Mapping the Evolving Intellectual Structure of Digital Innovation Research on the Public Sector: a Document Co-citation Analysis

Hugo Hedlund
Umeå University
hugo.hedlund@umu.se

Abstract

This paper uses document co-citation analysis (DCA) to explore the underlying and evolving structure of research on digital innovation (DI) in the public sector. As such, the DCA examines (1) what streams of scientific literature have been used in scholarly practices of citation in the study of innovation in the domain of e-government; (2) which are the central documents in the identified research streams and; (3) whether the emerging academic contributions around DI has had an impact on this field of research. Through the DCA of 1082 peer-reviewed papers three clusters of citation are identified, mapped, and categorized as: E-government diffusion and effects; Technology acceptance and adoption; and Digital innovation and infrastructures. The first two clusters are found to be tightly coupled while the last is found to currently be infrequently connected to either clusters. Implications for research and practice are presented and discussed

1. Introduction

It has previously been suggested that research on the digitalization of public services and administration could stand to gain from engaging with emerging Information Systems (IS) literature on digital and service innovation [5, 19, 22]. Through a mapping document co-citation analysis (DCA), this paper aims to reveal what streams of scientific literature e-government research has used in scholarly practices of citation when addressing innovation thus far. Further, this paper examines whether current research on digital innovation (DI) is seen to have impacted e-government studies to date. This is done to create an overview of existing research and identify avenues for future study.

E-government research is a cross-disciplinary field straddling IS, public administration, business administration, and policy concerning itself with the implementation and use of digital technology in the delivery, administration, and provision of public services. The field has also seen a growing interest in innovation and digital transformation beyond traditional digitization of analog application forms [7, 22]. However, the domain of e-government is sometimes accused of eschewing recent developments in fields such as IS, political science, and open innovation [6, 20, 22].

DI is a rapidly growing field of research within IS that emphasizes the recombinatorial and generative nature of digital technology and how it impacts both innovation processes and outcomes [21, 59, 60]. Extant theories and methods of innovation management are being upended by processes of digitalization challenging prior assumptions on the boundaries of innovation [34]. DI has been found to involve interrelated but competing concerns that must be managed in novel ways due to the introduction of ever-changing digital technologies [36, 46]. Further, recent reviews of the literature on DI illustrate this growing stream of study as informative on an individual, organizational, and environmental level [23], yet research is diverse and in need of bridges to further study [25]. As the scholarly body of work on DI could be said to still be in its infancy it is relevant to examine whether its theoretical contributions have impacted the study of innovation in an e-government context.

DCA constitutes a method that allows for the identification and mapping of clusters of references central to previous research and interaction between them [1, 50]. As such, the DCA method is fitting for the research objectives of this paper. While a full literature review lies beyond the scope of this DCA, the paper aims to create elementary theoretical descriptions of previous research streams and how they relate to each other [40]. Through a novel overview of the citation-based intellectual structure of a phenomenon of cross-disciplinary interest, this paper identifies and visualizes theoretical biases and gaps in previous research and suggests directions for future research through a juxtaposition of central literature.

2. Methodology and data collection

Scholarly citations of research documents has been taken to indicate, among other things, the recognition

HICSS

and engagement with ideas contained in the document [28]. Consequently, when several authors co-cite a number of documents this may indicate peer recognition of concepts, fields, and approaches [28, 44]. DCA is a bibliometric method that "may enhance transdisciplinary pursuits by helping scholars and practitioners to identify peer-recognized documents and communities of scholarship" [50:4]. A DCA can help to identify the organization of the most important research contributions in different fields of study, examine whether these fields interact, and reveal potential gaps in research [1]. For the purposes of this paper, DCA is used to identify central literature in diverse fields of research and examine the interaction between them. The identification and mapping of research streams reveal the emergent citation-based structure of scholarly intellectual activity.

Citation metrics are generally assumed to be a reflection of a publication's quality through exposure and influence [45, 51]. Meanwhile, others propose that citation numbers should not be assumed to reflect quality but rather be considered a measure of visibility [14, 54] inherently stacking the odds of being noticed against novel ideas challenging paradigmatic papers that have a head start in accumulating citations [2]. Further, publications in open access journals tend to get cited to a larger extent than closed ones providing a potential obstacle by journals charging authors publication fees which may impact whose research is easily accessible and thus easily citable [39]. Finally, patterns of citation have been found to differ between scholarly fields and types of papers (e.g. theoretical, method, empirical) [10, 48].

This paper makes use of two software packages: Microsoft Excel to collect, clean and organize both the collected data and co-citation tables; and VOSviewer version 1.6.11 [17] to create, visualize and examine scientific bibliometric networks. VOSviewer (VOS being an acronym for Visualization of Similarities) is a free, freely distributed, but copyrighted "software tool for constructing and visualizing bibliometric networks" developed by van Eck & Waltman [13]. VosViewer uses tab delineated or network bibliographic data files to produce bibliometric networks using factors such as citation, co-citation, or co-authorship [17]. The software also allows for the construction of network visualizations based on co-occurrences of certain terms in a corpus through its text mining functionality. The software allows for and assists with visual analysis of scientific relations by constructing networks where the proximity of nodes indicates stronger association and where the size of nodes and lines (edges), representing different metrics, make up the units of study.

VosViewer allows for a great deal of customization of data analysis through the application of threshold values and visualization metrics which determine what variables to include and how to weight them in an analysis. In this study, VosViewer's default values for analysis of documents were used to the largest extent, where the analysis deviated from this approach it is indicated and explained.

Following the approach of Appio et al. and Mascarenhas et al. [1, 30], clusters are identified through the DCA and the five most central articles of each cluster are presented in order to give an overview and understanding of each knot of references. While this paper does not present a review of the identified literature, its aim is complementary to creating a theoretical understanding of an interdisciplinary area of research. This paper paves the way for a full review aimed at understanding disparate streams of literature over a long period of time by using documents as its unit of study in the co-citation analysis [50] in lieu of a journal or author related analysis [40].

Since innovation vis-à-vis digital technology in the public sector is a phenomenon that is laid claim to by a wide variety of academic disciplines there is a need to go beyond the confines of any field-specific journals to create an overview of the state of research. While this approach may yield scattershot search results, the DCA method helps to organize and clarify what constitutes the established scholarly discourses within these results [1, 50]. This provides a complementary approach to handling Webster & Watson's [55] identified complexity of performing literature reviews in the diverse IS discipline.

The concept of innovation (in both research and practice) has been criticized for using the notion as a throwaway term for creativity, knowledge, or change [15]. This paper acknowledges this as a feature of extant research in its bibliometric analysis (and thus performs no screening for such use) yet recognizes that offhand acceptance of the use of the term does not add to a clearer distinction. Still, this carries into the data collection where any of the different search terms may be used in a passing manner in titles or abstracts. Because the included references have not been manually screened for relevance, the bearing of the included papers cannot be guaranteed. However, the method of this paper aims to map the underlying co-citation networks in the scholarly practice of studying innovation dealing with digital technology in a public sector context. The resulting co-citation structure, as well as the identified streams of literature, contribute to this goal irrespective of prior theoretical clarity.

Data collection was performed 2019-04-24 on the Web of Science website through a keyword topic search. To gather data, three search strings were combined in the following order: (digital innovat*) OR ("e-govern*") AND (innovat*"). The asterisks were

included in order to allow for variations on the terms innovation, (i.e. innovative, innovativeness), e-government, and e-governance. The search was performed with quotation marks in order to identify a tighter coupling between the search terms of individual search strings. The search for peer-reviewed articles and proceeding papers yielded 1082 results spread between 670 outlets between 1997 and 2019 in total. The most frequent document type was article (n=569), followed by proceeding papers (n=479), and lastly, items classified as both proceeding papers and articles due to initial conference presentation (n=34). The three journals with the most publications were Government Information Quarterly (n=61), American Review of Public Administration (n=9), and MIS Quarterly (n=9).

Records were downloaded containing data on author, title, source, abstract, as well as a full record of documents with references cited for each document. This allows for analysis of both bibliographical metrics and relations as well as of text contained in abstract and titles. Records were saved in a tab-delimited csv format in order to be processed in the VOSviewer and Microsoft Excel software packages.

3. Findings

Below, results are presented from the performed initial citation and the subsequent co-citation analysis.

This is followed by a descriptive summary of the identified clusters and the five most highly cited documents in each cluster as identified in the CDA.

3.1. Citation and document co-citation analysis

According to the Web of Science Core Collection citation count (as per 2019-04-24), out of the 1082 identified documents 517 (47,7 percent) documents have no citations and 398 (36,7 percent) have received less than ten citations. Table 1 presents the ten most highly-cited of the identified documents. An examination of the abstracts of the ten most highly cited documents reveal that six documents explicitly address e-government [12, 24, 27, 32, 41, 42] while one document proposes a shift toward service-dominant theory for public service management [38]. Two documents adopt an explicit DI perspective [59, 60] and one document discusses service innovation in the digital age [29]. Between the sampled 1082 documents relating to e-government and innovation or DI research, a total of 32 966 references are used, which forms the basis for the co-citation analysis.

VosViewer suggest a standard value of 20 citations for inclusion in a co-citation network, this threshold was adopted which included 48 documents in the analysis. One centrally-located document regarding theory building from case studies, and, conforming to

Table 1 Ten most highly cited articles*

#	Article	Authors	Journal	Total citations*
[12]	**The utilization of e-government services: citizen trust, innovation and acceptance factors**	Carter, L., & Bélanger, F. (2005)	Information Systems Journal	626
[60]	**Research Commentary — The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research**	Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010).	Information Systems Research	243
[29]	**Service innovation: A service-dominant logic perspective**	Lusch, R. F., & Nambisan, S. (2015)	MIS Quarterly	225
[59]	**Organizing for Innovation in the Digitized World**	Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012)	Organization Science	206
[38]	**A New Theory for Public Service Management? Toward a (Public) Service-Dominant Approach**	Osborne, S. P., Radnor, Z., & Nasi, G. (2013)	The American Review of Public Administration	189
[32]	**Does managerial orientation matter? The adoption of reinventing government and e-government at the municipal level**	Moon, M. J., & Norris, D. F. (2005)	Information Systems Journal	181
[41]	**e-Government Adoption Model (GAM): Differing service maturity levels**	Shareef, M. A., Kumar, V., Kumar, U., & Dwivedi, Y. K. (2011)	Government Information Quarterly	154
[27]	**Factors influencing intention to use e-government services among citizens in Malaysia**	Lean, O. K., Zailani, S., Ramayah, T., & Fernando, Y. (2009)	International Journal of Information Management	153
[42]	**Synthesizing e-government stage models – a meta-synthesis based on meta-ethnography approach**	Siau, K., & Long, Y. (2005).	Industrial Management & Data Systems	143
[24]	**Gauging e-government: A report on implementing services among American cities**	Kaylor, C., Deshazo, R., & Van Eck, D. (2001)	Government Information Quarterly	131
* According to the Web of Science Core Citation index as per 2019-04-24				
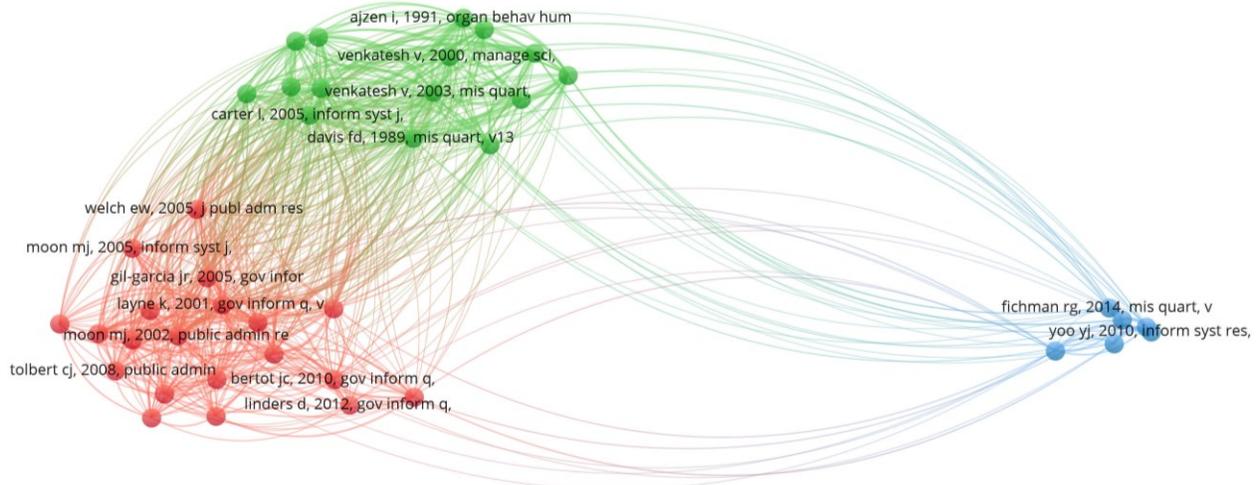
Figure 1 Visualization of document co-citation network

the initial search criteria, six books were omitted from analysis further winnowing down the co-citation network to include 41 documents.

The software supported DCA reveals three main clusters (see figure 1) of related literature where clusters one (bottom-left) and two (top-left) are found to be related to a significant extent while the third (middle-right) cluster stands pointedly away from both clusters of research. The co-citation analysis thus indicates three distinct fields of research where there is noteworthy conversation (in the form of co-citation) between the two left-hand side clusters while exchange with the right-hand side cluster is seen to be limited.

Below, the three identified clusters of the CDA are described and the top five most central documents, as stated by VosViewer's calculations of both link and citation strength, of each identified cluster (tables 2-4) are summarized in order to provide an overview of the foundations to studying innovation within an e-government context and its relationship to DI research.

3.1.1. Cluster 1: E-government diffusion and effects.
The first identified cluster (bottom-left in Figure 1) of

co-cited research is the one most clearly identifiable as dealing with e-government issues. All the five most central documents (table 2) are recognized as primarily dealing with issues in the public sector. E-government is presented as an emergent phenomenon and articles focus on the diffusion, impacts, and barriers of digital technology in the public sector. All documents are published in a four-year period between 2001 and 2005.

Using examples from government websites and e-government initiatives Layne & Lee [26] describe four stages of e-government growth with descriptions of technological and organizational challenges in each stage. The stages are cataloging; transaction; vertical integration; and horizontal integration. These stages are described as evolutionary and moving along the axis of simple to complex technological and organizational complexity, and from sparse to complex integration of processes between functions and levels of government. Three fundamental issues are raised for all levels: universal access; privacy and confidentiality and; citizen focus in government management.

Moon [31] concludes that early e-government

Table 2 Central articles of cluster 1

#	Article	Authors	Journal	Objective
[26]	**Developing fully functional E-government: A four stage model**	Layne, K., & Lee, J. (2001)	Government Information Quarterly	Describe four developmental stages of e-government growth and its challenges
[31]	**The Evolution of E-Government among Municipalities: Rhetoric or Reality?**	Moon, M. J. (2002)	Public Administration Review	Examine municipal e-government implementation and assess its perceptual effectiveness
[56]	**E-Government and the Transformation of Service Delivery and Citizen Attitudes**	West, D. M. (2004)	Public Administration Review	Assess the consequences of e-government for service delivery, democratic responsiveness, public attitudes
[47]	**Reinventing Local Governments and the E-Government Initiative**	Tat-Kei Ho, A. (2002)	Public Administration Review	Examine whether a shift from a traditional bureaucratic paradigm to an e-government paradigm is underway
[35]	**Advancing E-Government at the Grassroots: Tortoise or Hare?**	Norris, D. F., & Moon, M. J. (2005)	Public Administration Review	Examine adoption, sophistication, impacts, and barriers to e-government

efforts by municipalities had yet to yield expected results of efficiency. Further, it is suggested that a lack of financial, technical, and personnel capacities as well as legislative issues form barriers to improvements. City size and professional administrator (as opposed to political) council government is found to be positively correlated with the use of municipal web sites.

Studying budget and survey data as well as the content and functionality of government websites West [56] states that e-government has achieved some of its transforming potential on government service delivery while emphasizing the infancy of this transformation. Referring to unspecified research, the paper presents a stages of e-government transformation model similar to that of Layne & Lee [26] but with a further emphasis on interactive democracy. West suggests that challenges to "harness the transforming power of the internet" [56:24] lies in a streamlining of technology offerings, cooperation among government, visibility of digital government services, and giving these issues a budgetary priority.

Through a content analysis of government websites and surveys to webmasters Tat-Kei Ho [47] concludes that many cities are moving away from a traditional bureaucratic paradigm to an e-government paradigm by developing web-based "one-stop-shops" for government services, utilizing customer-centric design principles for their websites, and by emphasizing external collaboration and networking rather than technocratic push in their development processes

Finally, using survey data Norris & Moon [35] builds upon the findings of Moon's previous study in that deployment of government websites is moving rapidly and reaffirms the previously identified barriers.

Among the top five most central papers in the first cluster, frequent co-citations are seen with all the top five papers of the second cluster. Meanwhile, West [56] constitutes the only bridge of co-citation with any

of the central papers from the third cluster.

3.1.2. Cluster 2: Technology acceptance and adoption. The second cluster (top-left in Figure 1) identified through the DCA represents a stream of research clearly situated within an established Technology Acceptance Model (TAM) IS tradition where the five most central articles (table 3) all deal with issues of adoption and acceptance of technologies. One of these explicitly dealing with acceptance in an e-government context. Of the top five documents, two are published around the turn to the 1990s while the remaining three were published in the early to mid-oughts. Due to their level of historical interdependence, the identified papers are summarized chronologically, instead of by centrality as presented in table 3.

In order to understand and mitigate "users' unwillingness to accept and use available [computer] systems" [16:319] Davis develops and validates scales for measuring perceived usefulness and perceived ease of use. These variables are found to have a significant correlation with self-reported current usage and self-predicted future usage.

With a basis in literature on the diffusion of innovation Moore & Benbasat [33] construct and validate an instrument to measure perceptions of using an IT innovation in organizational work. The developed constructs are: relative advantage; compatibility; ease of use; result demonstrability; image; Visibility; trialability; and voluntariness.

In 2000 Venkatesh & Davis [53] extend the original TAM by introducing social influence and cognitive instrumental processes as mediating factors to one of the initial central notions behind the intention to use; perceived usefulness. This extension is labeled TAM2.

In 2003, the proliferation of user acceptance models motivated the review and synthesis of said models [52]. The result is the unified theory of acceptance and

Table 3 Central articles of cluster 2

#	Article	Authors	Journal	Objective
[12]	**The utilization of e-government services: citizen trust, innovation and acceptance factors**	Carter, L., & Bélanger, F. (2005)	Information Systems Journal	Understand and construct a model of the factors that influence citizen adoption of e-government innovations
[16]	**Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology**	Davis, F. D. (1989).	MIS Quarterly	Develop and validate new scales for perceived ease of use and usefulness of computers in order to predict user acceptance
[52]	**User Acceptance of Information Technology: Toward a Unified View**	Venkatesh, Morris, Davis, & Davis. (2003).	MIS Quarterly	Formulate and validate a unified model of user acceptance and use of technology-based on a review and comparison of extant models
[53]	**A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies**	Venkatesh, V., & Davis, F. D. (2000).	Management Science	Extend and validate the Technology Acceptance Model factoring in social influence and cognitive instrumental processes
[33]	**Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation**	Moore, G. C., & Benbasat, I. (1991).	Information Systems Research	Develop and validate an instrument to measure how the perception of an IT innovation explains adoption in organizational work

use of technology (UTAUT) which posits that there are four key factors explaining the intention and subsequent use of new technology: performance expectancy; effort expectancy; social influence; and facilitating conditions.

Combining constructs from TAM, diffusion of Innovations, and web trust model, Carter & Bélanger [12] find that perceived ease of use, compatibility and trustworthiness explain 85,9% of the variance in citizens intention to use e-government services. Factors not seen to have a significant impact on intention to use were perceptions of image and the perceived relative advantage of using the same services.

Mirroring the first identified clusters patterns of co-citation amongst the five most central papers, couplings are tighter between the second and first cluster than the second and the third cluster. Except for Carter and Bélanger [12], connections exist between all the top five papers of cluster two and most of the central papers of cluster 3.

3.1.3. Cluster 3: Digital innovation and infrastructures.
The third cluster (middle-right in Figure 1) of the DCA represents research addressing the theoretical currents on DI and digital infrastructures where three of the five most central articles (table 4) are explicitly defining and delineating DI as a concept. The central articles of the third cluster are exclusively conceptual except for Boland et al. [9].

According to Yoo et al. [60], persistent digitalization of products has produced a new form of product architecture: the layered modular architecture that loosely couples the technological layers of devices, networks, services, and contents. This loose coupling enables DI as a flexible process of recombining digital and physical components, thus facilitating unprecedented generativity in doubly distributed networks.

Building on the previous article, Yoo et al. [59] articulate DI as making use of convergences of disparate digital capabilities into artifacts and digital technologies capacity toward generativity through enduring malleability. These characteristics produce three important qualities in processes and outcomes of DI: digital technology platforms; distributed innovations; and combinatorial innovation. The presented challenges to organizations adopting DI lies in fundamentally changing their organization and their organizing logics.

Tilson et al. [49] call for greater recognition and theorizing of digital infrastructures as a specific type of IT artifact enabling generativity through features such as openness, unboundedness, and heterogeneity. An appreciation of the evolution of infrastructures is thought to lie in paradoxes of change and control. Further, researchers are encouraged to acknowledge how infrastructural change impacts IT governance and IS development in ways that have previously gone unrecognized.

Emphasizing the centrality of digitalization, Moore's law, and network effects Fichman et al. [18] frame DI as the IT-enabled change outcome (product, process, or business model) of a DI process involving the stages discovery, development, diffusion, and impact. To prepare students for the future, DI is proposed as a fundamental concept for IS education.

Studying the adoption of a tool for 3d-representation in an architecture firm Boland et al. [9] explain how this technology introduction led to wakes of innovation in an associated network of firms by creating innovation trajectories and trading zones for heterogenous actors.

Table 4 Central articles of cluster 3

#	Article	Authors	Journal	Objective
[60]	**Research Commentary — The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research**	Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010)	Information Systems Research	Develop a framework describing the organizing logic of digital innovation and advance an IS research agenda on digital strategy and management of IT infrastructures
[59]	**Organizing for Innovation in the Digitized World**	Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012)	Organization Science	Examine organizational research implications of digital platforms, distributed innovations, and combinatorial innovation
[49]	**Research Commentary: Digital Infrastructures: The Missing IS Research Agenda**	Tilson, D., Lyytinen, K., & Sørensen, C. (2010)	Information Systems Research	Put digital infrastructures at the center of research by recognizing infrastructures as: a type of IT artifact; a relational construct; related to paradoxes of change and control
[18]	**Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum**	Fichman, R. G., Dos Santos, B. L., & Zheng, Z. (Eric). (2014)	MIS Quarterly	Advance a vision of digital innovation as a fundamental and powerful concept for the IS curriculum
[9]	**Wakes of Innovation in Project Networks: The Case of Digital 3-D Representations in Architecture, Engineering, and Construction**	Boland, R. J., Lyytinen, K., & Yoo, Y. (2007)	Organization Science	Explain how changes in technologies of representation spark complex patterns of innovation in technologies, practices, structures, and strategies

Out of the five most central articles, Fichman et al. [18] and Yoo et al. [59] form the existing bridges to the central papers of the other clusters of literature as they have been co-cited with references from both groups.

4. Discussion and directions for future research

This paper presents a Document co-citation analysis of the scientific literature on e-government treatments of innovation and its connection to the growing stream of information systems research on DI. The following discussion suggests that future research on digital innovation in the public sector should adopt modern technology conceptualizations in order to account for processes of recombination and generativity, and that organizational implications of DI should inform issues of technology development, adoption, and barriers within a government context.

This DCA shows that research on innovation in the field of e-government primarily has drawn upon an intellectual tradition of technology acceptance and diffusion models when looking for outside influence. This partially reflects Bannister & Grönlund's [4] characterization of the field's historical focus. While the clusterization displayed in Figure 1 to some extent reflects a division of disciplinary knowledge as explained by Burawoy [11], it is clear that extant research on innovation in e-government contexts to date seems to have been dominated by a theoretical bias toward an acceptance and adoption perspective. Although technology acceptance is a quintessential body of IS theory and clearly has been utilized to further the understanding of technology adoption in government contexts, it is not uncontroversial. TAM (and its extensions) has been criticized for conflating intention to use with actual use, ignoring social aspects and emotions, as well as for its deterministic tendencies [3]. If e-government research is to continue drawing on this stream of literature these issues should be acknowledged and addressed explicitly.

While historically, the study of innovation in the field of e-government has had close ties with models of technology acceptance drawing upon other bodies of literature could further research. Though innovation in a public context could be considered an essentially separate phenomenon from innovation within a for-profit context (i.e. a different relationship to principles of universality or funding), the argument has been made for drawing on other streams of research [38]. Further exchange could certainly be had with the budding field of DI both through assimilation and critique. Interaction between clusters 1 and 3 in the form of co-citations exist with the newer stream of literature on DI, however, most of this exchange is

taking place away from what seems to be the core literature of the e-government field. Likewise, research utilizing literature on DI has not engaged with e-government literature to a large degree. The primary, emerging, connections lie with Fichman et al, and Yoo et al. [18, 59] and not with, for instance, Yoo et al. [60] indicating that the impactful notion of a layered modular architecture as a prerequisite for flexible and generative DI has not yet had an impact on e-government research.

The first two streams of research's´ characterization of digital technology as discrete and stable in order to promote acceptance stands in sharp opposition to the view of research stream 3 where digital technology is characterized as emergent, fluid, and recombinable. For example, one of the contributions from Carter & Bélanger in the second cluster states that "Online services should resemble traditional government services to encourage citizen acceptance. For instance, if a state agency makes tax filing available online, the agency should present a form that resembles the more familiar paper-based tax forms" [12:21]. This stands in stark contrast to the call in current research for digital public services that move beyond the traditional notion of digitized forms [22]. DI literature speaking to the notion of recombination [21] or generativity [58] could inform both practice and future studies of innovation in the public sector. A, further review of e-government technology conceptualizations, akin to Orlikowski & Iacono [37], could be highly informative.

While technology acceptance models may provide methods for verification or design of digital public services, they provide little guidance for practitioners and researchers as to questions of generativity and recombination that is instrumental from the perspective of DI. While still an emerging line of inquiry, DI literature is currently providing both theoretical and managerial implications that could be useful in research and practice for the public sector. For example, insights on digital service platform evolution [43] should be worth notice by both researchers and practitioners interested in interactive democracy [56] or different types of digital public service platforms.

While the central literature of Cluster 1 has an understandable bias toward issues of initial adoption (due to many e-government initiatives being in their infancy at their time of publication) it also discusses barriers [31, 35, 56], tied to issues of finances, legislation, and technological personnel capabilities. Among other things, Tat-Kei Ho [47] identifies external collaboration and networking as a factor for successful transformation, mirroring the assertions of Yoo et al. [59] that innovation is a distributed process where the integration of heterogeneous knowledge resources is a requisite for DI. Further, the citation

analysis identifies Lusch & Nambisan [29] as a highly cited article that presents a holistic service ecosystem perspective on innovation, incorporating social and cognitive aspects, as well as regulatory analysis of both technological and organizational rules. This article did not appear in the DCA, though its contributions has previously been argued to be of relevance to public sector research [19, 22]. The identification of these issues speaks to the use of cross-disciplinary analysis.

When looking for further bridges into or from e-government literature, more peripheral references (in the clusters), such as Bertot et al. [8], seem more likely to constitute a bridge between the scientific domains. As these have been published for a shorter amount of time, they have not had the same chance to accumulate (co-) citations and are thus less visible in this DCA. However, as the citation analysis reveals, the rapid adoption of ideas presented within the third cluster may be an indicator of their potential to have an impact on adjacent fields of research if its ideas are integrated.

Further qualitative and quantitative review of the identified literature could give nuance to the initial findings presented in this paper. The ambition of this paper is not to provide a complete review of the content of the documents identified in this analysis, as that, in and of itself, would require extensive content analysis [57] beyond the scope of this paper. However, the literature identified through this DCA could form the base of such future analysis. Beyond further content analysis of the identified scholarly literature, additional quantitative co-citation analyses in the vein of Appio et al. [1] and White & Mccain [57] could provide further detail as to the growth and interrelations between the identified clusters A more focused analysis with lower thresholds for inclusion on any of these clusters would reveal further nuances and insights among the identified clusters. However, space limitations place such a contribution beyond the scope of this paper. Worth note is that a more inclusive trial run of network visualizations provided largely the same network structure.

In their review of innovation literature Crossan & Apaydin [15] argue for the exclusion of innovation literature on the diffusion of innovations as it is considered a process taking place after innovation. The focus of much of the identified literature in the analysis on adoption and diffusion implies that there historically has been a tilt toward what could be considered innovation post factum. However, as evidenced by a recent review [23] of DI literature, distinctions of innovation process and outcome may be less applicable when studying or performing DI. This could pave the way for new lines of inquiry regarding the adoption and acceptance of ever-evolving digital technology in the public sector.

Finally, while the finding that 517 (47.7 percent) of the initially identified documents had not been cited at all was not a part of the aim of this paper, it is worth note that a substantial part of the examined body of research has not been further built upon. This in itself may indicate a need for a theoretical reorientation.

5. Limitations and conclusions

Some limitations apply to this bibliometric analysis. Firstly, the Web of Science was the only research repository used for data collection. While it is one of the largest databases on scholarly production issues have been raised regarding the indexation of non-English language research [2], and high-impact research [50] which may produce a skewed view on any body of knowledge. Furthermore, co-citation as a methodological metric assumes that citations indicate a deliberate and positive subscription to the ideas in the cited document by the citing author(s) [28]. Leydesdorff [28] point out that citations may be included for a plethora of reasons including social and cognitive. Therefore, future studies should also examine *how* references are used.

Research on information technology in the public sector has long been conducted but not always under the banner of e-government [4]. The narrow scope of the initial topic search may omit such research. The search could have been broadened but the previously mentioned issues of screening results for relevance would have been compounded from the inclusion of further keywords. However, the identification and mapping of cluster 2 as a classic IS cluster suggests that the DCA should have identified relevant literature addressing the public sector even if the primary audience lies outside of journals more clearly aimed at e-government research (e.g. Government Information Quarterly or Public Administration Review).

It could be argued that the inclusion of disparate disciplinary fields of research in any one bibliographic co-citation analysis would produce similar results, with some bodies of literature more closely related than others. However, the relatively high metrics for inclusion in the analysis and the demonstrable, weak but budding, connections between these fields of research illustrate the relevance of the analysis at hand. Considering the prior identification of literature on DI as relevant for the e-government field, this paper illustrates and strengthens the argument for more bridges between these streams of research. Further, this paper illustrates an approach for developing similar cross-disciplinary analyses of political science and open innovation found necessary by Bekkers [6] as well as by Heeks & Bailur [20].

This document co-citation analysis maps the underlying and evolving intellectual structure of research on digital innovation (DI) in the public sector and concludes that e-government research to date has relied heavily on technology acceptance models and measures of diffusion in its study of innovation. Further, nascent but growing interaction is seen between the fields of e-government and DI. However, notable gaps between scientific fields are identified. In particular, DI literature's perspective on digital technology and the processes surrounding their development and use as fluid and evolving has had little impact on the study of innovation in e-government. Future research should draw upon the impactful notions of recombination and generativity, as well as consider the organizational implications of DI, in order to address pressing practical and theoretical issues of innovation the public sector.

6. References

[1] Appio, F.P., F. Cesaroni, and A. Di Minin, "Visualizing the structure and bridges of the intellectual property management and strategy literature: a document co-citation analysis", *Scientometrics 101*(1), 2014, pp. 623–661.

[2] Archambault, É., and V. Larivviére, "The limits of bibliometrics for the analysis of the social sciences and humanities literature", In UNESCO, ed., *World social science report: Knowledge Divides*. Unesco Publ, Paris, 2010.

[3] Bagozzi, R., "The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift.", *Journal of the Association for Information Systems 8*(4), 2007, pp. 244–254.

[4] Bannister, F., and Å. Grönlund, "Information Technology and Government Research: A Brief History", (2017).

[5] Barrett, M., E. Davidson, J. Prabhu, and S.L. Vargo, "Service innovation in the digital age: key contributions and future directions", *MIS quarterly 39*(1), 2015, pp. 135–154.

[6] Bekkers, V., "Why does e-government looks as it does? looking beyond the explanatory emptiness of the e-government concept", *Information Polity: The International Journal of Government & Democracy in the Information Age 17*(3/4), 2012, pp. 329–342.

[7] Bertot, J., E. Estevez, and T. Janowski, "Universal and contextualized public services: Digital public service innovation framework", *Government Information Quarterly 33*(2), 2016, pp. 211–222.

[8] Bertot, J.C., P.T. Jaeger, and J.M. Grimes, "Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies", *Government Information Quarterly 27*(3), 2010, pp. 264–271.

[9] Boland, R.J., K. Lyytinen, and Y. Yoo, "Wakes of Innovation in Project Networks: The Case of Digital 3-D Representations in Architecture, Engineering, and Construction", *Organization Science 18*(4), 2007, pp. 631–647.

[10] Bornmann, L., and H. Daniel, "What do citation counts measure? A review of studies on citing behavior", *Journal of Documentation 64*(1), 2008, pp. 45–80.

[11] Burawoy, M., "Open the social sciences: To whom and for what?", *Portugese Journal of Social Sciences 6*, 2007, pp. 137–146.

[12] Carter, L., and F. Bélanger, "The utilization of e-government services: citizen trust, innovation and acceptance factors", *Information Systems Journal 15*(1), 2005, pp. 5–25.

[13] Centre for Science and Technology Studies, Leiden University, "VOSviewer - Visualizing scientific landscapes", *VOSviewer*, 2018. http://www.vosviewer.com//

[14] Chiu, W.-T., and Y.-S. Ho, "Bibliometric analysis of tsunami research", *Scientometrics 73*(1), 2007, pp. 3–17.

[15] Crossan, M.M., and M. Apaydin, "A Multi Dimensional Framework of Organizational Innovation: A Systematic Review of the Literature", *Journal of Management Studies*, 2010, pp. 11541191.

[16] Davis, F.D., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology", *MIS Quarterly 13*(3), 1989, pp. 319.

[17] van Eck, N.J., and L. Waltman, "Visualizing Bibliometric Networks", In Y. Ding, R. Rousseau and D. Wolfram, eds., *Measuring Scholarly Impact*. Springer International Publishing, Cham, 2014, 285–320.

[18] Fichman, R.G., B.L. Dos Santos, and Z. (Eric) Zheng, "Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum", *MIS Quarterly 38*(2), 2014, pp. 329–343.

[19] Hedlund, H., "Architecting Structural Flexibility in Design Processes – a Case Study of Public Sector Digital Innovation", *Proceedings of the 27th European Conference on Information Systems (ECIS)*, (2019).

[20] Heeks, R., and S. Bailur, "Analyzing e-government research: Perspectives, philosophies, theories, methods, and practice", *Government Information Quarterly 24*(2), 2007, pp. 243–265.

[21] Henfridsson, O., J. Nandhakumar, H. Scarbrough, and N.S. Panourgias, "Recombination in the Open-Ended Value Landscape of Digital Innovation", *Information and Organization*, 2018.

[22] Holgersson, J., I. Lindgren, U. Melin, and K. Axelsson, "Not another new wine in the same old bottles: motivators and innovation in local government e-service development", *25th European Conference on Information Systems (ECIS 2017), Guimarães, Portugal, 5-10 June 2017*, (2017).

[23] Hund, A., K. Drechsler, and V.A. Reibenspiess, "The current state and future opportunities of digital innovation: a literature review", 16.

[24] Kaylor, C., R. Deshazo, and D. Van Eck, "Gauging e-government: A report on implementing services among American cities", *Government Information Quarterly 18*(4), 2001, pp. 293–307.

[25] Kohli, R., and N.P. Melville, "Digital innovation: A review and synthesis", *Information Systems Journal*, 2018.

[26] Layne, K., and J. Lee, "Developing fully functional E-government: A four stage model", *Government Information Quarterly 18*(2), 2001, pp. 122–136.

[27] Lean, O.K., S. Zailani, T. Ramayah, and Y. Fernando, "Factors influencing intention to use e-government services

among citizens in Malaysia", *International Journal of Information Management 29*(6), 2009, pp. 458–475.

[28] Leydesdorff, L., "Theories of citation?", *Scientometrics*(43), 1998, pp. 5–25.

[29] Lusch, R.F., and S. Nambisan, "Service innovation: A service-dominant logic perspective", *MIS Quarterly: Management Information Systems 39*(1), 2015, pp. 155–175.

[30] Mascarenhas, C., J.J. Ferreira, and C. Marques, "University–industry cooperation: A systematic literature review and research agenda", *Science and Public Policy 45*(5), 2018, pp. 708–718.

[31] Moon, M.J., "The Evolution of E-Government among Municipalities: Rhetoric or Reality?", *Public Administration Review 62*(4), 2002, pp. 424–433.

[32] Moon, M.J., and D.F. Norris, "Does managerial orientation matter? The adoption of reinventing government and e-government at the municipal level", *Information Systems Journal 15*(1), 2005, pp. 43–60.

[33] Moore, G.C., and I. Benbasat, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation", *Information Systems Research 2*(3), 1991, pp. 192–222.

[34] Nambisan, S., K. Lyytinen, A. Majchrzak, and M. Song, "Digital Innovation Management: Reinventing Innovation Management Research in a Digital World", *MIS Quarterly 41*(1), 2017, pp. 223–238.

[35] Norris, D.F., and M.J. Moon, "Advancing E-Government at the Grassroots: Tortoise or Hare?", *Public Administration Review 65*(1), 2005, pp. 64–75.

[36] Nylén, D., and J. Holmström, "Digital innovation strategy: A framework for diagnosing and improving digital product and service innovation", *Business Horizons 58*(1), 2015, pp. 57–67.

[37] Orlikowski, and Iacono, "Research Commentary: Desperately Seeking the 'IT' in IT Research—A Call to Theorizing the IT Artifact", *Information Systems Research 12*(2), 2001, pp. 121–134.

[38] Osborne, S.P., Z. Radnor, and G. Nasi, "A New Theory for Public Service Management? Toward a (Public) Service-Dominant Approach", *The American Review of Public Administration 43*(2), 2013, pp. 135–158.

[39] Perakakis, P., M. Taylor, and V. Trachana, "Roads to open access", In UNESCO, ed., *World social science report: Knowledge Divides*. Unesco Publ, Paris, 2010.

[40] Rowe, F., "What literature review is not: diversity, boundaries and recommendations", *European Journal of Information Systems 23*(3), 2014, pp. 241–255.

[41] Shareef, M.A., V. Kumar, U. Kumar, and Y.K. Dwivedi, "e-Government Adoption Model (GAM): Differing service maturity levels", *Government Information Quarterly 28*(1), 2011, pp. 17–35.

[42] Siau, K., and Y. Long, "Synthesizing e-government stage models – a meta-synthesis based on meta-ethnography approach", *Industrial Management & Data Systems 105*(4), 2005, pp. 443–458.

[43] Skog, D.A., H. Wimelius, and J. Sandberg, "Digital Service Platform Evolution: How Spotify Leveraged Boundary Resources to Become a Global Leader in Music Streaming", *Proceedings of the 51st Hawaii International Conference on System Sciences*, 2018, pp. 11.

[44] Small, H.G., "Cited Documents as Concept Symbols", *Social Studies of Science 8*(3), 1978, pp. 327–340.

[45] Smith, D.R., "Historical development of the journal impact factor and its relevance for occupational health", *Industrial health 45*(6), 2007, pp. 730–742.

[46] Svahn, F., L. Mathiassen, and R. Lindgren, "Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns.", *MIS Quarterly 41*(1), 2017.

[47] Tat-Kei Ho, A., "Reinventing Local Governments and the E-Government Initiative", *Public Administration Review 62*(4), 2002, pp. 434–444.

[48] Tijssen, R.J.W., and A.F.J. Van Raan, "Mapping Changes in Science and Technology: Bibliometric Co-Occurrence Analysis of the R&D Literature", *Evaluation Review 18*(1), 1994, pp. 98–115.

[49] Tilson, D., K. Lyytinen, and C. Sørensen, "Research Commentary: Digital Infrastructures: The Missing IS Research Agenda", *Information Systems Research 21*(4), 2010, pp. 748–759.

[50] Trujillo, C.M., and T.M. Long, "Document co-citation analysis to enhance transdisciplinary research", *Science Advances 4*(1), 2018.

[51] Ugolini, D., S. Bonassi, A. Cristaudo, G. Leoncini, G.B. Ratto, and M. Neri, "Temporal trend, geographic distribution, and publication quality in asbestos research", *Environmental Science and Pollution Research 22*(9), 2015, pp. 6957–6967.

[52] Venkatesh, Morris, Davis, and Davis, "User Acceptance of Information Technology: Toward a Unified View", *MIS Quarterly 27*(3), 2003, pp. 425.

[53] Venkatesh, V., and F.D. Davis, "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies", *Management Science 46*(2), 2000, pp. 186–204.

[54] Walter, G., S. Bloch, G. Hunt, and K. Fisher, "Counting on citations: a flawed way to measure quality", *The Medical Journal of Australia 178*(6), 2003, pp. 280–281.

[55] Webster, J., and R.T. Watson, "Analyzing the past to prepare for the future: Writing a literature review", *Management Information Systems Quarterly 26*(2), 2002, pp. 3.

[56] West, D.M., "E-Government and the Transformation of Service Delivery and Citizen Attitudes", *Public Administration Review 64*(1), 2004, pp. 15–27.

[57] White, H.D., and K.W. McCain, "Visualizing a discipline: An author co-citation analysis of information science, 1972–1995", *Journal of the American Society for Information Science 49*(4), 1998, pp. 327–355.

[58] Yoo, Y., "The Tables Have Turned: How Can the Information Systems Field Contribute to Technology and Innovation Management Research?", *Journal of the Association for Information Systems 14*(5), 2013, pp. 227–236.

[59] Yoo, Y., R.J. Boland, K. Lyytinen, and A. Majchrzak, "Organizing for Innovation in the Digitized World", *Organization Science 23*(5), 2012, pp. 1398–1408.

[60] Yoo, Y., O. Henfridsson, and K. Lyytinen, "Research Commentary — The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research", *Information Systems Research 21*(4), 2010, pp. 724–735.