & Ferro (2009)	2009	88	17.6
27	Jaeger & Thompson (2003)	2003	186	16.9
28	Lean, Zailani, Ramayah & Fernando (2009)	2009	84	16.8
29	Gupta & Jana (2003)	2003	179	16.3
30	Sandoval-Almazan & Gil-Garcia (2012)	2012	32	16.0
31	Norris & Reddick (2013)	2013	16	16.0
32	Jaeger & Bertot (2010)	2010	63	15.8
33	Guijarro (2007)	2007	110	15.7
34	Kim, Kim &Lee (2009)	2009	78	15.6
35	Scholl & Klischewski (2007)	2007	109	15.6
36	Reddick (2004)	2004	146	14.6
37	Linders (2012)	2012	29	14.5
38	Klievink & Janssen (2009)	2009	71	14.2
39	Ebbers, Pieterson & Noordman (2008)	2008	85	14.2
40	Jaeger (2003)	2003	155	14.1
41	Gil-Garcia, Chengalur-Smith &Duchessi (2007)	2007	98	14.0
42	Bertot, Jaeger & Grimes (2012)	2012	28	14.0
44	Kim & Lee (2006)	2006	109	13.6
43	Fu, Farn & Chao (2006)	2006	109	13.6
45	Picazo-Vela, Gutierrez-Martinez & Luna-Reyes (2012)	2012	27	13.5
46	Evans & Yen (2006)	2006	106	13.3
47	Schuppan (2009)	2009	65	13.0
48	McDermott (2010)	2010	52	13.0
49	Irani , Elliman & Jackson (2007)	2007	88	12.6
50	Gil-Garcia & Martinez-Moyano (2007)	2007	86	12.3

Table 1: List of 50 Most Cited E-Government Articles

3.2 Co-citation Analysis

A Co-citation matrix was drawn from the dataset of 50 most cited documents (table 1) and 8,195 citing documents. Pearson's correlation coefficient was applied to normalise this co-citation matrix before statistical analysis using UCINET. FA and MDS were applied to identify intellectual structure and visualise the distribution of the articles.

FA was performed using principal component analysis with Varimax (orthogonal) rotation. In UCINET, we are allowed to set eigenvalue and number of factor as a cut-off point. Initially an eigenvalue greater than 1 was set and number of factors selected was 10. At this point, the analysis generated six factors with total variance explained was 80.1 percent. This

resulted in factors four, five and six having only one item each which were articles by (Norris & Reddick 2013), (Kim & Lee 2006) and (Bertot et al. 2010) respectively. For the next iteration of analysis, the eigenvalue remained at greater than 1 but number of factors was reduced to three. Consequently, three factors resulted in 71.4 percent total variance explained. In social science research, total variance greater than 50 percent is acceptable and more than 70 percent is considered high (Hair et al. 2010). The articles by (Norris & Reddick 2013) and (Bertot et al. 2010) were placed in factor two with factor loadings greater than 0.45 and the article by (Kim & Lee 2006) was placed in factor three with factor loading -0.384 as shown in table 2.

ID	Author	Factor 1	Factor 2	Factor 3
P36	Reddick (2004)	0.935	0.028	-0.173
P11	Coursey & Norris (2008)	0.91	0.05	-0.151
P29	Gupta & Jana (2003)	0.882	-0.053	-0.313
P38	Klievink & Janssen (2009)	0.877	0	-0.012
P23	Moon & Norris (2005)	0.861	0.06	-0.305
P8	Ho (2002)	0.857	0.073	-0.106
P15	Andersen & Henriksen (2006)	0.849	0.017	-0.12
P18	Ebrahim & Irani (2005).	0.838	-0.014	-0.341
P49	Irani , Elliman & Jackson (2007)	0.836	-0.018	-0.374
P50	Gil-Garcia & Martinez-Moyano (2007)	0.832	-0.054	-0.186
P4	West (2004)	0.824	0.029	-0.179
P47	Schuppan (2009)	0.82	0.092	-0.287
P40	Jaeger (2003)	0.811	-0.059	-0.423
P27	Jaeger & Thompson (2003)	0.808	0.01	-0.342
P16	Thomas & Streib (2003)	0.783	0.066	-0.291
P46	Evans & Yen (2006)	0.766	-0.038	-0.465
P34	Kim, Kim &Lee (2009)	0.759	0.322	-0.275
P6	Heeks & Bailur (2007)	0.758	-0.073	-0.266
P3	Moon (2002)	0.758	0.016	-0.15
P7	Yildiz (2007)	0.755	-0.083	-0.257
P21	Reddick (2005)	0.751	0.024	-0.459
P41	Gil-Garcia, Chengalur-Smith &Duchessi (2007)	0.74	-0.117	-0.181
P1	Layne & Lee (2001)	0.715	-0.015	-0.127
P33	Guijarro (2007)	0.705	-0.214	-0.164
P14	Saebo, Rose, Skiftenes (2008)	0.692	0.233	-0.163
P26	Helbig, Gil-Garcia & Ferro (2009)	0.661	0.041	-0.496
P35	Scholl & Klischewski (2007)	0.642	-0.136	0.155
P39	Ebbers, Pieterson & Noordman (2008)	0.641	0.069	-0.397
P2	Carter & Belanger (2005)	0.606	-0.182	-0.345
P42	Bertot, Jaeger & Grimes (2012)	-0.166	0.912	0.062
P30	Sandoval-Almazan & Gil-Garcia (2012)	0.033	0.88	-0.04
P45	Picazo-Vela, Gutierrez-Martinez & Luna-Reyes (2012)	-0.222	0.877	0.108
P19	Bonson, Torres, Royo & Flores (2012)	-0.097	0.858	0.17
P37	Linders (2012)	-0.116	0.844	0.146
P32	Jaeger & Bertot (2010)	0.084	0.807	-0.018
P48	McDermott (2010)	0.142	0.796	0.097
P10	Bertot, Jaeger & Hansen (2012)	-0.131	0.787	0.17
P31	Norris & Reddick (2013)	0.336	0.521	0.151
P5	Bertot, Jaeger & Grimes (2010)	0.221	0.496	0.083
P28	Lean, Zailani, Ramayah & Fernando (2009)	0.078	-0.169	-0.913
P24	Horst, Kuttschreuter & Gutteling (2007)	0.177	-0.141	-0.899
P44	Fu, Farn & Chao (2006)	0.124	-0.081	-0.887
P12	Teo, Srivastava & Jiang (2009)	0.316	-0.068	-0.863
P9	Belanger & Carter (2008)	0.244	-0.088	-0.846
P22	Hung, Chang & Yu (2006)	0.245	-0.133	-0.838
P13	Wang & Liao (2008)	0.323	-0.204	-0.808
P20	Carter & Weerakkody (2008)	0.42	-0.031	-0.806

P25	Shareef, Kumar, Kumar & Dwivedi (2011)	0.454	-0.057	-0.758
P17	Verdegem & Verleye (2009)	0.456	-0.155	-0.695
P43	Kim & Lee (2006)	0.372	-0.222	-0.384
Variance Explained		23.934	7.373	4.402
Percent of Variance Explained		47.9	14.7	8.8

Total variance explained: 71.4%

Table 2: Factor Analysis

Factor 1 explained 47.9 percent of the variance and most of the articles received higher factor loading. For that reason, it is difficult to select an appropriate label to represent all articles in this factor. However, it contains most of the early e-government research including e-government development models (Reddick 2004; Coursey & Norris 2008; Klievink & Janssen 2009; Andersen & Henriksen 2006; Layne & Lee 2001), e-government frameworks (Gupta & Jana 2003; Guijarro 2007), evolution of e-government (Moon 2002; Gil-Garcia & Martinez-Moyano 2007), citizen interactions (Thomas & Streib 2003; Reddick 2005) and critical review of e-government research and implementation (Jaeger 2003; Jaeger & Thompson 2003; Yildiz 2007; Heeks & Bailur 2007). Two articles had factor loadings more than 0.9. The first article is (Reddick 2004) which examined the current development of e-government implementation in American cities using the first two stages of Layne & Lee's (2001) model. The second article empirically analysed five different e-government development models (Coursey & Norris 2008). Based on these works, factor 1 was labelled as e-government development model.

Factor 2 was dominated by articles related to suitability of e-government using Web 2.0 technology and social media in order to improve transparency (Bertot, Jaeger, Grimes, et al. 2012; Bonsón et al. 2012; Jaeger & Bertot 2010; McDermott 2010; Bertot et al. 2010), citizen interaction and collaboration (Sandoval-Almazan & Gil-Garcia 2012; Picazo-Vela et al. 2012; Norris & Reddick 2013; Linders 2012) and government policy and regulation related to anti-corruption and trust issues (Bertot, Jaeger & Hansen 2012)(McDermott 2010). The variance explained by this factor was 14.7 percent.

Factor 3 focused on adoption and diffusion of e-government. Multiple theories of adoption and acceptance were tested to measure intention of citizen towards e-government implementation in different levels. More specifically, intention to use e-government (Lean et al. 2009), adoption (Horst et al. 2007; Carter & Weerakkody 2008; Shareef et al. 2011), acceptance (Fu et al. 2006; Hung et al. 2006), user satisfaction (Verdegem & Verleye 2009; Wang & Liao 2008) and trust (Teo et al. 2009; Bélanger & Carter 2008).This factor explained 8.8 percent of the variance.

The FA method means that an article can appear in more than one factor. In contrast, MDS limits an article to being graphically located only in one point. Thus, MDS can complement FA findings to position an article in a major sub-research domain. Thus, all 50 articles in this dataset were located on a network map as shown in Figure 4 which only displayed links with values (correlation coefficient) exceeding 0.7. The stress value is 0.105 (lower than an acceptable value 0.2). Clearly, three main groups can be seen where group 1 (in the middle) is the biggest group with most articles from factor 1, group 2 (bottom left) with articles from factor 2 and group 3 (top right) with articles from factor 3. The MDS findings were consistent with those of the FA confirming the grouping of articles and enabling us to confidently extract the major themes and issues from these groups.

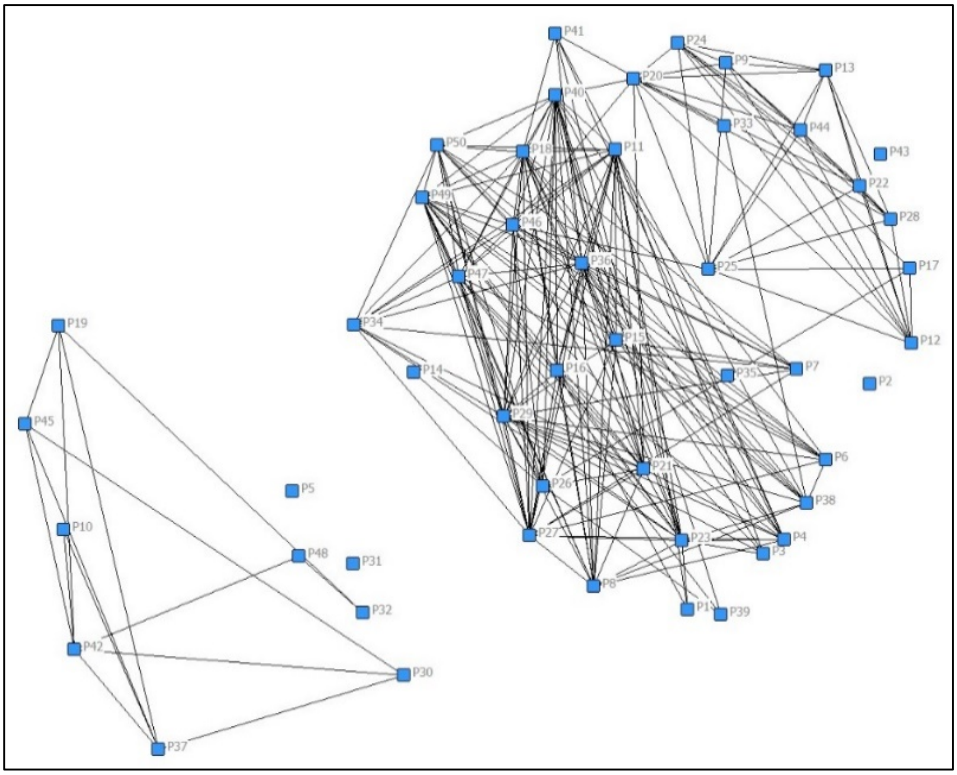

Figure 4: Network Map (Multidimensional Scaling)

*(correlation coefficient >=0.7).

3.3 Social Network Analysis (SNA)

Studying the relationships between research articles through SNA exposes the characteristics and level of ties among articles in a network map. Further investigation revealed the impact of certain articles on the sub domain of e-government research. SNA was applied using three centrality measures as discussed in the methodology section.

Table 3 provides an overview of the key e-government articles based on their three different centrality measures. The article by (West 2004) clearly dominated the centrality measure results. Degree centrality results showed an article by (West 2004) received the largest connection in the network map. Five other articles (Layne & Lee 2001), (Moon 2002), (Bertot et al. 2010), (Ho 2002), and (Coursey & Norris 2008) shared the second place. An article by (Norris & Reddick 2013) received the lowest degree centrality score.

A high value of betweenness centrality has the potential to link between establish researchers and new comers (Abbasi et al. 2012) because new researchers mostly link to betweenness centrality. Results of betweenness centrality showed the same article by (West 2004) received the highest score followed by three other articles in the second place including (Moon 2002), (Ho 2002) and (Coursey & Norris 2008). An articles by (Bertot et al. 2010) was in the fifth place followed by (Layne & Lee 2001). An article by (Kim & Lee 2006) received zero score of betweenness centrality.

An eigenvector centrality results changed the network map relationship. An article by (Moon 2002) received the highest score followed by (Layne & Lee 2001). An articles by (West 2004) dropped to the third place followed by (Ho 2002). Interestingly, an article by (Bertot et al. 2010) received low score in eigenvector centrality measure compared with the first two centrality measures.

Author	Degree	Author	Betweenness	Author	Eigenvector
West (2004)	49	West (2004)	9.351	Moon (2002)	60.204
Layne & Lee (2001)	48	Moon (2002)	7.966	Layne & Lee (2001)	57.932
Moon (2002)	48	Ho (2002)	7.966	West (2004)	46.77
Bertot, Jaeger & Grimes (2010)	48	Coursey & Norris (2008)	7.966	Ho (2002)	45.217
Ho (2002)	48	Bertot, Jaeger & Grimes (2010)	7.881	Carter & Belanger (2005)	37.467
Coursey & Norris (2008)	48	Layne & Lee (2001)	7.649	Thomas & Streib (2003)	28.125
Carter & Belanger (2005)	47	Thomas & Streib (2003)	7.182	Heeks & Bailur (2007)	25.26
Heeks & Bailur (2007)	47	Carter & Belanger (2005)	6.759	Yildiz (2007)	23.807
Yildiz (2007)	47	Yildiz (2007)	6.493	Andersen & Henriksen (2006)	22.557
Thomas & Streib (2003)	47	Heeks & Bailur (2007)	6.264	Moon & Norris (2005)	21.722
Belanger & Carter (2008)	46	Belanger & Carter (2008)	6.126	Reddick (2004)	21.716
Andersen & Henriksen (2006)	46	Saebo, Rose, Skiftenes (2008)	6.036	Reddick (2005)	19.266
Reddick (2005)	46	Reddick (2005)	5.993	Gupta & Jana (2003)	18.705
Moon & Norris (2005)	46	Kim, Kim &Lee (2009)	5.973	Jaeger (2003)	18.459
Jaeger & Thompson (2003)	46	McDermott (2010)	5.558	Ebrahim & Irani (2005).	18.362
Kim, Kim &Lee (2009)	46	Helbig, Gil-Garcia & Ferro (2009)	5.25	Coursey & Norris (2008)	17.827
Saebo, Rose, Skiftenes (2008)	45	Moon & Norris (2005)	5.154	Jaeger & Thompson (2003)	17.365
Ebrahim & Irani (2005).	45	Jaeger & Thompson (2003)	5.042	Belanger & Carter (2008)	15.808
Helbig, Gil-Garcia & Ferro (2009)	45	Andersen & Henriksen (2006)	5.008	Carter & Weerakkody (2008)	14.657
Klievink & Janssen (2009)	45	Ebrahim & Irani (2005).	4.969	Hung, Chang & Yu (2006)	13.346
Verdegem & Verleye (2009)	44	Schuppan (2009)	4.575	Evans & Yen (2006)	10.762
Jaeger (2003)	44	Teo, Srivastava & Jiang (2009)	4.443	Horst, Kuttschreuter & Gutteling (2007)	10.488
Teo, Srivastava & Jiang (2009)	43	Sandoval-Almazan & Gil-Garcia (2012)	4.409	Gil-Garcia & Martinez-Moyano (2007)	10.262
Hung, Chang & Yu (2006)	43	Klievink & Janssen (2009)	4.264	Wang & Liao (2008)	10.193
Reddick (2004)	43	Jaeger (2003)	4.224	Verdegem & Verleye (2009)	9.6
Ebbers, Pieterson & Noordman (2008)	43	Jaeger & Bertot (2010)	3.951	Irani , Elliman & Jackson (2007)	8.726
Evans & Yen (2006)	43	Verdegem & Verleye (2009)	3.726	Helbig, Gil-Garcia & Ferro (2009)	8.632
Shareef, Kumar, Kumar & Dwivedi (2011)	42	Bertot, Jaeger & Hansen (2012)	3.66	Teo, Srivastava & Jiang (2009)	8.448
Gupta & Jana (2003)	42	Ebbers, Pieterson & Noordman (2008)	3.337	Ebbers, Pieterson & Noordman (2008)	7.834
Gil-Garcia, Chengalur-Smith &Duchessi (2007)	42	Hung, Chang & Yu (2006)	2.75	Bertot, Jaeger & Grimes (2010)	7.719

Schuppan (2009)	42	Lean, Zailani, Ramayah & Fernando (2009)	2.649	Klievink & Janssen (2009)	7.628
Wang & Liao (2008)	41	Evans & Yen (2006)	2.437	Kim, Kim &Lee (2009)	7.07
Carter & Weerakkody (2008)	41	Reddick (2004)	2.237	Lean, Zailani, Ramayah & Fernando (2009)	6.67
Guijarro (2007)	41	Gil-Garcia, Chengalur-Smith &Duchessi (2007)	2.11	Gil-Garcia, Chengalur-Smith &Duchessi (2007)	6.456
Gil-Garcia & Martinez-Moyano (2007)	41	Bonson, Torres, Royo & Flores (2012)	2.1	Shareef, Kumar, Kumar & Dwivedi (2011)	6.139
Horst, Kuttschreuter & Gutteling (2007)	40	Gil-Garcia & Martinez-Moyano (2007)	2.038	Fu, Farn & Chao (2006)	5.814
Lean, Zailani, Ramayah & Fernando (2009)	40	Gupta & Jana (2003)	1.872	Schuppan (2009)	5.743
McDermott (2010)	40	Picazo-Vela, Gutierrez-Martinez & Luna-Reyes (2012)	1.686	Guijarro (2007)	5.583
Irani , Elliman & Jackson (2007)	39	Wang & Liao (2008)	1.527	Saebo, Rose, Skiftenes (2008)	5.075
Sandoval-Almazan & Gil-Garcia (2012)	38	Guijarro (2007)	1.448	Scholl & Klischewski (2007)	4.231
Jaeger & Bertot (2010)	38	Shareef, Kumar, Kumar & Dwivedi (2011)	1.395	Jaeger & Bertot (2010)	2.754
Bertot, Jaeger & Hansen (2012)	37	Linders (2012)	1.319	McDermott (2010)	2.746
Fu, Farn & Chao (2006)	37	Horst, Kuttschreuter & Gutteling (2007)	1.139	Sandoval-Almazan & Gil-Garcia (2012)	1.905
Scholl & Klischewski (2007)	32	Carter & Weerakkody (2008)	1.012	Bertot, Jaeger & Hansen (2012)	1.873
Bonson, Torres, Royo & Flores (2012)	29	Norris & Reddick (2013)	0.817	Bonson, Torres, Royo & Flores (2012)	1.533
Linders (2012)	24	Bertot, Jaeger & Grimes (2012)	0.695	Norris & Reddick (2013)	1.451
Kim & Lee (2006)	24	Fu, Farn & Chao (2006)	0.651	Kim & Lee (2006)	1.371
Picazo-Vela, Gutierrez-Martinez & Luna-Reyes (2012)	24	Irani , Elliman & Jackson (2007)	0.617	Linders (2012)	0.88
Bertot, Jaeger & Grimes (2012)	23	Scholl & Klischewski (2007)	0.325	Bertot, Jaeger & Grimes (2012)	0.838
Norris & Reddick (2013)	21	Kim & Lee (2006)	0	Picazo-Vela, Gutierrez-Martinez & Luna-Reyes (2012)	0.653

Table 3: Result of Centrality Measures

4. Discussion

The initial objective of this study was to better understand the intellectual structure of the body of e-government research and identify the works that have had the greatest impact on the field. Using the statistical methods of FA and MDS the findings showed that the articles clustered around three major themes namely (1) e-government development models (2) adoption and diffusion; and (3) social media.

The first cluster, contained more than 50 percent of articles in this study highlighting the early focus on e-government development models and frameworks, the way citizen interact with e-government and critical reviews of e-government research. The early years were influenced by the predominance of staged e-government models and similar e-government based frameworks largely driven by practitioner based stage models of e-government development showing the different phases through which e-government would progress, summarised in table 4. In particular Layne and Lee (2001) introduced a four stages of e-government development model as a guideline for public administrators to implement e-government in their organisations. West (2004) built on this and examined government service delivery and public attitudes towards e-government using the four stages of e-government transformation. The study found that technology used in government could improve democratic processes through better response to citizens' requests and increase government effectiveness. However, the same study revealed that implemented e-government had not yet reached its potential to transform service delivery and public trust in government.

Author	Development Model
(Layne & Lee 2001)	Four Stages: I. Catalogue; II. Transaction; III. Vertical integration; IV. Horizontal integration
(Moon 2002)	Five Stages (adapted from (Hiller & Belanger 2001): I. Simple information dissemination (one-way communication) II. Two-way communication (request and response) III. Service and financial transactions IV. Integration (horizontal and vertical integration) V. Political participation
(West 2004)	Four stages: I. Billboard II. Partial service delivery III. Portal with fully executable and integrated IV. Interactive with public out-reach
(Klievink & Janssen 2009)	Five dynamic stages: I. Stovepipes II. Integrated organizations III. Nationwide portal IV. Inter-organizational integration V. Demand-driven, joined-up government

Table 4: Literature Cluster 1: E-government development models

Moon (2002) adopted a five stage framework introduced by (Hiller & Belanger 2001) in order to measure activities in local government. The study revealed immature e-government implementation (at stage I or stage II) and highlighted how government were struggling with limited budgets and technical aspects. Reddick (2004) built on this study with empirical data

from three perspectives government to citizen (G2C), government to government (G2G) and government to business (G2B). Using Layne & Lee's (2001) model of e-government development they found G2C was lagging behind G2G and G2B having only reached Stage I while the others had reached Stage II. Andersen and Henriksen (2006) further highlight the limitations of the four stages model proposed by (Layne & Lee 2001) and propose an e-government maturity model known as Public Sector Process Rebuilding (PPR) maturity model.

Table 4 provides an overview of how e-government development models and frameworks were extended by researchers to better reflect issues involved in the implementation of e-government and thus evaluate its implementation. However, scholars have argued that these development models are neither representative of the stages through which e-government implementation progresses neither can they forecast the development of e-government (Coursey and Norris, 2008). While there have been recommendations for additional factors to be incorporated such as dynamic capabilities (Coursey & Norris, 2008) and incorporating national perspectives in addition to the organisation level (Klievink & Janssen 2009). Overall, the e-government development model has continued to be a topic of interest in e-government research until 2006 but interest has subsequently moved to new topics such as adoption and acceptance.

This second cluster of e-government research covers the period from 2006 to 2009 and focuses on topics related to adoption and diffusion of e-government which examined the issues related to post implementation and usage by citizens, summarised in table 5. Here, theories of adoption and acceptance, such as Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Planned Behaviour (TPB), Theory of Reasoned Action (TRA), and Diffusion of Innovations (DOI) were applied to measure multiple perspectives and factors related to e-government, including trust, intention to use, user acceptance, and user satisfaction. Trust was found to be a particularly important factor of investigation in e-government adoption studies, as more than 50 percent of research in this cluster examined trust.

Author	Theory
(Horst et al. 2007)	Trust
(Teo et al. 2009)	Trust, DeLone and McLean model
(Lean et al. 2009)	Trust, TAM, DOI
(Carter & Weerakkody 2008)	Trust, TAM, UTAUT
(Bélanger & Carter 2008)	Trust, TRA
(Fu et al. 2006)	TAM,TPB
(Hung et al. 2006)	TPB
(Wang & Liao 2008)	DeLone and McLean model
(Shareef et al. 2011)	Trust

Table 5. Literature Cluster 2: Adoption Theory and Trust

The third cluster of e-government research focuses on current technology trends and use of social media to improve interaction and collaboration with citizens, reduce corruption and increase transparency. E-government research in this area is still in the early stages. A number of studies review transparency issues related to e-government. For instance, considerations and challenges of social media usage to open up access to government (Jaeger and Bertot, 2010); exploring the potential of e-government and social media to create a culture of transparency (Bertot et al. 2010); exploring ICT and social media to enhance collaboration between government and the public in order to promote transparency (Bertot et al. 2012); and the impact of social media on e-participation and transparency in EU countries (Bonsón et al. 2012).

These and other studies show how social media has great potential to increase participation and improve communication between government and citizens (Picazo-Vela et al. 2012) and improve services particularly at a local level (Sandoval-Almazan & Gil-Garcia 2012; Norris & Reddick 2013). However, there is still a need to ensure that government policies, laws and regulations are able to deal with the changes and implications of using these technologies (Bertot, Jaeger & Hansen 2012; McDermott 2010).

A Social network analysis approach was applied to identify the most influential articles contributing to e-government research and the interrelationships between them. West (2004) was the only article found to have the maximum number of ties highlighting this as the most important and influential article in e-government research between 2000 to 2013. Using a four stage model of e-government transformation, West (2004) links government service delivery and public attitudes which attracted many subsequent researchers to explore advanced strategies and solutions for better government services. This article was found to have been cited as a central reference around the world. Interestingly, there no single article was categorised as isolated which means that all articles were in some way connected in the network. The same article (West 2004) was also found to be important as a central article that providing a link bridging the most articles in the network together. At the other extreme, the article by Kim & Lee (2006) was found to have no influence and was the least important in this network map. Furthermore, the articles by Moon (2002) followed by Layne & Lee (2001) were found to be in the central position and connected to the other important articles in the network map. The article focusing on social media and e-government (Bertot et al. 2010) was found to have the lowest score and consequently was the least connected indicating the relative newness of the paper and the topic in the body of e-government research.

5. **Conclusion and limitations**

Evaluating the intellectual structure of e-government research provides some very interesting insights to the literature published from 2000 to 2013. We can see the subject area is dynamic as evidenced in the development and evolution of themes and issues from the literature over the past 14 years. The research has moved from the rather static evaluation of e-government through frameworks and models in the first cluster, highlighting issues of users, citizen inclusion and implementation of e-government in the second cluster and finally, emerging in line with the changing technological trends and digital environments to issues of new technologies and social media in the third cluster. This provides fertile ground to further develop a greater understanding of e-government in the context of the ever changing landscape of new technologies and related phenomena of social media.

While the data analysis process has been rigorous as with any research, this study has several limitations which could be addressed in future research. First, the database used for data extraction was limited to Scopus. Some others journals might not be covered in this database. Future study is recommended to apply the same techniques using other database as a complimentary to this study. Second, the keywords used in this study were specific to terms related to “e-government”. Since this research domain is new and evolving, new terms are expected to be introduced and used. Other keywords such as digital government, seamless government and online government can be added into search process. The keywords used in the search process could be extended to enhance comprehensive coverage of e-government articles. Third, document co-citation was used in this study as a unit of analysis. Alternatively, other type of analysis (author co-citation or journal co-citation) can be applied. While we have adopted three centrality measures in SNA, there are other techniques in SNA can be used to measure different level of relationships.

This study has used some novel analytical techniques to shed some light on and deeper understanding of the body of e-government research to date. It provides some insights not only on the dominant themes that have pre-occupied the community of scholars, but has also provided some deep insights to the inter-connectedness of research that enriches our understanding of the e-government field and presents opportunities for identifying future areas of research.

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